# COMPLETE STREETS DESIGN GUIDE

*City of Appleton, WI*

03.2024 **alta**

# DOCUMENT OVERVIEW

**What is a Complete Street?**

Complete streets are multi-faceted and holistic streets that support multimodal transportation, active commerce, and vibrant communities. They meet the needs of a growing and thriving city by improving safety, enhancing access, and leading to even more growth in the community.

This design guide is an evolution and update of ongoing efforts over the past 15 years. Appleton adopted its first Complete Streets policy in 2006 and has been incorporating Complete Streets practices into street design beginning in the early 2010s.

Complete street elements or designs have been implemented on a number of Appleton Streets, including:

- Badger Ave (Packard to Wisconsin)
- John St (College to Calumet)
- Newberry St (Schaefer to STH 441)
- Prospect Ave (Haskell to W city limits)
- Glendale Ave (Richmond to Mason)
- Madison St / Maple St intersection
- Linwood Ave (College to Badger)
- Evergreen Dr (Richmond to Haymeadow)

**How can the Design Guide be used?**

This design guide should be used to support City of Appleton staff in identifying and implementing complete street design solutions from initial concept through final engineering. The design guide is intended to support and augment existing street design policies and standards, including the most recent complete streets policy.

The three sections of the design guide, as included in the table of contents, provide a framework for incorporating complete street elements into a broad array of contexts and project budgets.

# TABLE OF CONTENTS

# WHAT ARE THE COSTS AND BENEFITS OF COMPLETE STREETS?

## COSTS

### Cost

In most locations, the cost of constructing complete streets is comparable to conventional streets.

## BENEFITS

### Economy

Complete streets support greater business access and walkability, and have been shown to support new businesses and increased employment.

### Safety

Complete street designs result in fewer crashes, injuries, and deaths for people walking, biking, and driving.

### Mobility

Complete streets designed for all modes of travel expand the capacity of streets as well as individuals' mobility choices.

### Health

Complete streets encourage people to walk and bike, which is associated with improved health outcomes for people at all stages of life.

### Environment

Complete streets make the built environment more accessible for non-motorized modes, reducing the impact of travel on the environment. They can also provide more space for plants and wildlife habitat.

# HOW LONG WILL IT TAKE?



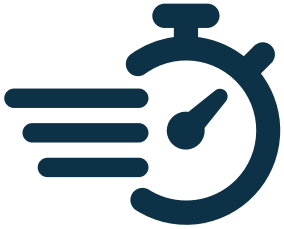
**200+ Years at the Current Rate**

A complete build-out of Appleton's streets would take over 200 years given current rates of funding for street reconstruction or resurfacing.

**Accelerator #1: Quick-build**

Quick-build techniques utilize relatively inexpensive materials such as paint and flex posts to add traffic calming to existing roadways.

Reference traffic calming retrofit program and policy in Section 3.



**Accelerator #2: Diversified Implementation and Funding Strategies**

Diversifying federal, state, and local funding streams will allow for increased complete street projects.

Reference funding information on pg. 69.

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# COMPLETE STREET CROSS-SECTIONS

# WHAT FACTORS INFLUENCE COMPLETE STREET DESIGN?

For any complete street project, four primary factors should be considered.

1. **Type of Street Project**: What is the nature of the street construction project and how much of the street is being reconstructed? This will determine whether or not the entire right of way (ROW) or a portion of it is being reconstructed.
2. **Street Classification**: What is the functional classification of the street?
3. **Context**: What is the surrounding context for the street? This has a major impact on the character and function of the complete street design.
4. **Priority Street**: Is this street a part of a larger regional network for mobility, such as a regional bike or transit network?

