KIRKWOOD
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TRAFFIC CALMING GUIDANCE

CITY OF KIRKWOOD

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PREPARED BY

alta
PLANNING + DESIGN

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INTRODUCTION

WHAT IS TRAFFIC CALMING?

Traffic calming is the practice of implementing interventions to reduce automobile speeds and volumes on a single street or street network for the purpose of encouraging safer, more responsible driving and improve safety for people driving, walking, and bicycling.

Traffic calming improves safety and livability primarily through physical measures on or adjacent to the street, and may also include programs, education, and other behavior change methods. Implemented measures intend to slow traffic to the posted speed limit and discourage unnecessary through traffic on neighborhood streets, while maintaining access for local residents, police, fire, and emergency services. The use of traffic calming may also include non-residential streets which are typically evaluated on a case-by-case basis through engineering studies and analysis.

Why Traffic Calming Guidance?

EnVision Kirkwood 2035 Comprehensive Plan, Action Step 3.B.1. recommends evaluating and updating current criteria and creating a procedure for the implementation of appropriate traffic calming techniques within the City. Kirkwood's residents stated their expectations for streets to be pedestrian–oriented and safe. Traffic Calming is one tool the City may employ to meet these expectations.

PURPOSE

COMMON TRAFFIC CALMING GOALS

The most common goals of traffic calming is improving the quality of life or livability in residential areas and increasing traffic safety and walkability in commercial areas. These goals are accomplished by reducing speeds of vehicular movement and controlling the volume of vehicular traffic.

Livability

Livability can be defined as a suitable and comfortable place for dwelling . Listed below are ways in which traffic calming can create livable spaces like these.

- **Enhanced aesthetic values and a sense of nature**: Traffic calming interventions, such as adding landscaping and amenities can both help create a sense of place and deter motorists from speeding.
- **Reduced crime**: Traffic calming has the potential to increase eyes on the street as more people walk and bike.
- **Decreased fuel consumption**: A safer right-of-way encourages more biking and walking, rather than using an automobile. This in-turn, cuts down fuel consumption for the users.
- **Improved experience of the street**: The reduction of car speed and volume allows people walking and biking to feel safe traveling along and across city streets.

Traffic Safety

A combination of traffic calming measures can decrease the probability of traffic related incidents and add to the improvement of traffic safety.

- **Decreased severity of injury in traffic crashes**: Slower car speeds cuts down the chances for fatal and severe traffic crashes and incidents
- **Equitable balance among transportation modes**: Managing the speed and volume of motorist allows other users to use the public right-of-way. This allows equal utilization of the roadway amongst all users.
- **Continued accommodation of motor vehicle traffic**: Traffic calming simultaneously provides safer modes of travel for non-motorists, while solving problems on the roadway for motorists. The goal is to make streets safe for all users and abilities (i.e pedestrians, bicyclists, transit users, and motorists).

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ADMINISTRATION PROCESS

PROCESS OVERVIEW

A structured and balanced process is key to achieving successful traffic calming implementation. The ideal process should respond to constituent needs and desires while applying the best technical judgment and understanding. Establishing a clear process and defining technical standards will help apply the process equitably throughout the community.

Transparent Process

Creating a transparent process requires easy to understand steps from project initiation to implementation, as well as well defined roles and responsibilities. This chapter and Chapter 4: Implementation outline detailed guidance for an open and interactive process to address perceived or real traffic concerns. Three basic steps are recommended:

- **Project Identification**
- **Project Evaluation**
- **Project Approval**
- **Project Implementation**

The initiation for a traffic calming program may be reactive or proactive, responding to citizen requests for action, or proactive, with City staff or elected officials identifying problems and initiating action preempting consequences. Once a potential project is identified, City staff requests a study to evaluate the eligibility of the potential project. If it is eligible, the project moves through the approval phase and onto implementation.

Questions to Consider

The questions below are just a few to consider while going through the process for implementing traffic calming measures:

- Which street or neighborhood receives attention when there are more requests than resources?
- Who defines the problem (staff, residents, politicians)?
- What solutions are eligible for an application and a given problem?
- How is a neighborhood traffic calming plan developed ?
- What is the approval process and the role of residents , emergency services, etc?
- What are the sources of funding (capital and maintenance)?
- How is a plan monitored and potentially modified?

PROJECT IDENTIFICATION

The project request may be initiated by residents, property owners, business owners, elected officials, or City staff.

Steering Committee Oversight

It is recommended the City establish an inter-departmental steering committee to oversee traffic calming identification and implementation. ***The Steering Committee may include elected officials, Street Division, Engineering, Planning and Zoning, Police and Fire Departments, School District, and the Parks and Recreation Department. This committee may also include advocates and/or other community representatives***.

The Traffic Calming Steering Committee will meet at least quarterly to review requests in the traffic calming process and assess potential project and implementation needing attention. The committee may identify priority areas based on crash data; recommend places to integrate traffic calming principles into appropriate policy documents, plans, project selection processes, design manuals and maintenance procedures; and collaborate with internal and external transportation stakeholders to identify performance measures and establish benchmarks.

New Development

Developers are encouraged to address traffic calming measures through alternate street designs as required by the City, implementing the measures outlined in the Institute of Transportation Engineers (ITE) informational report entitled “Traffic Calming State of the Practice,” and/or as directed by City Staff. City Staff may also initiate a traffic calming request for a proposed development.

Existing Development

A group of ten (10) or more owning residents from different households, individual property owners, or business owners from separate establishments in the affected area submit a letter to the City Engineer expressing interest in improving traffic conditions. For locations within a neighborhood association's jurisdiction, the association must submit a letter supporting the request. City employees will not be counted toward the qualifying number of signatures. Requests will be processed in the order received unless extenuating safety concerns necessitate immediate action.

The Traffic Calming Request Letter should describe the location and perceived traffic problems. A list with the minimum required qualified supporters must be included along with their signatures, relationship to the location (owning resident, property owner, or business owner), street addresses, telephone numbers, and email addresses. City staff may initiate a request for an existing documented speeding and traffic problem, or as recommended by the Traffic Calming Steering Committee.

City staff will verify the request's names and

addresses. After name and address verification, the City Engineer will review the traffic calming request. Education and enforcement may be effective non-physical traffic calming alternatives. When non-physical option are not effective, City Engineering will determination the project's classification as Minor, Typical, or Major Projects. Major Projects are ineligible for this process as these require more in-depth engineering evaluation, project development, and community engagement.

Upon initiation of a Minor or Typical project, a community meeting will be held at an accessible location. The community meeting must be advertised to those the traffic calming project could impact and listed on the City website for a minimum fifteen (15) days prior to the meeting. Documented meeting attendance of a minimum eighty-percent (80%) of the required request signatures is needed to move forward.

The community meeting will identify and validate concerns and establish a Traffic Calming Working Group. ***The Traffic Calming Working Group will be comprised of a minimum of three (3) representative community members which may include, but is not limited to, neighborhood trustees, residents, business owners, and/or property owners.*** The group will be tasked with supporting the City in organizing any future meetings, educating themselves of the project process, and regularly helping the City communicate with impacted community members throughout the process.

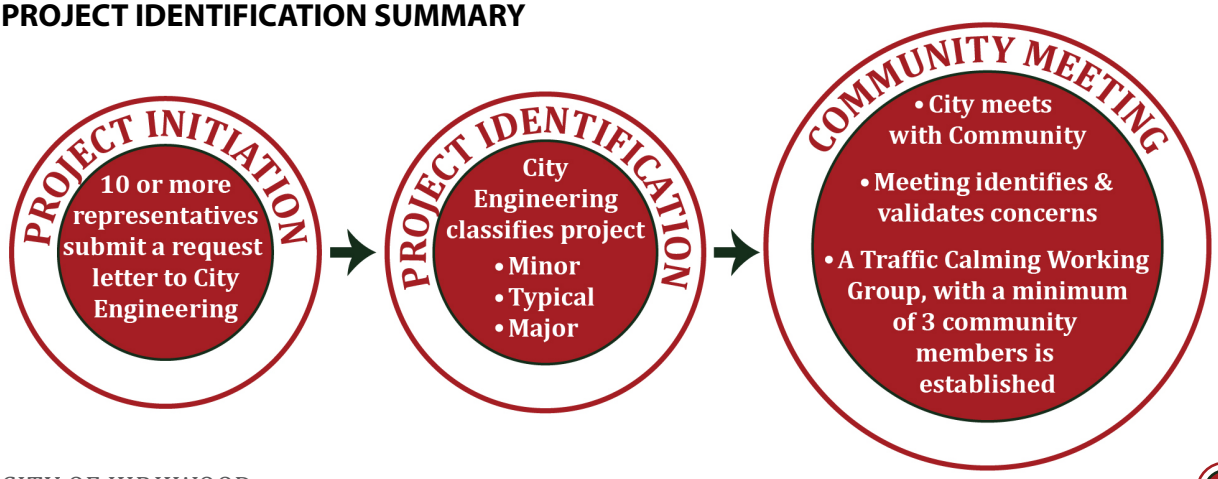
REQUEST LETTER CHECKLIST

- → Traffic Calming Request Letter with location & perceived traffic problem.
- → List of qualified supporters with names, signatures, relationships to identified location, street addresses, telephone numbers & emails.
- → Neighborhood association or HOA letter of support may be required.

COMMUNITY MEETING CHECKLIST

- → Secure an accessible meeting location.
- → Openly advertise to those the traffic calming project potentially impacts the date, time & meeting location a minimum 15 days prior to meeting.
- → List meeting details on City website a minimum 15 days prior to meeting.
- → Host & document a minimum of 80% of qualified supporters
- → Establish Traffic Calming Working Group with a minimum 3 representative community members.

PROJECT IDENTIFICATION SUMMARY

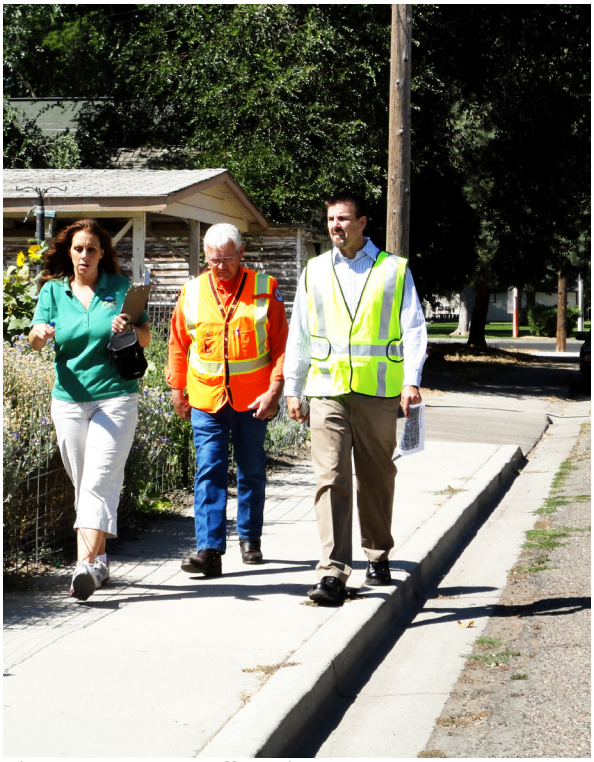


Eligibility

Often, a traffic study is needed to verify residents' concerns. When establishing eligibility, standards and/or guidelines apply. A street's measured traffic speed and volume are primary determining factors. Other factors include street classification, functionality, and adjacent land uses.

Traffic calming standard and guidelines for multiple peer communities in the region and nationally were reviewed and a range of approaches for determining project eligibility were identified. Two representative communities include the City of O'Fallon, Missouri, and Redwood City, California. The City of O'Fallon has traffic calming eligibility minimums. A speed study needs to demonstrate that the average speed is greater than 25 mph or the traffic volume must exceed 600 average daily traffic (ADT) for the roadway of concern. If one of these minimum criteria is not met, the roadway will not qualify for traffic calming consideration. Redwood City's policy includes a list of streets not eligible for traffic calming. The policy requires a study to determine the eligibility of the roadway for traffic calming.

These reviews, along with input from City staff, informed the eligibility standards and guidance presented in the table on the following page that will be part of the City of Kirkwood policy. The primary difference between a Minor and Typical project designation is street classification and/or traffic volumes. A Minor Project designation is only for local streets with a posted speed limit of 30 mph or less and below 1,500 in average daily traffic volumes. A Typical Project designation is for local or minor collector streets with a posted speed limit of 30 mph or less and between 1,500 and 5,000 in average daily traffic volumes. If all criteria within the Minor and Typical designations are not met, the City Engineer may consider the project request as a Major Project with justification.



The City reviews traffic calming requests to determine if physical traffic calming is appropriate. If it is necessary, the project is classified as a Minor, Typical, or Major project.

The City meets with the community to identify & validate concerns, then forms a Traffic Calming Working Group comprised of at least 3 community members to help steward the project process.

CITY OF KIRKWOOD ELIGIBILITY GUIDANCE

Minor Project	Typical Project	Major Project
Persistent speed problem: 85th percentile speed greater than 30 mph, or 60% of all vehicles exceed speed limit, or Average of top 15th percentile speeds observed is 40 mph.	Persistent speed problem: 85th percentile speed greater than 30 mph, or 60% of all vehicles exceed speed limit, or Average of top 15th percentile speeds observed is 40 mph.	Persistent speed problem: Posted speed of 35 mph or greater with: 85th percentile speed 10 mph or greater above posted speed limit, or 60% of all vehicles exceed speed limit.
Local street	Local or minor collector street	Arterial or collector street.
Streets with two travel lanes (with or without center turn lane).	Streets with two travel lanes (with or without center turn lane).	Street with more than two travel lanes.
Street width less than 40-feet.	Street width less than 40-feet.	Street wider than 40-feet
Satisfactory drainage.	Satisfactory drainage.	Poor drainage and/or ponding
Grade 5-percent or less at installation location.	Grade 5-percent or less at installation location.	Grades greater than 5 percent or sustained downgrade at installation location.
Straight and level roadway alignment, or Mild horizontal and/or vertical curves.	Straight and level roadway alignment, or Mild horizontal and/or vertical curves.	Less than 300-foot horizontal centerline radius horizontally, or Vertical curve with unsafe stopping sight distance.
Posted speed 30 mph or less	Posted speed 30 mph or less	Posted speed 35mph or more
Low volume streets below 1500 average daily traffic, or More than 60-percent cut through traffic.	Low volume streets between 1500 to 5000 average daily traffic, or More than 60-percent cut through traffic.	Moderate to high volume streets with more than 5,000 average daily traffic, or Less than 40-percent cut through traffic .
Streets with long wheel based vehicles (trucks) totaling less than 5-percent of traffic.	Streets with long wheel based vehicles (trucks) totaling less than 5-percent of traffic.	Streets with long wheel based vehicles (trucks) totaling greater than 5-percent of traffic.
Streets with occasional emergency vehicles operating at low to moderate speeds.	Streets with occasional emergency vehicles operating at low to moderate speeds.	Primary emergency vehicle circulation routes.
Street with infrequent or irregularly scheduled public transit, but may include school transit, paratransit.	Street with infrequent or irregularly scheduled public transit, but may include school transit, paratransit.	Conventional transit routes with regular or frequent service.

PROJECT APPROVAL

Education and enforcement may be effective non-physical traffic calming alternatives. If ineffective, City staff will determine a physical project's eligibility, location, and priority.

Approval Process

Once the identification process is complete and an eligible project is classified, City staff will analyze the data to establish the validity of the reported concern. If the roadway data confirms excessive speeds and/or safety concerns, staff may recommend the development of a traffic calming alternative.

Minor Project Approval Process

The below diagram illustrates an example Minor Project approval process. For Minor projects, City staff will collect crash data from the past three years, conduct a speed study, and traffic count to establish the validity of the reported concern. If the roadway data confirms excessive speeds and/or safety concerns, staff may recommend traffic calming options and establish the Traffic Calming Working Group. If City staff and the Traffic Calming Working Group agree on the traffic calming measure and location, ballots with the recommendation will be distributed to affected residents, property owners, and business owners to measure support. Should the project receive sixty-percent (60%) support, the project proceeds to implementation. If the project fails to secure sufficient support in two consecutive iterations, it is dropped from further consideration.

Typical Project Approval Process

The diagram, on page 11, illustrates an example Typical Project approval process. The process begins with City staff reviewing the roadway's functional classification, collecting crash data from the past three years, and conducting speed and volume studies to establish the validity of the reported concern. If the roadway data confirms

MINOR PROJECT APPROVAL PROCESS

excessive speeds and/or safety concerns, staff will identify potential traffic calming options and locations. Options will be evaluated to determine potential impacts. If necessary, additional information may be necessary.

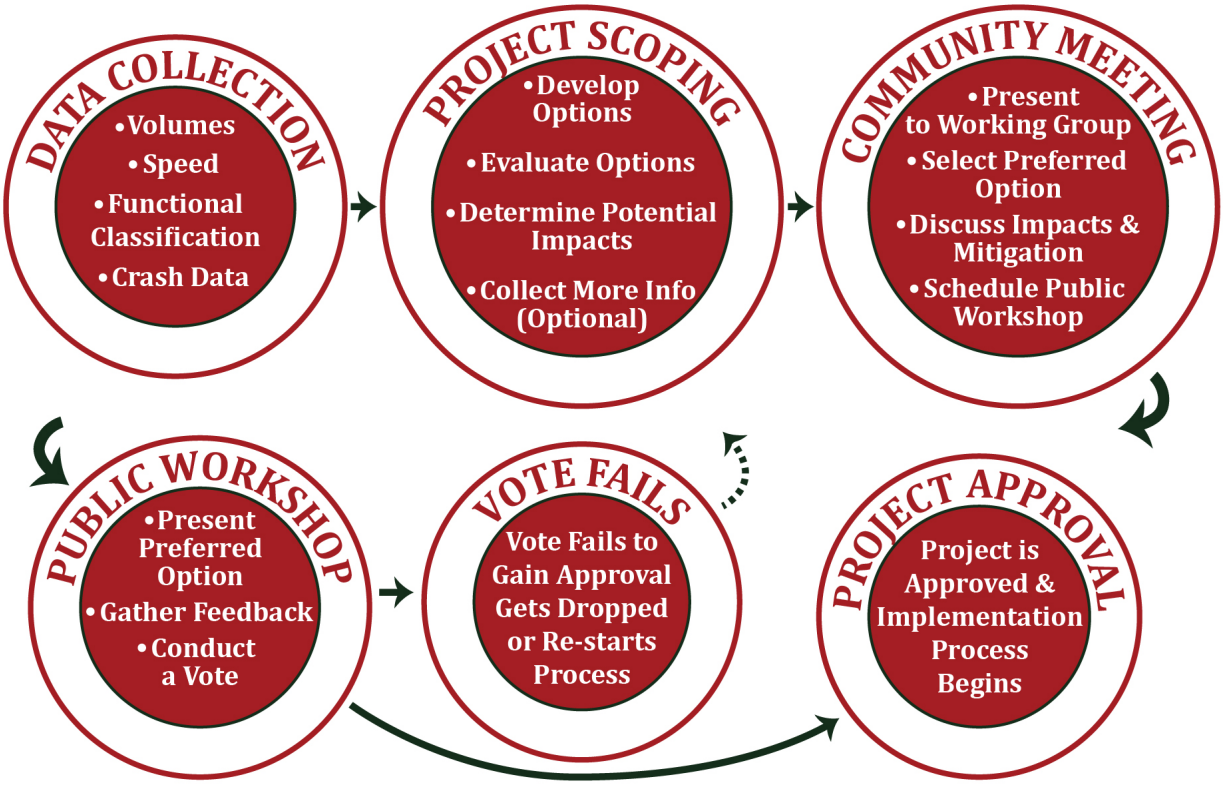
Projects and options meeting the City Engineering evaluation standards will be presented to the Traffic Calming Working Group. The Traffic Calming Working Group will rank options from least to most preferred. Once ranking is complete, a Public Workshop will be scheduled.

At the Public Workshop, City staff will present no more than three (3) options for consideration with one (1) preferred option, distribute comment forms, and collect feedback. Relevant feedback will be incorporated, if necessary. If City staff and the Traffic Calming Working Group agree on the preferred option, ballots will be distributed to affected residents, property owners, and commercial property owners. Should the preferred solution receive sixty-percent (60%) support, the project proceeds to implementation.

If the project fails to secure sufficient support, the project is passed back to the Traffic Calming Working Group to find a consensus solution for re-submittal. If consensus is established, the project will re-enter the approval process. Should support fail a second time, the process will be closed for no further action from the City. In the case of disagreement between the Traffic Calming Working Group and City staff, the proposed plan will be brought before a Traffic Calming Steering Committee for discussion and recommendations.

Once a traffic calming application and location are meet the requirements for community support, the City Council must approve the proposed traffic calming project with input from City Administration, Police Chief, Fire Chief, City Planner, Public Services Director, and City Engineer.

TYPICAL PROJECT APPROVAL PROCESS



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IMPLEMENTATION

IMPLEMENTATION PROCESS

Once the traffic calming application and location are vetted with the community, the City Council must approve the proposed traffic calming project with input from City Administration, Police Chief, Fire Chief, City Planner and City Engineer.

Process Overview

Traffic calming construction projects are typically smaller and less involved than most roadway construction, meaning implementation can be completed in a relatively short period of time. By definition regular traffic calming projects do not require right-of-way acquisition, though temporary construction easements may be necessary in some instances. Should the project require right-of-way acquisition, it will be recategorized as a major project. This chapter details the following implementation items:

- **Demonstration Projects**
- **Project Prioritization**
- **Project Funding**
- **Installation**
- **Project Removal**

Traffic calming projects may, or may not, incorporate each of the steps dependent on project complexity, evaluation results, available funds, and project success.

Demonstration Projects

Simplified project installation also allows the opportunity to evaluate the application prior to investing in a permanent application. Demonstration projects may be warranted when implementing complex area-wide plans, whose traffic diversion potential is difficult to predict. These installations may also be warranted when deploying specific traffic calming measures for the first time. City Staff will determine the benefit and/or necessity of a demonstration project. A trial period will ordinarily last a minimum of one (1) month during which time the application and location will be evaluated. Should the traffic calming measure perform as expected, installation will proceed in accordance with comments, observations, and gathered information.

In cases where a community and/or City may be uncertain of the results or effectiveness of a traffic calming measure, other demonstration projects can help define the appropriate measure for permanent installation. These projects should be based on the ranked alternatives vetted with the Traffic Calming Working Group. City staff will meet with the Traffic Calming Working Group to determine next steps.

Project Prioritization

Prudent staffing and resource allocation requires project prioritization to address areas of highest need or benefit first. Projects with the highest score will be considered for funding implementation. Prioritization criteria, outlined in the table below, will determine prioritization, ranking the order of implementation.

Project Funding

Project scheduling will depend on budget and available resources. The project's cost estimate will be presented to the City Council for consideration.

When funds are approved by the City Council and available, final designs will be completed and the project scheduled for implementation. If no funding is available, the traffic calming location will go on a waiting list and move forward when funds are available. Once funding is in place, design plans and specifications will be developed and the project constructed.

Installation Evaluation

A trial period after the installment of a traffic calming measure is used to determine effectiveness of the treatment for calming traffic, reducing crashes, and improving overall safety. This also allows for

PRIORITIZATION CRITERIA

Criteria	Point Value
Speed	2 points for each mph difference between the 85th percentile speed and the posted or prima facie speed limit
Volume	▪ 1 point for each 500 vehicles over 1,000 vehicles per day ▪ 5 points if 40 to 65-percent or more ADT on local street is cut through traffic between arterials or major roadways ▪ 10 points if higher than 65-percent
Crash History	▪ 5 points for each speed-related crash in the past 3 years ▪ 8 points for each injury crash in the past 3 years ▪ 8 points for each crash involving a pedestrian or a cyclist in the past 3 years
Pedestrian Generators (15 points max)	▪ 5 points for each school, park, library or community center along roadway ▪ 3 points if within 1 block ▪ 2 points if within 2 blocks
Support	▪ 8 points for 80% representation of neighborhood ▪ 5 points for 70% representation of neighborhood ▪ 2 points for 60% representation of neighborhood
Unique Conditions (15 points max)	▪ 5 points for designation as a Bike Route or as a Complete Street pedestrian corridor, or for proximity to neighborhood business district or existing/planned transit hub ▪ 5 points for evidence of crashes or speeding, such as long skid marks or broken glass ▪ 5 points for missing sidewalk section ▪ 5 points for unique roadway geometry that substantially restricts visibility; ▪ 5 points for high crash rate

feedback from the community on how well the traffic calming measure is performing.

No earlier than 6 months and within 18 months of implementation, City staff will conduct traffic studies on the project to determine traffic calming effects. Before and after studies should be performed at the same time of year, with similar weather conditions, and considering school days as a factor to traffic calming effectiveness. Traffic volumes and speed data will be recorded for comparison. Available crash information as well as resident satisfaction survey data may also be gathered. Staff will report the results to the City Administrator and the City Council.

Project Removal

Two years or greater from the date of implementation, impacted constituents in the study area may petition to have the traffic calming application removed. There must be 51-percent of the households, property owners, or business owners (each having one vote) in the study area supporting the removal. The application cannot be considered for removal until after studies have been completed. Once the petition has been verified, the City Administrator, or their designee, may order the removal of the devices. As a standard of practice, future traffic calming requests will not be approved in an area where traffic calming devices were removed unless otherwise directed by the City Administrator or City Council.

TRAFFIC CALMING TOOLBOX

TRAFFIC CALMING TOOLBOX

Traffic calming supports the livability and vitality of residential and commercial areas by improving non-motorist safety, mobility, and comfort. Two methods, reducing vehicle speeds and/or volumes on a single street or street network, achieve these goals.

Speed Management

Speed Management measures bring motor vehicle speeds closer to those of bicyclists, reduce passing, enhance drivers' ability to see and react, and diminish the severity of crashes should one occur. Speed management is critical to creating comfortable and effective complete streets.

Benefits

- Decreases motor vehicle speeds.
- Decreases the likelihood that crashes will occur, by increasing drivers' response time and minimizing motor vehicles overtaking movements.
- Decreases likelihood of an injury resulting from a crash.
- Improves bicyclist comfort and benefits pedestrians and residents by reducing traffic speeds along the corridor.
- Establishes and reinforces bicycle priority on bicycle boulevards by discouraging through vehicle travel.
- Provides opportunities for landscaping and other community features such as benches, message boards, and colored pavement in the intersection, benefiting all roadway users and residents.
- Correlates posted speeds with the actual speed peopla drive.

Volume Management

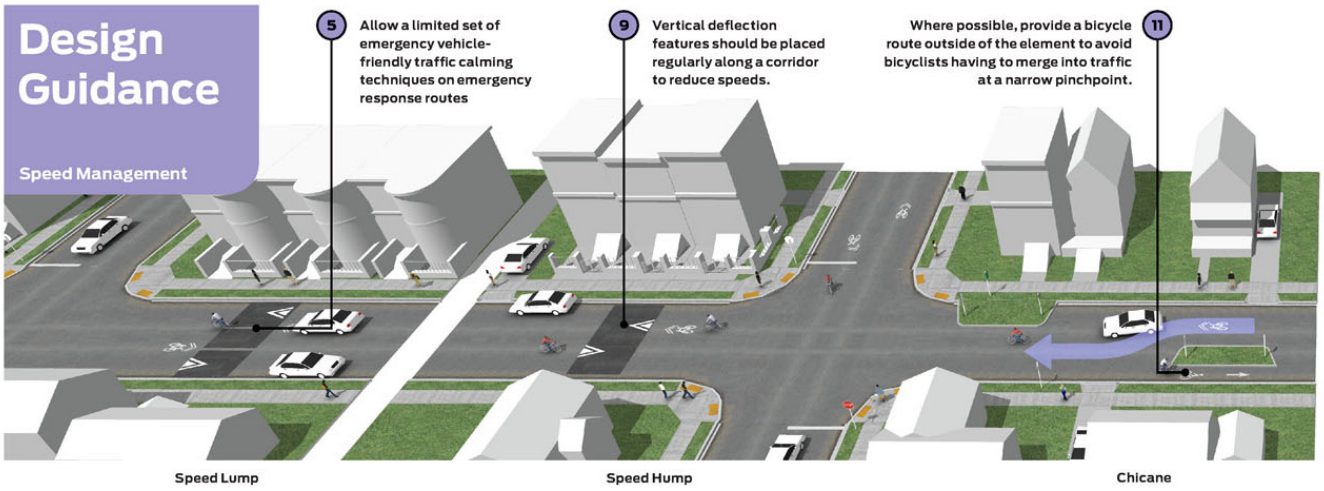
Volume Management measures reduce or discourage through traffic by physically or operationally reconfiguring select corridors and intersections with the transportation network.