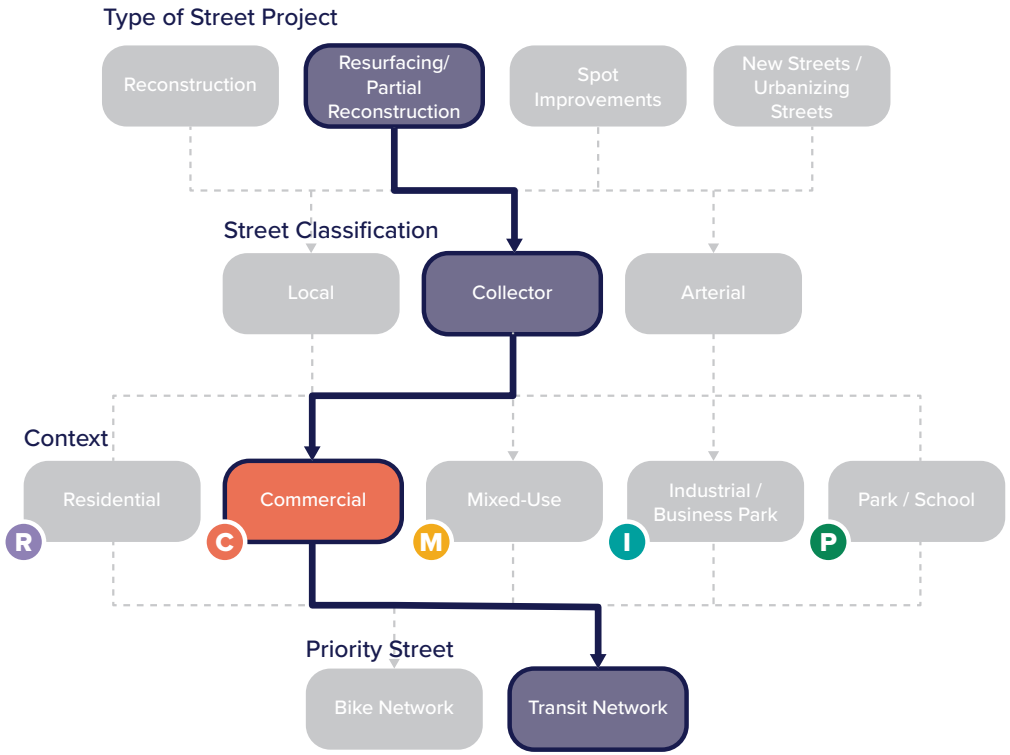



**Figure 1:** *Decision making flowchart to guide the complete street design. An example set of attributes is shown, but almost any combination is feasible.*

## TYPES OF STREET PROJECTS

Every street construction project will fall into one or more of the following categories. Each project type may have different impacts to existing ROW and street width.

### Full reconstruction

Full reconstruction involves completely tearing out an existing roadway and installing a new stone base layer as well as a new paved driving surface, often with all new concrete curb and gutter. These types of projects provide the opportunity to adjust street width.

Full reconstruction projects maintain the existing ROW.

### Resurfacing/ Partial Reconstruction

Resurfacing/partial reconstruction projects maintain the original base layer, but apply a new pavement overlay. Portions of the concrete curb & gutter may be replaced.

While resurfacing projects maintain the existing street width, they do provide an opportunity to re-stripe a roadway and make minor geometric changes.

### Spot improvements

Spot improvements are typically added to address a specific issue along a roadway, such as frequent speeding, unsafe crossings, or high traffic volumes.

Spot improvements can be independent of complete street redesign, and tend to be located at intersections or mid-block.

### New street

A new street can be added to create a new connection where there previously was not a street. Adding a street will involve the installation of a base layer and pavement overlay, which allows for many design possibilities for the new street.

New streets are typically established when new and redevelopment projects occur. The ROW width is determined at that time.

## STREET CLASSIFICATION

Appleton's street network is made up of local, collector, and arterial streets. These classifications are set by the City and differ from Wisconsin DOT classifications. This study does not include private roads or streets outside of the public ROW.

### Local

Local roadways feature lower speed limits and a greater frequency of stop-controlled intersections. The primary role of local roadways to provide direct access to homes and businesses throughout the community.