Benefits

- Reduces motor vehicle volumes by completely or partially restricting through traffic on a bicycle boulevard to improve walking, biking, and driving for current and future users.
- Establishes and reinforces bicycle priority by restricting vehicle through movements.
- Improves comfort on a corridor for people walking, biking, and driving by reducing traffic volumes along the corridor.
- Provides opportunities for landscaping, stormwater management, and other community features such as benches and message boards.

SPEED MANAGEMENT

Speed Management measures bring motor vehicle speeds closer to those of people riding bikes. Reducing speeds improves the walking and biking environment by reducing overtaking events, enhancing driver's ability to see and react, and diminishing the severity of crashes if they occur. Speed management is critical to creating a comfortable and effective multi-modal transportation



Required Features

1. When using horizontal speed management treatments, a minimum clear width of 12 feet for travel shall be maintained.
2. Speed limits shall comply with local restrictions.
3. Speed zones (other than statutory speed limits) shall only be established on the basis of an engineering study that has been performed in accordance with traffic engineering practices (MUTCD 2B.13).
4. Speed limits shall be in multiples of 5 mph and signs shall be located at the points of change from one speed limit to another (MUTCD 2B.13).

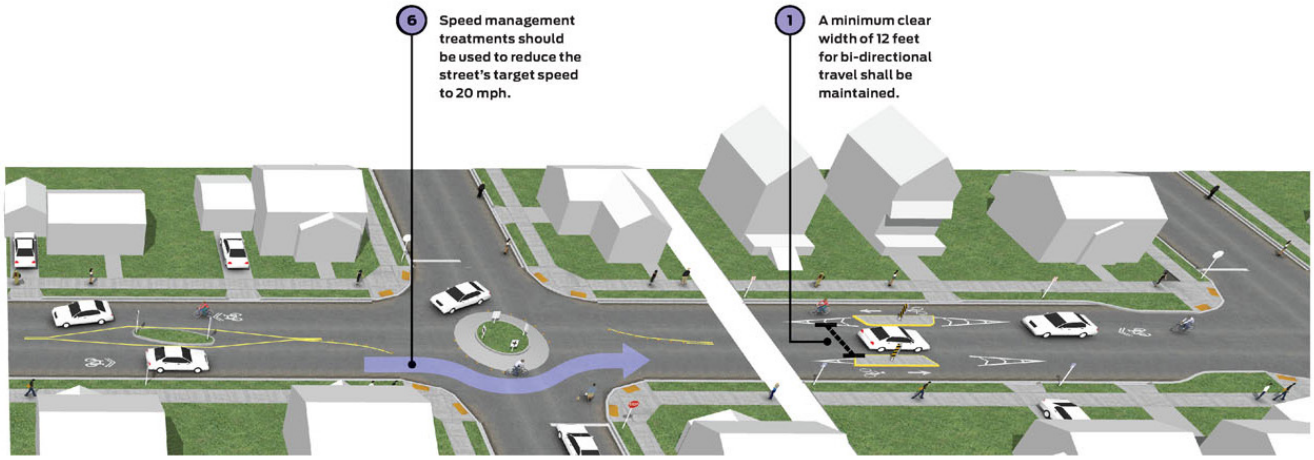
Recommended Features

5. Emergency services should be in sync with transportation departments in recognizing that reducing speed and volume on local roadways, in addition to getting more people on foot and bike and out of cars, benefits their overall safety goals by reducing crash frequency and severity. The primary way of doing this is to develop an emergency response route classification map at the onset of the planning process, as discussed in route planning. Emergency vehicle response times should be considered where vertical deflection is used. Because emergency vehicles have a wider wheel base than passenger cars, speed lumps/cushions allow them to pass unimpeded while slowing most traffic.

Strategies include the following:

- Seek approval by emergency response officials for treatments on emergency response routes.
- Allow a limited set of emergency-vehicle-friendly traffic calming techniques on emergency response routes.[146]
- Estimate travel time impacts on emergency vehicle response time, and define goals to evaluate during a trial.[147]
- Implement speed management treatments on a trial basis, and work with emergency response officials to determine whether permanent features are appropriate.

6. Speed management treatments should be used to reduce the street's target speed to 20 mph.
7. After speed management measures are implemented, posted speed limits should be reduced to match 85th percentile speed (5 mph speed increments are recommended).
8. The impacts to traffic on adjacent streets should be monitored; while speed management treatments primarily affect motor vehicle speeds, they also reduce volumes, as drivers tend to avoid slower streets.[148]
9. Vertical deflection features should be placed regularly along a corridor to reduce speeds.[149]



(10) Guidance for vertical traffic calming features:

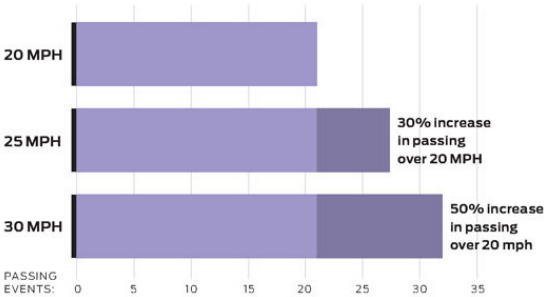
- Slopes should not exceed 1:10 or be less steep than 1:25.
- Side slopes on tapers should be no greater than 1:6 to reduce the risk of bicyclists losing their balance.
- The vertical lip should be no more than a quarter-inch high (Ewing, 2009).

(11) Horizontal speed control measures should not infringe on bicycle space. Where possible, provide a bicycle route outside of the element to avoid bicyclists having to merge into traffic at a narrow pinchpoint. This technique can also improve drainage flow and reduce construction and maintenance costs.

Optional Features

(12) Speed management may be implemented on a trial basis to gauge residents' support prior to finalizing the design. Temporary speed humps, tables, and lumps are available. Temporary traffic calming should be used with caution as they can diminish residents' opinions due to unappealing design and reduced functionality.

Depending on motor vehicle speeds, a bicyclist will be passed by a car going the same direction this many times during a 10 minute trip:

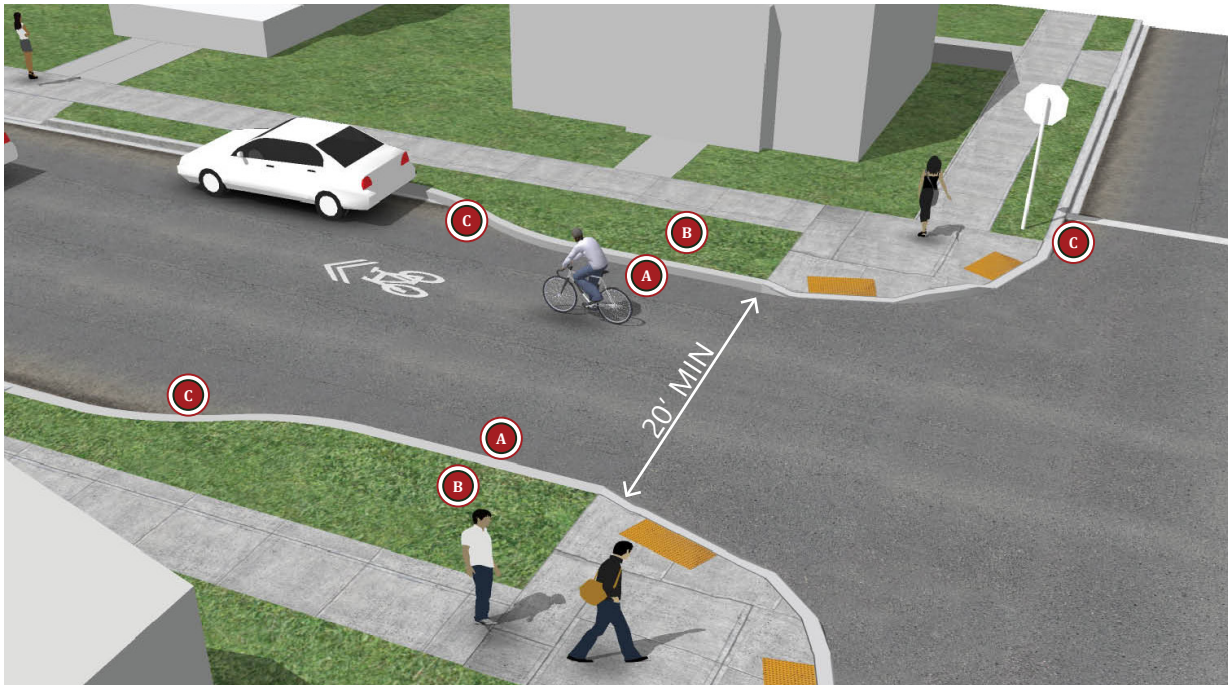


Values shown assume 3,000 VPD. Local street peak hour is 15 percent of ADT. 70 percent of peak hour traffic is in the peak direction. Cars are evenly spaced along the street; no platooning. Ten minute trip calculated during peak hour. Cars are travelling the posted speed limit (speed management techniques may be necessary). Note: Cars may pass bicyclists more or less frequently depending on how well these assumptions reflect reality.

TRAVEL LANE IMPEDIMENTS

CURB EXTENSION / BUMP OUT

A curb extension / bump out is an extension of the tree lawn and sidewalk into the parking lane, reducing the roadway width, and creating a shorter crossing distance for pedestrians. These can also be called neck-downs.



Typical Application

- Can be placed in all street classifications; arterial, collector,or local streets.
- Appropriate for any speed limit, provided an adequate shy distance is provided between the travel lane and the corner extension curb
- Can be used on both one-way and two-way streets. Can also be applied with a bicycle facility.
- May, or may not, be used in conjunction with a pedestrian crossing.

Design Features

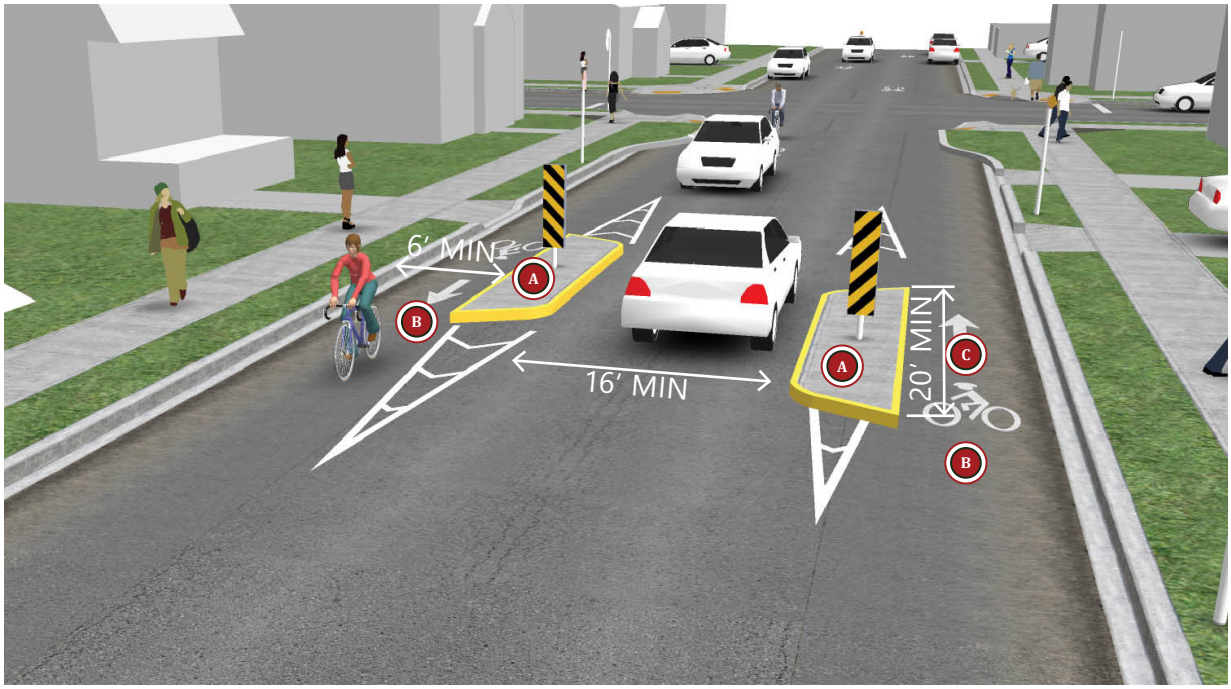
A Corner extension is typically constructed to a width of between 6 and 8 feet. Provide a minimum 1.5 foot shoulder on collectors and arterials.

B Can be used to help mitigate storm water run-off by creating a bioretention planting feature within the curb extension.

C Positive drainage should be retained. Realigning the drainage system and/or pavement warping may be necessary.

CHOKER

Chokers are curb extensions or islands which narrow a street at mid-block. In different configurations, they are called mid-block narrowings, mid-block yield points, and pinch points. If marked as crosswalks, they are also called safe crosses. Chokers can provide the street cross section with two narrower lanes.



Typical Application

- Applicable for a local collector, or local street.
- Can only be placed mid-block; at an intersection use a corner extension/bump out.
- Two lane chokers are appropriate for any speed limit provided an adequate shy distance is given between the travel lane and the choker curb.
- Install on a crest vertical curve only if there is adequate stopping sight distance and warning signs are provided.

Design Features

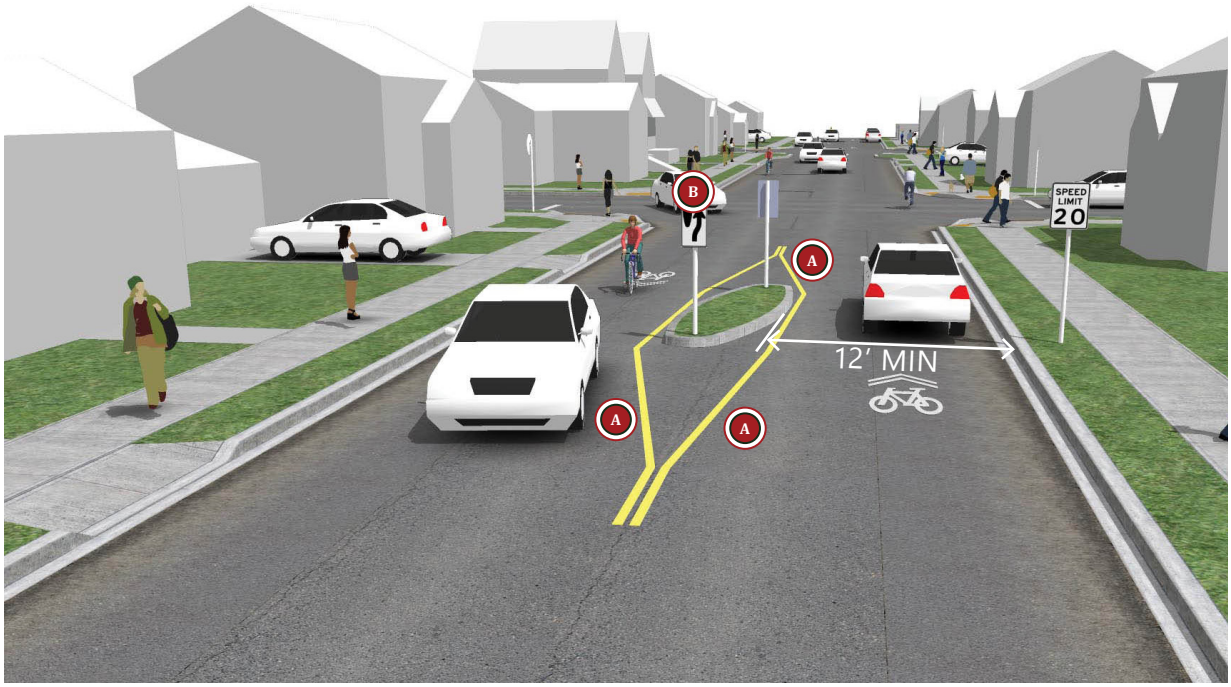
(A) The curb extension for a choker is typically constructed to a width of between 6 and 8 feet. It should offset from the through traffic lane by 1.5-feet at speeds over 25 mph.

(B) Bicycle bypass lanes can be provided for streets with heavy vehicular and bicycle traffic

(C) The length of a choker island should be at least 20-feet.

MEDIAN ISLAND

Median islands are raised islands located along the centerline of a street which narrow travel lanes. They are also called mid-block medians, median slow points, and median chokers.



Typical Application

- Applicable for an arterial, collector, or local street in urban or suburban settings.
- Can be placed at a mid-block location or on an intersection approach.
- May be more effective when placed immediately downstream of an intersection forcing motorists to turn more tightly around a corner.
- Can be designed as a crossing refuge, minimum 6-feet wide.

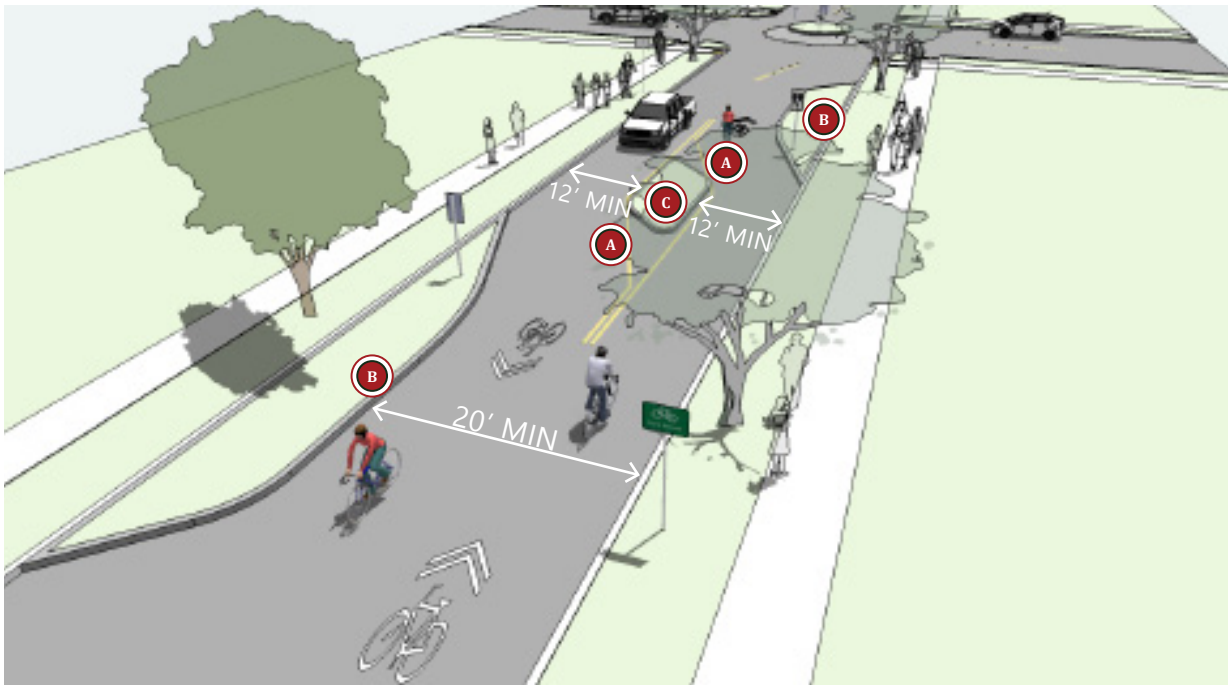
Design Features

A Appropriate taper distances apply according to posted speed.

B Include compliant signs in order to alert motorists of the presence of the median island. Landscaping can reinforce the island's presence.

LATERAL SHIFT

Lateral shifts are realignments of a straight travel path. When multiple lateral shifts are applied to form an S-shaped curve, it is called a chicane. Taper length design, and optional median islands, help reduce travel speeds.



Typical Application

- Can be appropriate at all levels of traffic volume on local, collector, and arterial roadways.
- Can be appropriate across a range of speed limits, provided the lateral shift has a taper designed for the posted speed
- Can be installed on a crest vertical curve with adequate stopping sight distance and warning signs.

Design Features

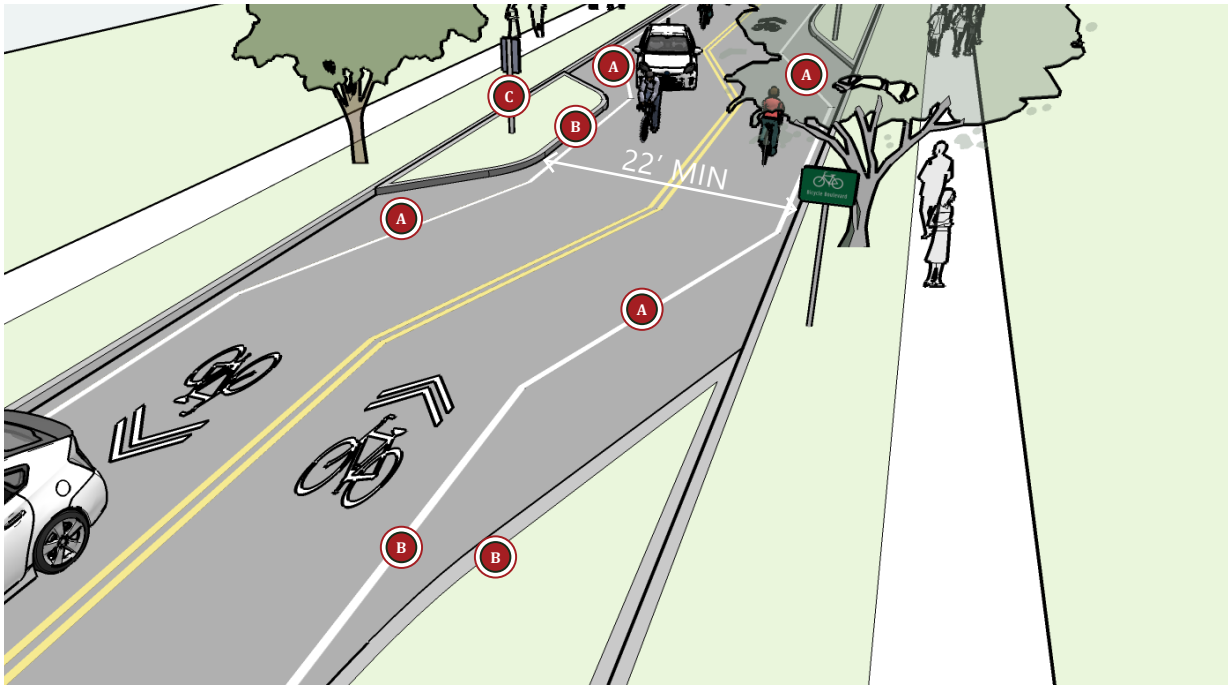
A The amount of speed reduction is a function of the amount of lateral shift and the taper angle.

B A curb extension or choker island reinforces lateral shifts. Reflectors and signage serve as warning features.

C Median islands reinforce lateral shifts separating opposing traffic (Reference Page 22).

CHICANES

Chicanes are consecutive lateral shifts realigning a straight travel path in an S-shaped curve. Curb extensions and/ or medians may be employed to reinforce the turns in the roadway.



Typical Application

- Appropriate for a local road or low-volume collector with the properly designed taper angle and lateral shift distance.
- Can be applied to a road that has a 35 mph speed limit or less.
- Not suitable for roads with bus transit service routes.
- Can be installed on a crest vertical curve with adequate stopping sight distance and warning signage.

Design Features

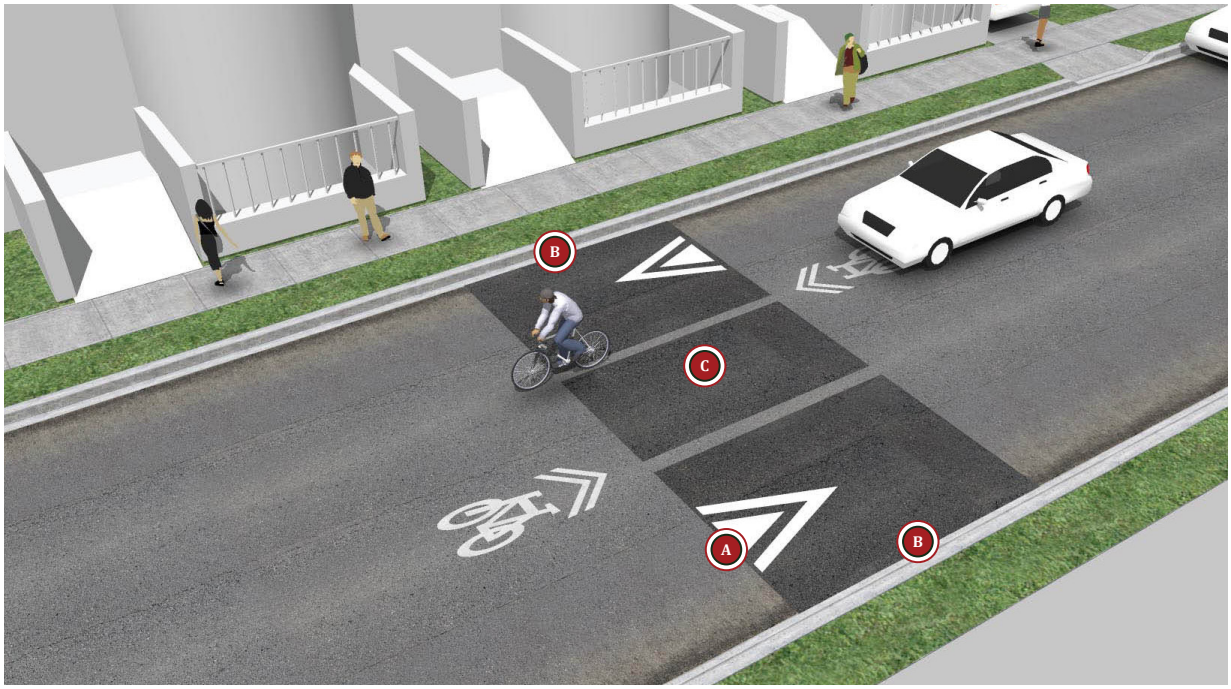
A The amount of speed reduction is a function of the amount of lateral shift and the taper angle.

B Can be created with pavement markings, curb extensions, choker islands, and/or vertical elements like planters.

C A curb extension or edge island that forms a chicane should have vertical elements (i.e. signs, planters, and landscaping) to draw attention to it.

SPEED CUSHION

Speed cushions are either speed humps or speed tables that include wheel cutouts to allow large vehicles to pass unaffected, while reducing passenger car speeds.



Typical Application

- Suitable for local collector streets
- Appropriate maximum speed limit is 30 mph or less.
- Can be placed at mid-block location, if it is at least 150 feet from a non-signalized intersection and 250 feet from a signalized intersection.
- Can be installed on a crest vertical curve only if there is adequate stopping sight distance or warning signs provided.

Design Features

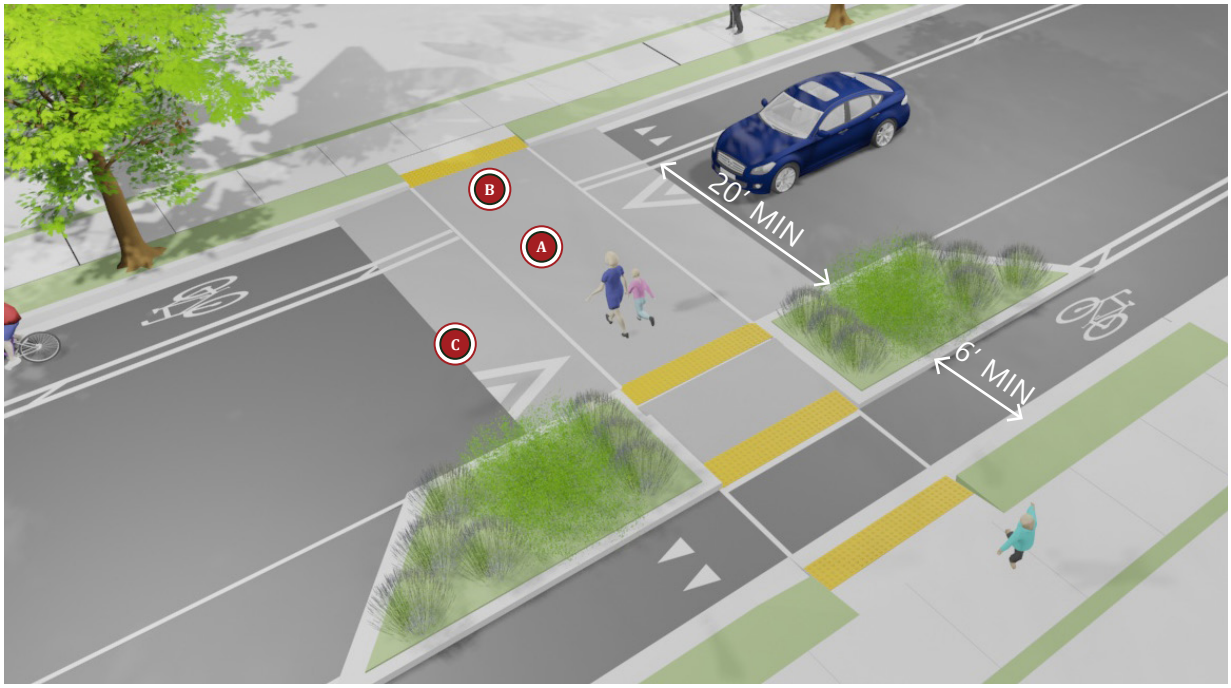
A Pavement markings (i.e. striping, arrows) and signage for a speed cushion should indicate the hump in the road.