**70.2%** of all public streets in Appleton

**247.3 miles** in length

**55%** of local streets in Appleton feature a 60ft ROW and 32ft Face to Face (F-F) width.

### Collector

Collectors are low to moderate capacity roadways that connect local roadways and arterials. These roadways vary greatly between different contexts and typically feature moderate speed limits, multiple travel lanes, and relatively high-volumes of transit and bike traffic.

**15.1%** of all public streets in Appleton

**53.4 miles** in length

**29.3%** of collectors in Appleton feature with a 66ft ROW and 36ft F-F width.

### Arterial

Arterials feature the greatest vehicular speed limits, traffic volumes, and number of lanes. These roadways provide long-distance and uninterrupted travel. Arterial roadways frequently extend beyond Appleton and into other jurisdictions.

**14.7%** of all public streets in Appleton

**52.0 miles** in length

Arterials are the least consistent street class in Appleton with highly variable ROW and street widths.

## CONTEXT

The complete street design needs to respond to the nearby land-use context. This ensures that the street reflects the character and function to support the adjacent community. It should be noted that context may vary along a singular corridor, and it can change over time with new development or redevelopment.

| Context | Description | Key Features |
|---|---|---|
| R **Residential** | Quiet residential streets with relatively low traffic volumes and speeds. Though they have lower activity levels relative to other street types, they play a key role in supporting the character and comfort of a neighborhood. | • Traffic calming for slow streets<br>• Ample street terrace for urban greening |
| C **Commercial** | Corridors with large amounts of adjacent commercial land uses that often include retail and office uses. Commercial corridors feature significant day-time and weekend demand, and require a full suite of multimodal access options. | • Wide sidewalk and space for amenities<br>• Traffic calming<br>• Multimodal infrastructure |
| M **Mixed-Use** | Corridors with a blend of commercial, residential, and other land uses. Mixed-Use corridors typically feature significant demand and need to serve a wide range of modes of transportation and functional uses of the street. | • Wide sidewalk and space for amenities<br>• Traffic calming<br>• Multimodal infrastructure |
| I **Industrial or Business Park** | Industrial or business parks are employment hubs and need to be able to serve a broad range of vehicle traffic, including personal vehicle and freight traffic, as well as multimodal access for commuters and transit users. | • Maintain roadway function to support large businesses<br>• Provide sidewalks, sidepaths, and urban greening for employees |
| P **Park or School** | Parks or schools serve high levels of bike and pedestrian traffic. Safety is critical, as these land uses serve higher percentages of vulnerable street users such as youth and seniors. Ample traffic calming is essential to these land uses. | • Wide sidewalk<br>• Ample traffic calming with safe crossings |

## PRIORITY STREET CONSIDERATIONS

The complete street design needs to align with the multimodal goals and ongoing planning efforts of the region, in particular the existing local and regional bike and transit planning.

**Bike and Trail Network.** Outagamie County has recently drafted a Bicycle and Pedestrian plan including recommendations for the growth of Appleton's bike network. Appleton has also established a Downtown Streetscape Design Guide, which recommends various street types in Appleton's downtown, many of which contain bike facilities.

**Reference plans:**

- Outagamie County Bicycle and Pedestrian Plan (pending adoption, 2023)
- ECWRPC Bike & Pedestrian Plan (2021)
- Appleton Trails Master Plan (2017)
- City of Appleton On-Street Bike Lane Plan (2010)


**Transit.** Appleton worked with Valley Transit (VT) to establish a Transit Development Plan (TDP) in 2020 to evaluate Valley Transit's vision/mission statements, short and long term goals, and reevaluate its transportation programs to ensure effective and efficient transportation to its clientele.