B Typically designed with sides that taper off at the gutter for drainage. The design may be modified to end the taper further from the gutter to create a wide, flat surface for bicycle bypass lane.

C Cushion width should be wide enough to slow personal passenger vehicles and yet narrow enough to permit fire trucks and transit vehicles to pass easily.

SPEED TABLE AT MID-BLOCK LOCATION

Speed tables are speed humps with a flat top which raise the entire wheel base of a vehicle. Speed tables often coincide with mid-block crossings.



Typical Application

- May be used on collector streets and/or transit and emergency response routes. All speed tables must be designed to support emergency vehicles.
- Can be installed on, or beyond, a vertical curve crest with adequate stopping sight distance and/or warning signs as well as sufficient lighting.
- Streets with speeds at 30 mph or less and with traffic volumes less than 3,000 vehicles per day.
- Speed tables should not be applied to streets wider than 50 feet.

Design Features

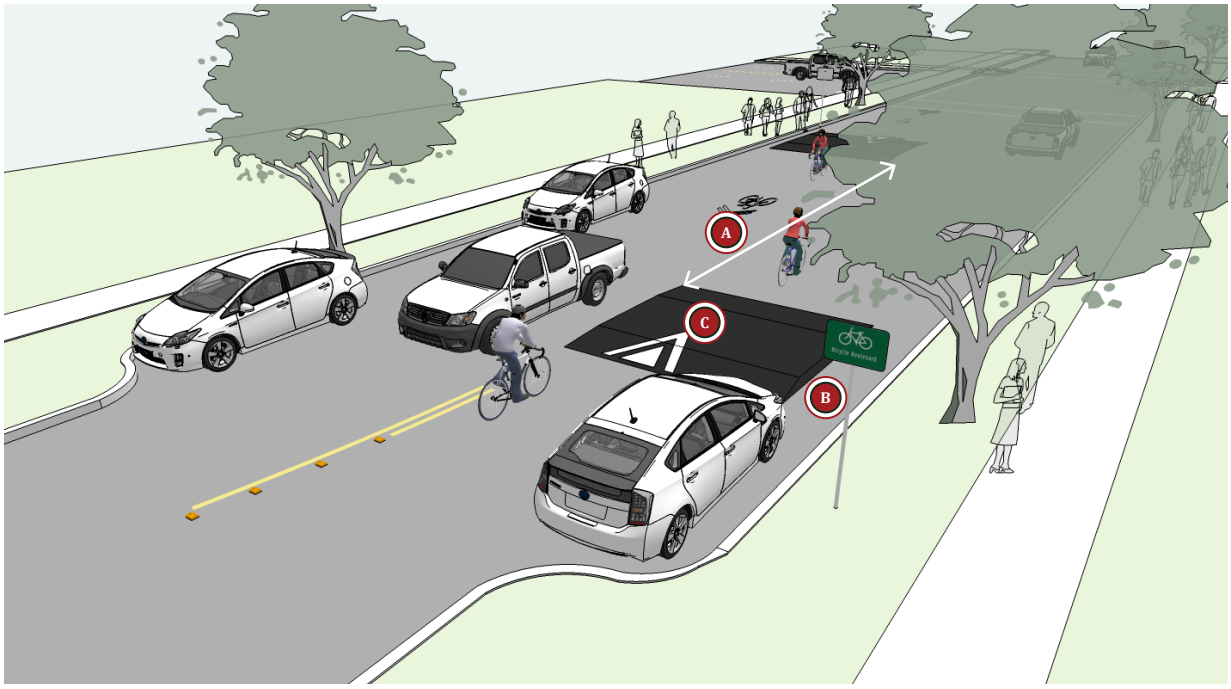
A Table top length should be designed to accommodate emergency and/or transit vehicles.

B Speed tables may coincide with a crossing as a raised crosswalk.

C Slopes should not exceed 1:10 or be less than 1:25.

OFFSET SPEED TABLE

Offset speed tables are two speed tables, one in each lane, separated along the roadway. Like a speed table, they have a flat top to raise the entire wheelbase of most passenger vehicles.



Typical Application

- May be used on a local, collector, and, in limited circumstances, arterial streets with or without curb and gutter.
- Should not be installed on a roadway with a horizontal curve less than 300 feet.
- Streets with travel speeds at or below 30 mph - 35 mph with maximum traffic volumes of 4,000 vehicles per day, at least 1,000 in each direction
- May be applied in a series with minimum 350 foot spacing, clear visibility for 200 feet, and 150 feet from an unsignalized intersection.

Design Features

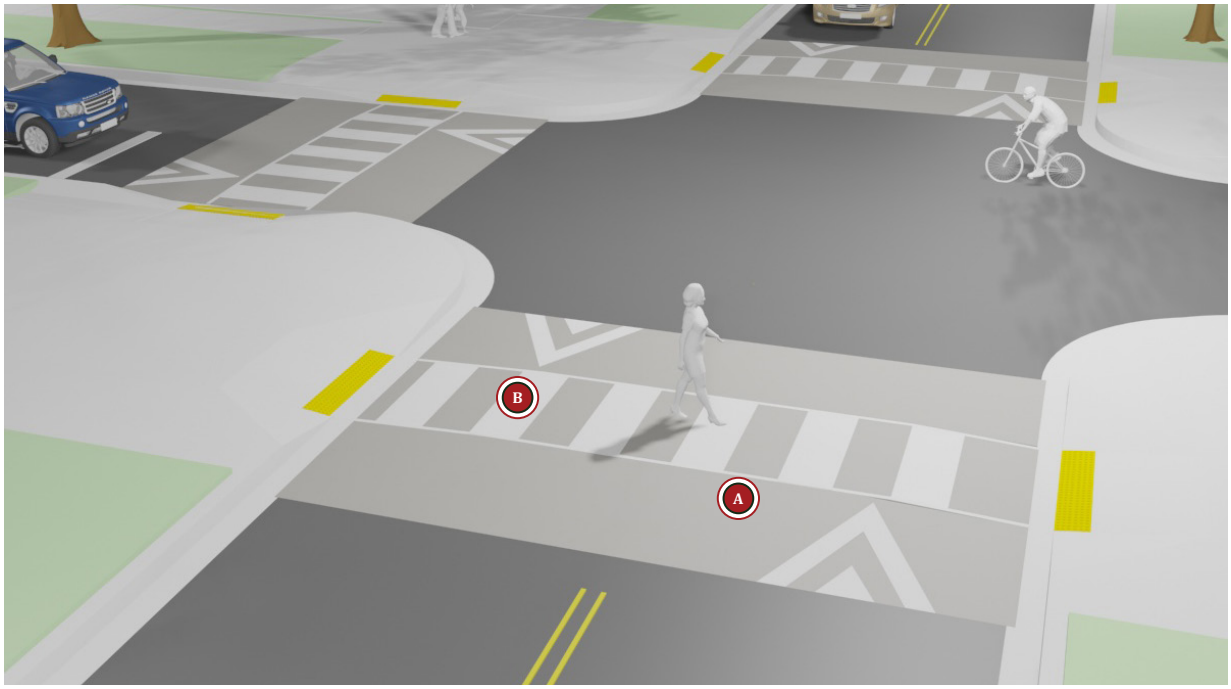
A Recommended spacing between offset speed tables is feet 260 to 500 feet (measured between the closest taper edges)

B Should be designed to support stormwater drainage and located away from adjacent vertical elements, particularly utilities.

C Plateaus length should accommodate fire trucks and transit buses.

RAISED CROSSWALK AT INTERSECTION

Raised crosswalks are a variation of a speed-table located at intersections where people cross the road on foot. Crosswalk pavement markings are installed in addition to the required speed bump pavement markings.



Typical Application

- May be used at mid-block or intersection crossings on local, collector, and, in limited circumstances, arterial streets. Not appropriate along primary access to a commercial or industrial site.
- Appropriate at existing crosswalk or where a crosswalk is warranted based on local standards and criteria.
- Streets with speeds at or below 30 mph - 35 mph in locations of high pedestrian traffic, maximum traffic volumes is 3,500 - 4,000 vehicles per day.

Design Features

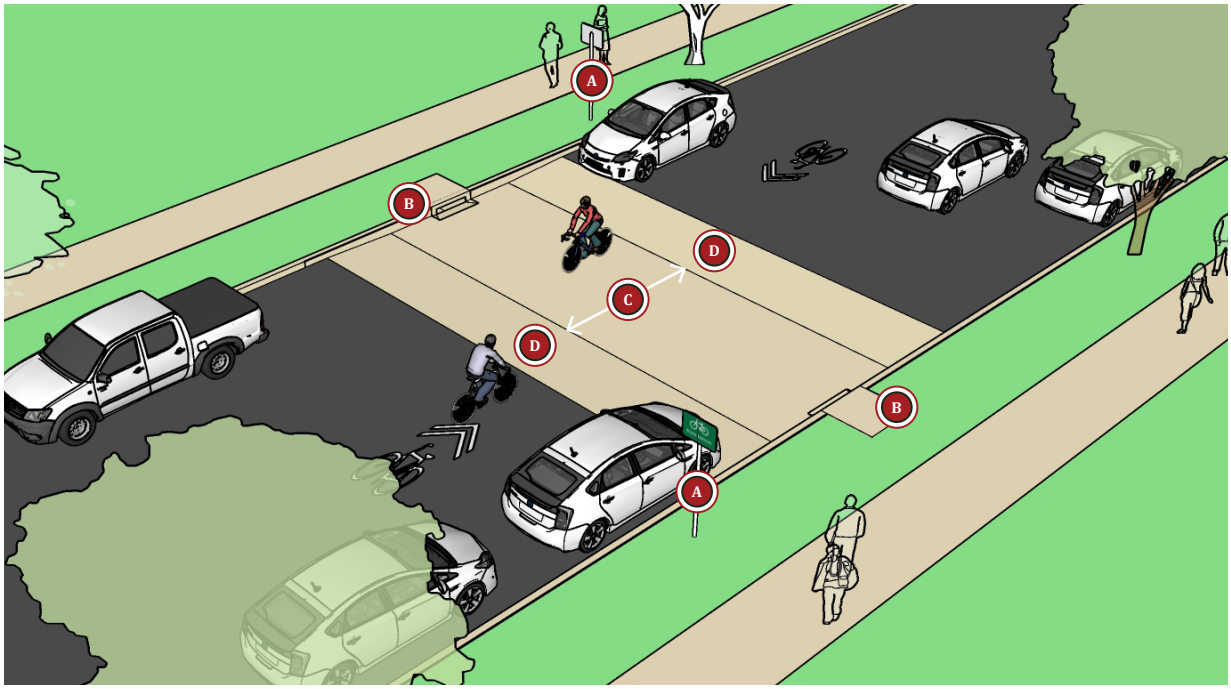
A New installations should be raised 3 - 3.5 inches and meet flush with the walk differentiated with detectable warning strips. Retrofits should meet existing ADA ramps with a slope not to exceed 1:6.

B Use high visibility continental crosswalk pavement markings.

C Where parking lanes exist, curb extensions should be used to shorten crossing distance and position users in a more visible location.

SPEED DIP

Speed dips are similar in design to speed humps or tables, only depressed. They should be located in association with stormwater drainage inlets.



Typical Application

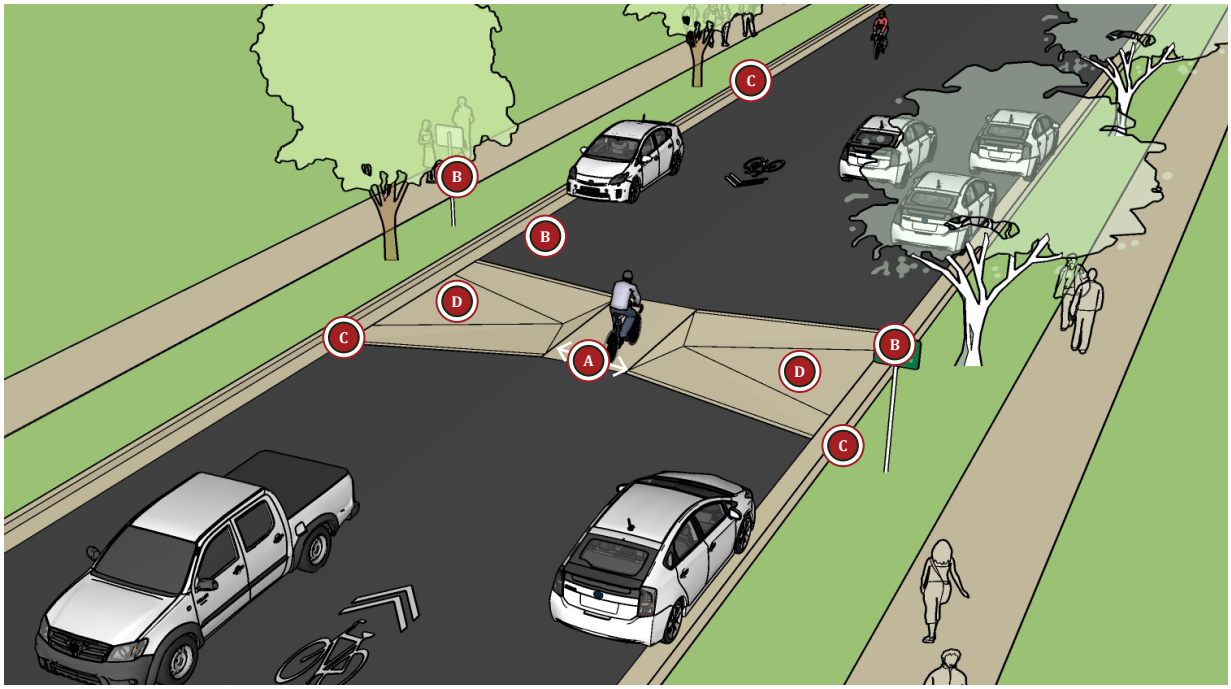
- Suitable for both local and collector streets
- Appropriate maximum speed limit is 30 mph or less.
- Place at mid-block locations at least 150 feet from an unsignalized intersection and 250 feet from a signalized intersection.
- Can be installed on the crest of vertical curves only with adequate stopping sight distance, warning signs, and appropriate stormwater considerations.

Design Features

- (A) Appropriate signs are the minimum indication necessary.
- (B) Co-locate dip with required stormwater drainage structures.
- (C) Basin length should be designed to accommodate emergency and/or transit vehicles.
- (D) Slopes should not exceed 1:10 or be less than 1:25.

BICYCLE BRIDGE

Bicycle bridges are speed dips on either side of a channel that is flush with the roadway which allows bicycles smooth passage while vehicles experience the dip. The dips are designed to allow stormwater to flow along the gutter.



Typical Application

- Suitable for both local and collector streets
- Appropriate maximum speed limit is 30 mph or less.
- Place at mid-block locations at least 150 feet from an unsignalized intersection and 250 feet from a signalized intersection.
- Can be installed on the crest of vertical curves only with adequate stopping sight distance and warning signs.

Design Features

A Bridge channel should be between 6 feet and 7.5 feet wide.

B Sign just like a dip. Signs are the minimum indication necessary.

C Design to allow uninhibited stormwater drainage along the gutter.

D Dip flare should be designed to accommodate slopes between 1:25 and 1:10 which support emergency and/or transit vehicles.

SIGNALIZATION

SPEED MONITOR

Speed monitors are permanent devices to keep drivers aware of their speeds and alert them to slow down when traveling too fast. They are typically mounted on a speed limit sign and visually display a driver's real-time speed as they pass.

Typical Application

- Appropriate for roadways with travel speeds between 25 mph to 45 mph.
- Ideally used on long, continuous bike routes.
- Do not install along or after a curve in the roadway or under trees if solar powered sign is used.
- Use in locations where speed study determines 85th percentile speeds exceed 3 mph over posted speed during the time period of concern.

Design Features

A Signs must be installed per MUTCD standards in plain view of motorists.

RECTANGULAR RAPID FLASHING BEACON (RRFB)

Rectangular rapid flashing beacons are highly visible warning signs, using flashing yellow LED lights to supplement standard pedestrian crossing warning signs at mid-block and unsignalized crossing locations. Typically user-activated, they promote increased yield rates and improved pedestrian safety.

Typical Application

- At locations where driver compliance at bicycle crossings is low.
- Should not be used where the crosswalk approach is controlled by a yield sign, stop sign, or traffic-control signal.
- Applicable at locations where bike facilities cross roads at mid-block locations or at intersections where signals are not warranted or desired
- Usually implemented at high volume pedestrian crossings

Design Features

A Active warning beacons shall be installed on the side of the road .

B Combined bicycle and pedestrian warning signage (MUTCD W11-15) should be used at crossings bicyclists are expected to used.

C Beacons are unlit when they are not activated.

HAWK SIGNAL (HIGH-INTENSITY ACTIVATED CROSS-WALK BEACON)

A high-intensity activated crosswalk beacon is used to stop traffic on higher volume, higher speed roadways. The beacon remains off until activated by a pedestrian.

Typical Application

- Install on multiple lane, high volume, and/or high speed roadways which pose a barrier to pedestrian mobility.
- Install at locations with long distances between signalized or stop controlled intersections.
- Locations should be selected to provide safe pedestrian crossings and not solely volume of people walking.
- Pedestrians and bicyclists actuate lights, not part of timed signal operations.

Design Features

A Typically mounted overhead like standard traffic signals.

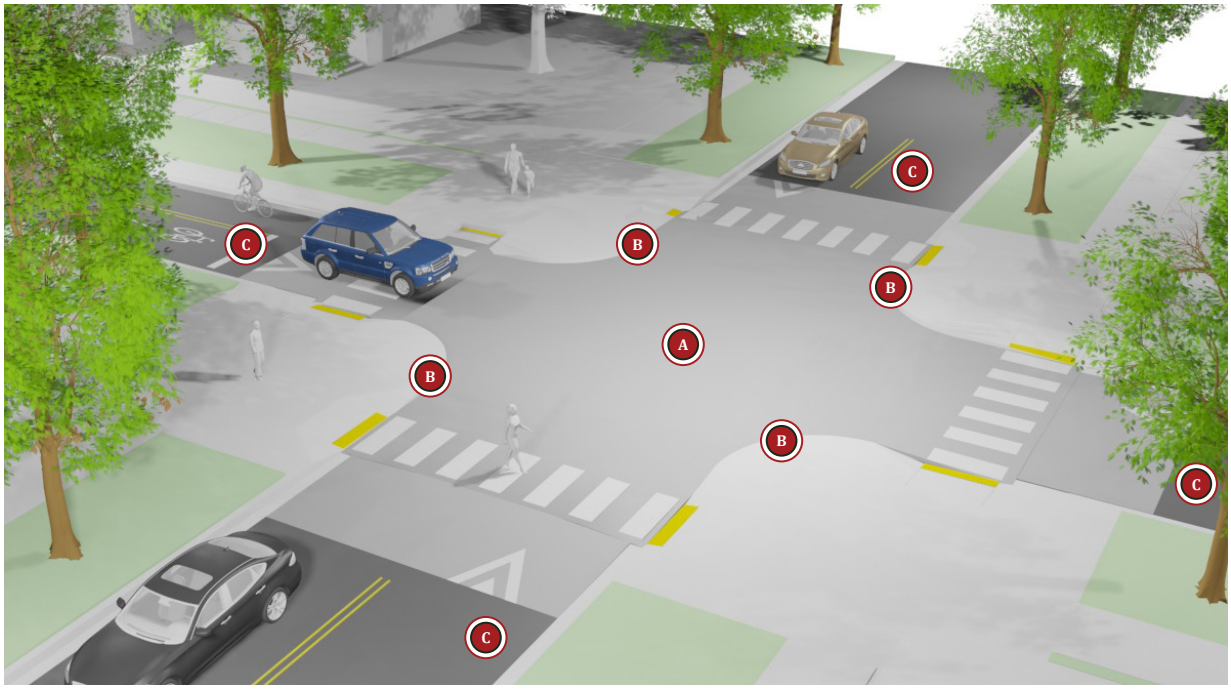
B May supplement with a bike signal and signal detection minor street approaches to facilitate bicycle crossings.

C No parking or visual obstructions should be present 100 feet prior and 20 feet after the crossing.

INTERSECTIONS

RAISED INTERSECTION

Raised intersections bring the roadway pavement to sidewalk level to prioritize pedestrian and bicycle crossings. This technique works best in pedestrian priority areas, often with enhanced pavement, and should have complementary pedestrian infrastructure connected to each corner.



Typical Application

- Appropriate if there are existing crosswalks on all four legs of the intersection or if crosswalks are warranted.
- Place within an urban cross-section (i.e. curb and gutter) that includes sidewalks on all sides of the intersection.
- Placed on streets with travel speeds at 30 mph or less.

Design Features

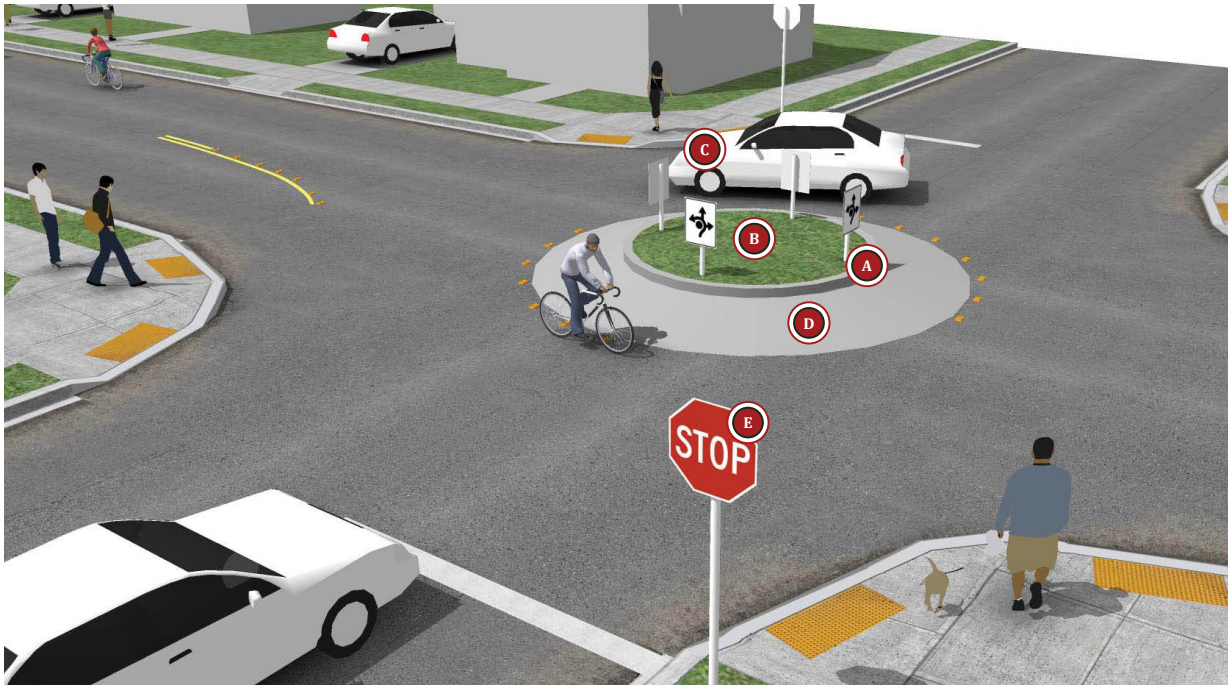
A Grade of entire intersection is raised to pedestrian level.

B Differentiate between the roadway and sidewalk, include a color contrast and detectable warning truncated domes for visually impaired.

C Stormwater drainage structures should be implemented prior to rise in elevation. Provide for positive drainage no greater than 2 percent in areas where pedestrians walk.

TRAFFIC CIRCLE

A traffic circle is a raised island, placed within an unsignalized intersection, around which traffic circulates. The circle forces a motorist to use reduced speed when passing directly through an intersection or making a turn.



Typical Application

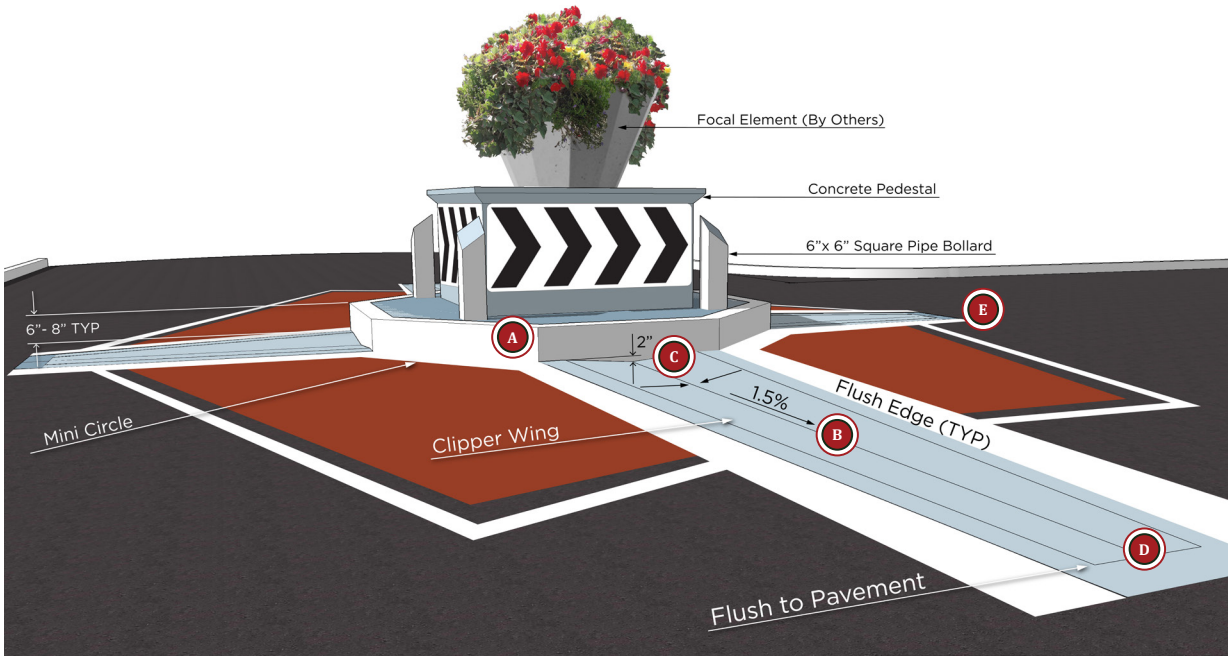
- Should be placed at the junction of two local roads.
- Applicable at intersections of both one-way and two-way streets.
- Can be applied on a cross-section both with and without a bicycle facility; a bicycle lane is not striped within a traffic circle.
- Appropriate only for streets with relatively low speed limits and low traffic volumes.

Design Features

- (A) Circle should be large enough to force vehicles to make an indirect path.
- (B) Landscaping in circle should not block site distance.
- (C) Tighten turning movements to increase pedestrian and bicycle safety.
- (D) Accomodate larger vehicles with a mountable apron.
- (E) May be signed with stop or yield signage at each approach.

CLIPPER WING MINI-CIRCLE

Clipper wing traffic circles are similar to typical traffic circles with a smaller raised island around which traffic circulates. The difference is the addition of speed dips on two opposing sides or on all four quadrants. The "clipper wing" dips clip the driver side of a vehicle and provide visual narrowing of the intersection pavement.



Typical Application

- Should be placed at the junction of two local roads or a stop controled intersection of a local and collector street .
- Applicable at intersections of both one-way and two-way streets.
- Can be applied in intersections with or without a bicycle facility; skip pavement markings may indicate the location of bicycle travel on bicycle boulevards.
- Appropriate only for streets with a 30 mph speed limit or less.