**Reference plans:**

- City of Appleton Transit Development Plan (2020)

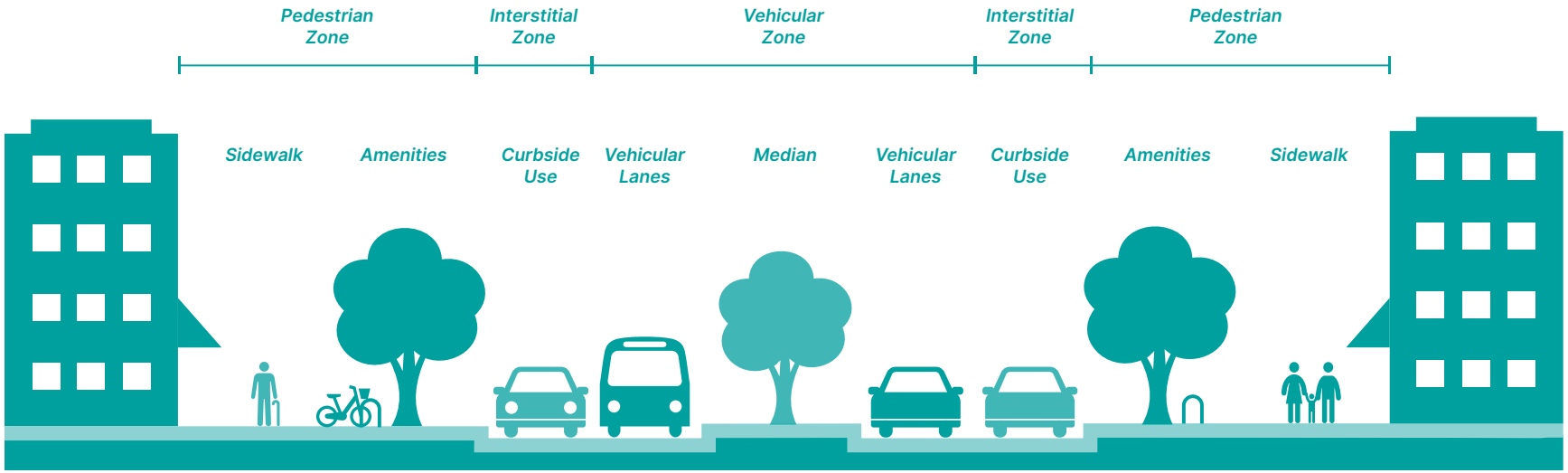

**Additional Plans.** Many other plans include content that impacts or overlaps with this guide, including aspects of street design, school-specific recommendations, or policies.

**Reference plans:**

- City of Appleton Downtown Streetscape Design Guide (2021)
- ECWRPC Complete Streets Policy (2018)

# WHAT GOES INTO A STREET?

The figure below highlights the typical complete street cross-sections included in this guide. While this list is not exhaustive, it presents a starting place for most streets in Appleton*.




*Any street design and development project needs to consider utilities

**Pedestrian Zone:**

- **Sidewalk**: A designated, paved space for pedestrian travel.
- **Sidepath**: A designated, paved space for pedestrians, bicyclists, and users of other mobility devices.
- **Amenity Zone**: A space along the sidewalk that can contain amenities such as seating, bike racks, plants, transit stops, and more.

**Interstitial Zone:**

- **Curb & Gutter**: A space designed to prevent the roadway or pedestrian zone from flooding by allowing for drainage.
- **Parking**: A space designated for vehicle parking.
- **On-Street Bike Infrastructure**: A designated facility for those using a bicycle, scooter, or other mobility device.

**Vehicular Zone:**

- **Vehicular lanes**: A space for vehicles to travel.
- **Center turn lane**: A lane for vehicles that will be turning left across the opposite travel lane.
- **Median**: A physical element that divides the two directions of travel; it can contain plants, public art, and can serve as a pedestrian crossing refuge.

**Figure 2:** *Elements of a typical complete street cross-section.*

## DESIGN STANDARDS

Table 1 below indicates typical dimensions for street elements based on street classification and context*.