Design Features

A Circle should be visible to oncoming traffic with reflective indicators.

B Locate on the high point of the intersection to allow positive drainage with a minimum 1.5 percent slope away from center island.

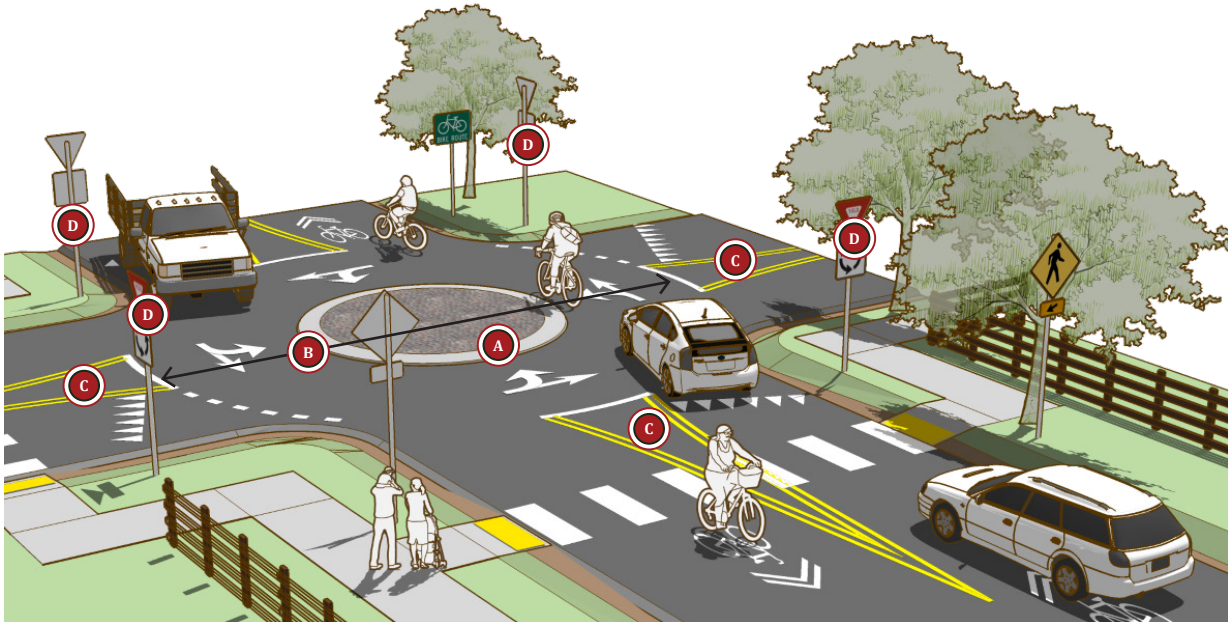
C Dips should be no greater than 3 inches deep

D Align clipper wings with the centerline of the intersecting roadway.

E Wings may have shorter length to allow bicycles to travel a more direct route without crossing the it, specifically on bike boulevards.

MINI-ROUNDABOUT

Mini-Roundabouts are a smaller version of the traditional modern roundabout, with a fully mountable center island that can be driven over by emergency vehicles and occasional buses or large trucks.



Typical Application

- May be used to replace existing two-way stop controlled intersections. Can be used at the intersection of one-way and two-way streets.
- May be used in space constrained locations with speed limits of 30 mph or less with a design speed between 15 mph and 20 mph.
- Are not recommended in locations with high volumes of truck traffic or low cross street traffic volumes
- Design center island large enough to deter left turn movements in front of the island.

Design Features

A Center island should be a different pavement type than the surrounding roadways to increase its visibility.

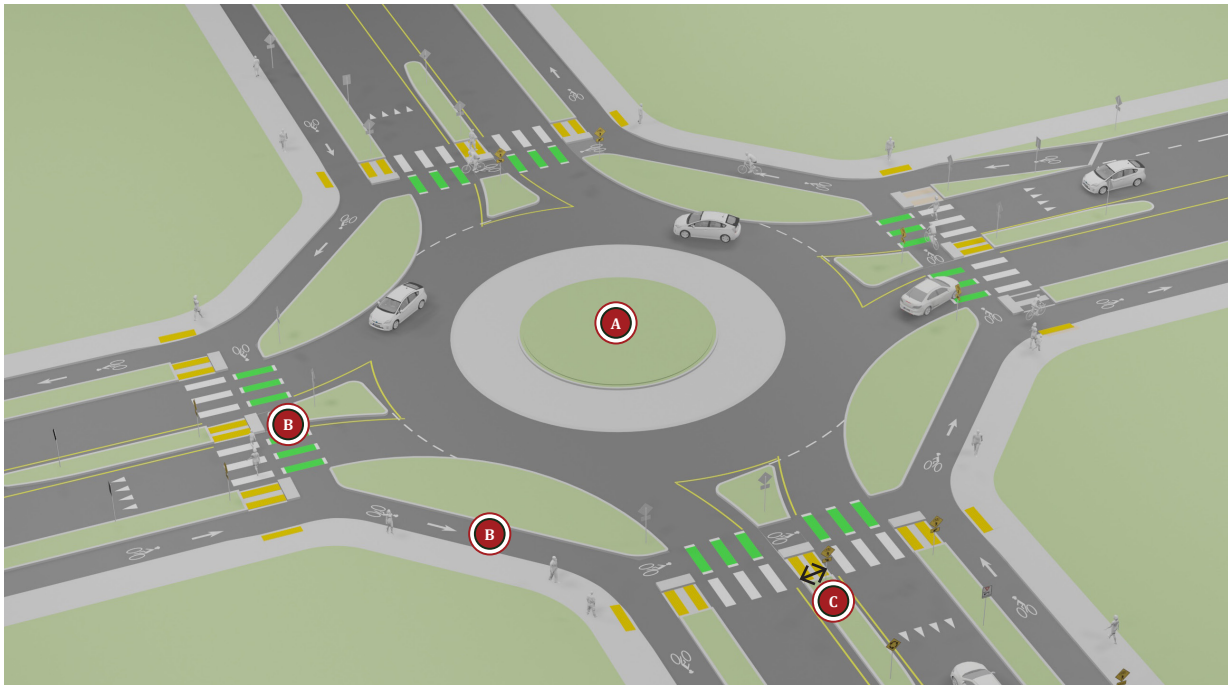
B Inscribed circle diameter not to exceed 90 feet.

C Install with striped or raised splitter islands with accommodations for pedestrian crossings.

D Typically a yield sign is placed at the approach and typical roundabout pavement markings throughout the intersection.

ROUNDABOUT

Roundabouts direct users through intersections in a predictable manner at slow speeds without stopping. Roundabouts provide simple pedestrian crossings, set a tone of cautious driving, and reduce crashes and collisions by 50 percent or more compared to traffic signals.



Typical Application

- Appropriate for the junction of arterial streets and of arterial streets with collector streets.
- Can be used to realign a closely-spaced offset intersection into a single intersection, and in complex intersections with more than four intersection legs.
- Can be appropriate at any level of traffic volume; multi-lane modern roundabout can be effective at daily entering volumes up to 60,000.

Design Features

A. A landscape feature can be placed within the center of the roundabout.

B. Provide separate bicycle facility on designated bike routes for roundabouts with a design speed greater than 25 mph.

C. Provide a recommended minimum width of 6 feet in splitter islands for pedestrian refuges.

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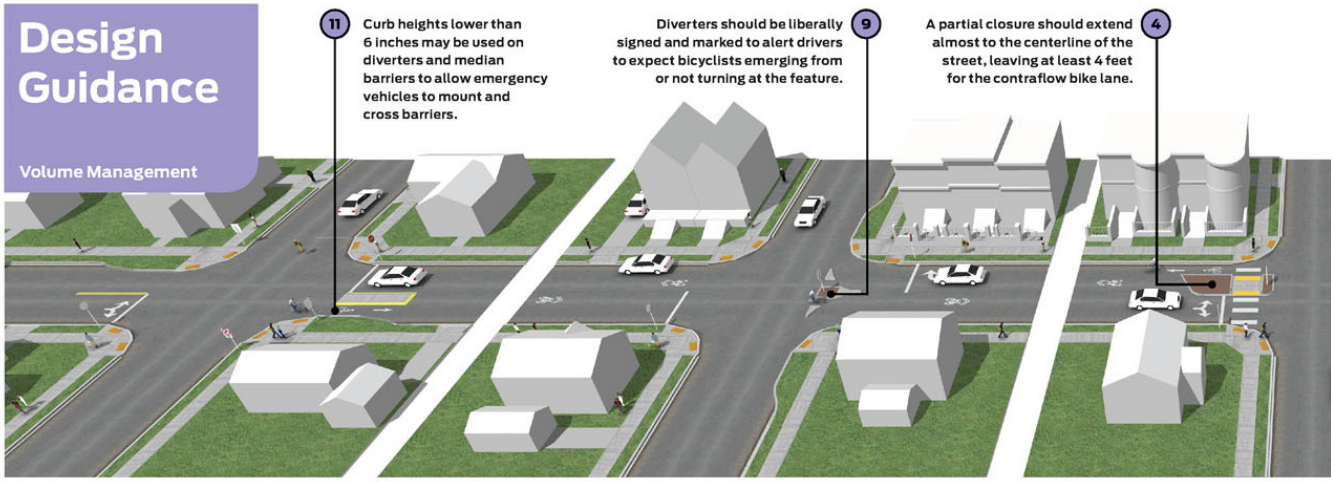
VOLUME MANAGEMENT

Volume Management measures discourage or prevent through traffic. Less traffic translates into less conflicts between people walking, biking, and driving. These measures improve the corridor's comfort for people walking and biking as well as heightening livability for



Regulatory Partial Closure

Channelized right-in/ right-out island

Partial Closure (Edge Island with Pass Through)

Required Features

1 Where emergency vehicle access is provided, an absolute minimum of 10 feet of clear space shall be maintained between bollards or features. The presence of mountable curbs, flexible or collapsible objects, or restricted lanes may reduce space requirements.

2 Volume management treatments shall provide bicycle access, either through a 4-foot minimum contra-flow bike lane or a 5- to 6-foot opening between vertical curbs.

Recommended Features

3 Appropriate signs should be used to prohibit undesired automobile movements and access while permitting desired bicycle access.[154]

4 For a partial closure, the curb extension or edge island should extend almost to the centerline of the street, leaving at least 4 feet for the contraflow bike lane, and the adjacent travel lane may be narrowed through the closure. The length of the closure should be about 30 feet, an uncomfortable distance for drivers traveling the wrong way.

5 Diagonal diverters, median barriers, and forced-turn islands should have clear widths sufficient for single-unit trucks to make turns without encroaching on opposing lanes.

6 Volume control measures should not be used along primary emergency response routes. See route planning and speed management for a discussion of designating an emergency response network and minimizing impacts to emergency vehicles along bicycle boulevards.

7 Traffic volumes on other parallel non-arterial streets should be monitored to determine the impacts to volumes, which may require further mitigation. Neighbors and nearby businesses should be consulted to build support for volume management treatments prior to implementation.

8 Appropriate education for use of proposed treatments should be provided to neighbors and others who are likely to use the corridor.

9 Closures and diverters should be liberally signed and marked to alert drivers to expect bicyclists emerging from or not turning at the feature.

residents. Volume management may impact residents more than through traffic and can effect the broader street network. Other traffic management tools should be considered prior to preventing through traffic.

Optional Features

(10) The partial closure curb extension or edge island may be tapered to deflect drivers to the right as they approach the feature.

(11) Curb heights lower than 6 inches may be used on diverters and median barriers to allow emergency vehicles to mount and cross barriers.

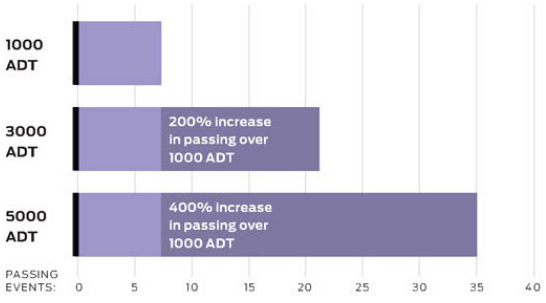
(12) Bollards may be used for diagonal diverters, but 5 feet should be provided between them to accommodate one direction of bicycle travel.

(13) Measures may be implemented on a trial basis to gauge resident support prior to finalizing the design. Temporary closures can be created with construction barrels or planters; however, an unappealing design aesthetic may diminish residents' opinions.

(14) Channelizing devices may be used along a center line to preclude turns or along lane lines to preclude lane changing, as determined by engineering judgment.[155]

(15) Consider defining a threshold of acceptable motor vehicle volume impacts to traffic on adjacent streets when using speed and volume management.[156]

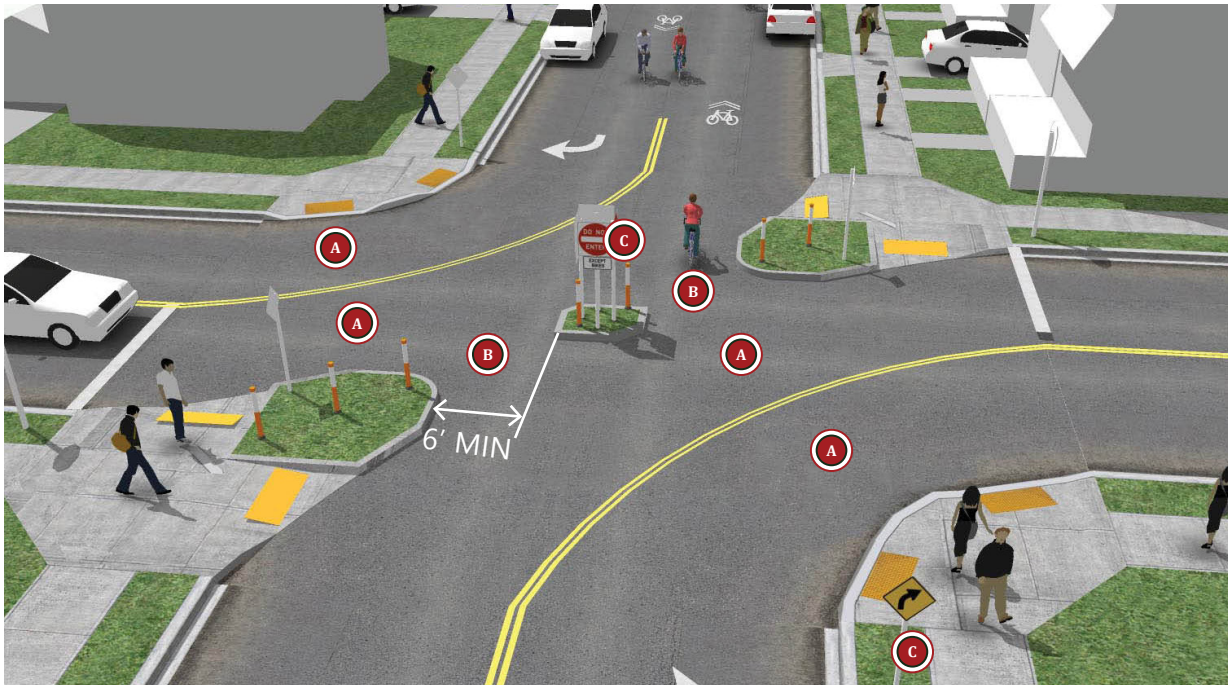
Depending on motor vehicle volumes, a bicyclist will be passed by a car going the same direction this many times during a 10 minute trip:



Values shown assume 20 mph posted speed. Local street peak hour is 15 percent of ADT. 70 percent of peak hour traffic is in the peak direction. Cars are evenly spaced along the street: no platooning. 10 minute trip calculated during peak hour. Cars are travelling the posted speed limit (speed management techniques may be necessary). Note: Cars may pass bicyclists more or less frequently depending on how well these assumptions reflect reality.

DIAGONAL DIVERTER

Diagonal diverters are barriers built across an intersection that prevent through and/or turning movements. Pedestrian and bicycle travel is usually maintained. Typical barriers may include a cul-de-sac, mountable median(s), and doweled-on median(s) which may incorporate stormwater bmp's, landscaping, bollards or gateway features.



Application

- Applicable for subdivisions, local, and minor collector streets. Suitable in urban and suburban settings.
- Can be applied on corridors with or without a bicycle facilities.
- Evaluate traffic patterns to determine whether other streets would be adversely affected.
- Consider emergency vehicle circulation and access before implementing.

Design Features

A Diagonal diverter should maintain full lane widths.

B An opening can be provided for a bicyclist to pass through the barrier. If bicycle channel is provided, it should have a vertical feature adjacent to each edge of the channel.

C Appropriate signs and markings need to be implemented to heighten motorist awareness.

MEDIAN BARRIER AND FORCED TURN ISLAND

Median barriers and forced turn islands are raised islands placed in the center of the roadway and across an intersection. Median barriers prevent left turns from the through street and force right turn movements on the bike boulevard.

Typical Application

- Suitable for installation on an arterial or collector street to prevent turns into or out of a minor collector, local, or subdivision street.
- Bicycle and pedestrian crossings can be incorporated.
- More effective on streets with a speed limit of 25 mph.
- Can be installed on a crest vertical curve only if there is adequate stopping sight distance or if appropriate warning signs are provided.

Design Features

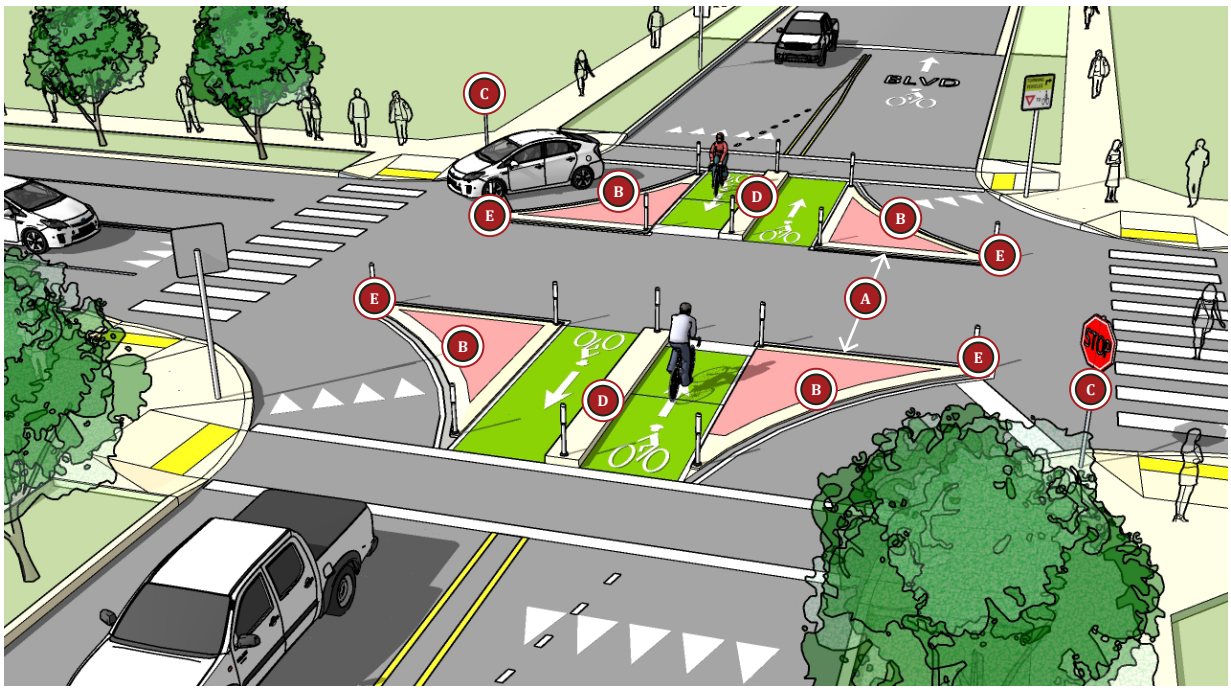
A Median barrier should have minimum 6 foot openings in both directions for bicycle refuges.

B 8 foot minimum island width for bicycle crossings and 6 foot minimum island width for pedestrian crossings.

C The median barrier should extend a minimum of 20 feet beyond both sides of the intersection.

RIGHT-IN RIGHT-OUT BIKE BOULEVARD CROSSING

Right-in right-out bike boulevard crossings are raised islands which allow cyclists to travel straight through an intersection while eliminating through movements for motorists. Drivers on the bike boulevard must make a right turn onto the crossing street. Left turns onto the bike boulevard for cross street traffic are restricted and access is only available turning right.



Typical Application

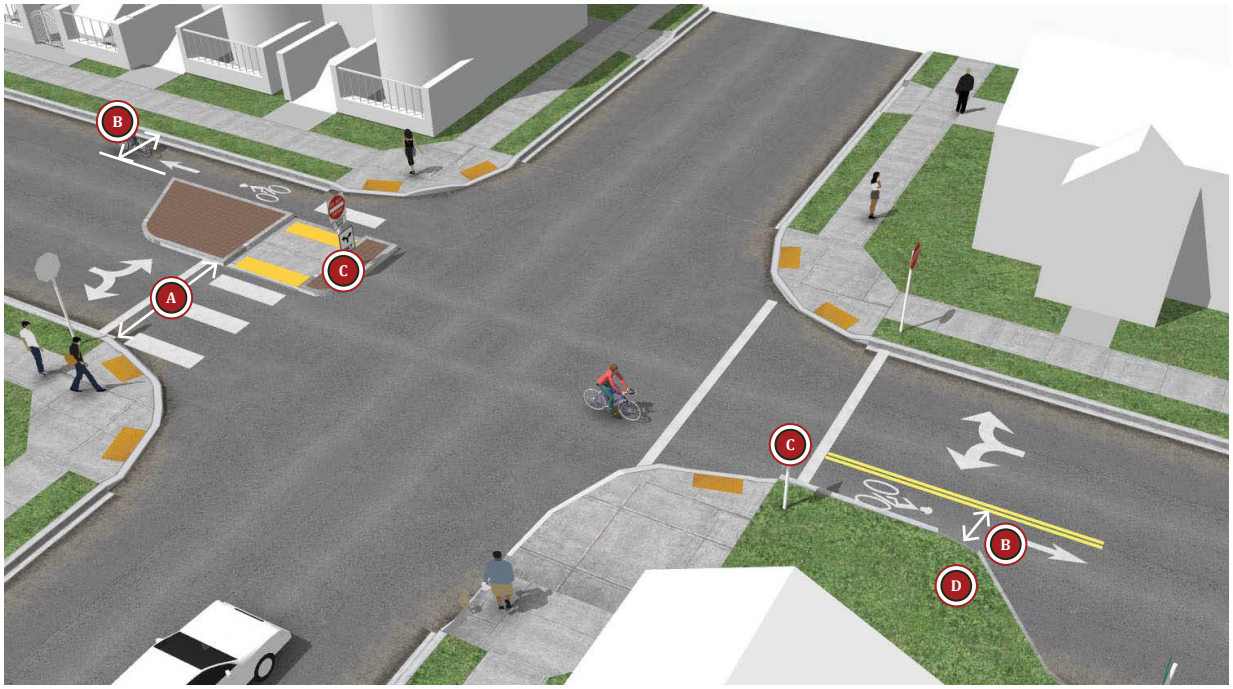
- May be used on local roads crossing another two lane roadway.
- Design right turn channel to minimize vehicular speeds for passanger vehicles.
- Not recommended at the crest of a hill.
- Evaluate traffic patterns to determine whether other streets would be adversely affected.

Design Features

- **A** Crossing travel lanes may be narrowed to 20 feet or as directed by fire department.
- **B** Mountable islands allow access for vehicles with turning radii greater than passanger vehicles.
- **C** Stop control right turns onto roadway crossing bike boulevard.
- **D** Install median with vertical curb to reinforce restricted left turn movements and protect waiting bicyclists.
- **E** Vertical flex posts alert motorist about the right turn islands.

HALF CLOSURE

A half closure is a physical barrier that blocks travel in one direction at an intersection. Pedestrian and bicycle traffic are usually maintained in all directions. Typical barriers may include bump outs, mountable medians, and doweled-on medians which may incorporate stormwater bmp's, landscaping, bollards or gateway features.



Application

- Appropriate for a subdivision or local street; not recommended on collector streets and arterials.
- Avoid streets with traffic volumes above 6,000.
- Not recommended along a bus transit route. May be appropriate for emergency vehicle access routes with a mountable median.
- With advanced warning, street speed limits are not constrained.
- Evaluate traffic patterns to determine whether other streets would be adversely affected.

Design Features

A Should provide a full lane width in the open direction with sufficient curb radii at the entrance intersection.

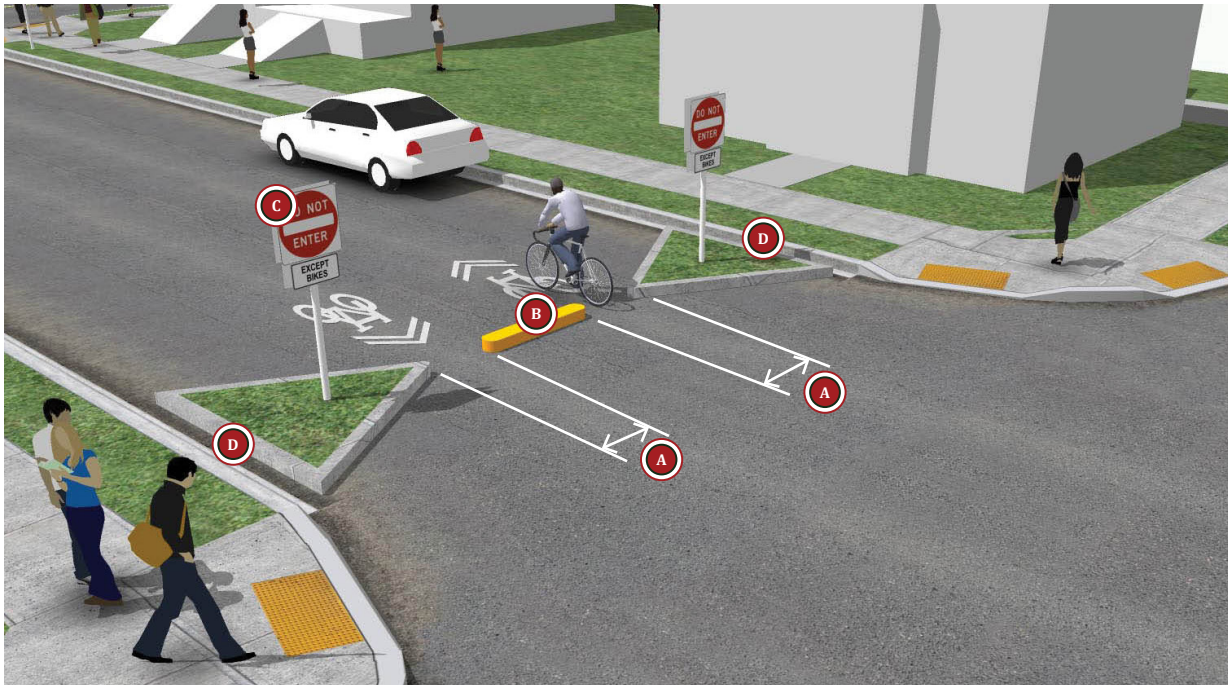
B A half closure island may have an opening a minimum 5 feet wide to allow drainage flow and to permit bicyclists to pass through the barrier.

C One-way and do not enter signs should be used to advise traffic on the crossing street that a turn onto the closed street is not permitted.

D Ensure positive drainage to inlet when utilizing a bump out.

FULL CLOSURE

A full closure is a physical barrier placed across a roadway at an intersection to block all vehicle access. Pedestrian and bicycle traffic are typically maintained in all directions. Barriers may include a cul-de-sac, island(s), and/or doweled-on median(s) which may incorporate stormwater bmp's, landscaping, bollards or gateway features.



Application

- May be used for a subdivision or street with only local traffic or through traffic below 500 vehicles per day. Not recommended for most through streets.
- Not recommended along a bus transit or emergency vehicle route.
- Evaluate traffic patterns to determine whether other streets would be adversely affected. Consider other traffic calming alternatives prior to implementing a full closure.

Design Features

- (A) May have a minimum 5 feet wide opening in both directions to permit bicyclists to pass through the barrier.
- (B) Provide barrier between bicycle openings to restrict vehicle access.
- (C) Do not enter signs should be used to advise traffic on the crossing street that a turn onto the closed street is not permitted.
- (D) Ensure positive drainage to inlet or install drainage structure.