All width dimensions are in feet, and organized as:
**Preferred** - Minimum - Maximum

| | | Local | | | | Collector | | | | Arterial | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Zone** | **Name** | R | C M | P | I | R | C M | P | I | R | C M | P | I |
| Pedestrian Zone | Sidewalk | **5**-5-6 | **8**-5-10 | **5**-5-6 | **6**-5-6 | **5**-5-6 | **8**-5-10 | **5**-5-6 | **6**-5-6 | **5**-5-6 | **8**-5-10 | **5**-5-6 | **6**-5-6 |
| | Sidewalk at back of curb | **7**-7-8 | **10**-7-12 | **7**-7-8 | **8**-7-8 | **7**-7-8 | **10**-7-12 | **7**-7-8 | **8**-7-8 | **7**-7-8 | **10**-7-12 | **7**-7-8 | **8**-7-8 |
| | Sidepath** | N/A | | | **10**-8-12. For high-usage routes, a 5ft parallel walkway is recommended. | | | | | | | | |
| | Amenity (café seating) | N/A | **6**-5-8 | N/A | N/A | | **6**-5-8 | | N/A | | **6**-5-8 | | N/A |
| | Amenity (parkway with trees) | **5 to 8+**-5-8+. Along arterials or roadways without a curbside parking lane, additional width is highly recommended. | | | | | | | | | | | |
| Interstitial Zone | Curb | **0.5**-0.5-1. Wider curbs may be more common in downtown areas. | | | | | | | | | | | |
| | Gutter | **1**-1-2+. For bike lanes, a widened integral gutter should be used whenever possible. | | | | | | | | | | | |
| | Bike Lane** | N/A | | | | **6**-5-6. Where space allows, buffered or protected bike lanes are preferred. | | | | | | | |
| | Buffered Bike Lane** | N/A | | | | **8**-7-8+. For arterial roads, protected bike lanes are preferred. | | | | | | | |
| | Protected Bike Lane** | N/A | | | | **8**-7-8+ | | | | | | | |
| Vehicular Zone | Parking | **7**-7-7.5 | **7.5**-7.5-8 | | | **8**-7.5-9 | | | | | | | |
| | Vehicle Lane (excluding gutter) | **9**-9-10 | **10**-10-12 | | | | | | | | | | |
| | Median | N/A | | | | **Varies**-6-10+. 6ft is the minimum recommended width for pedestrian refuge islands at crossings. Wider medians allow for trees. | | | | | | | |
| | Bus Lane / Truck Route | **10**-10-11 | **11**-11-12 | | | | | | | | | | |

*The preferred widths on all cross-sections represent a starting point for design. Specific site conditions may result in min or max dimensions being more appropriate.
**Bike infrastructure may vary and selection of infrastructure type will depend upon context and available right-of-way.

**Table 1:** *Design standards for complete street cross-section elements.*

# TYPICAL CROSS-SECTIONS

Table 2 below highlights the typical complete street cross-sections included in this guide. While this list is not exhaustive, it presents a starting place for most streets in Appleton. The cross sections on the following pages illustrate a variety of preferred cross sections. When the requirements for a preferred cross section cannot be met, the minimum widths for the complete street can be explored.

| | ID | Pg | Name | Description | Contexts | When to use* |
|---|---|---|---|---|---|---|
| **Local** | L.1 | 16 | Residential Traditional Local | Residential local street with parking along both sides. | R | • High parking demand |
| | L.2 | 16 | Residential Smart Local | Residential local street with parking along one side. | R | • Average to low parking demand<br>• Constrained ROW |
| | L.3 | 17 | Generic Traditional Local | Local street with parking along both sides. | C M P I | • High parking demand |
| | L.4 | 17 | Generic Smart Local | Local street with parking along one side. | C M P | • Average to low parking demand<br>• Constrained ROW |
| | L.5 | 18 | Industrial Smart Local with Sidepath | Industrial local street with parking along one side and a sidepath. | I | • Average to low parking demand<br>• Critical corridor for bike connectivity |
| **Collector** | C.1 | 19 | Low-Density Residential Collector | Residential collector street with parking along one side and a sidepath. | R P I | • Residential low-density neighborhoods<br>• Medium to low parking demand |
| | C.2 | 19 | Bike Priority Collector | Residential collector street with buffered bike lanes on both sides. | R P I | • Critical corridor for bike connectivity<br>• Average to low parking demand |
| | C.3 | 20 | Multimodal Collector | Commercial collector with parking along one side and bike lanes along both sides. | C M P I | • Critical corridor for bike connectivity<br>• Average to low parking demand |
| | C.4 | 20 | Generic Traditional Collector | Adaptable collector with parking along both sides. | R C M P I | • High parking demand areas only, particularly in commercial areas |
| | C.5 | 21 | Generic Smart Collector | Adaptable collector with parking along one side. | R C M P I | • Average to low parking demand |
| **Arterial** | A.1 | 22 | Boulevard | Arterial with center median and protected bike lanes. | R P I | • Critical corridor for bike connectivity<br>• Road diet and impervious surface reduction |
| | A.2 | 22 | Multimodal Arterial | Arterial with parking on one side and protected bike lanes. | C M P I | • Critical corridor for bike connectivity<br>• High to average parking demand |
| | A.3 | 23 | Constrained Arterial | Arterial with protected bike lanes. | R C M P I | • Critical corridor for bike connectivity<br>• Constrained ROW |
| | A.4 | 24 | Multi-Lane Commercial Destination | Multi-lane arterial with parking on both sides and wide street terrace. | C M | • Only for commercial areas where multiple lanes and parking is necessary |
| | A.5 | 25 | Multi-Lane Boulevard | Multi-lane arterial with center median and sidepaths. | C M P I | • Only appropriate for outlying areas where multiple lanes is necessary |

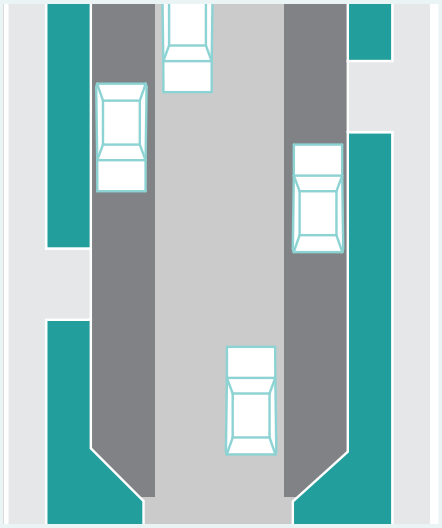
*Using parking demand to inform an appropriate cross-section should consider existing parking use as well as future land-use decisions and expectations.

**Table 2:** *Typical cross-section reference table.*

## LOCAL STREETS

Local streets make up the majority of the street network. The preferred local street cross-section varies based on parking demand, ROW constraints, and desired impervious surface reduction, per Figure 3.

**Figure 3:** *Local street parking strategy.*

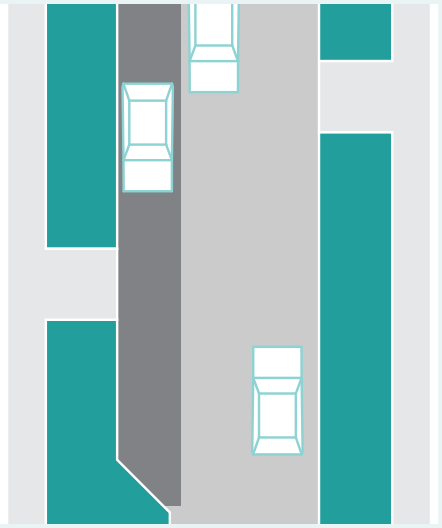


### Traditional (L.1/L.3)

- Parking both sides
- 32ft to 36ft street width based on context

Applications:

- High parking demand

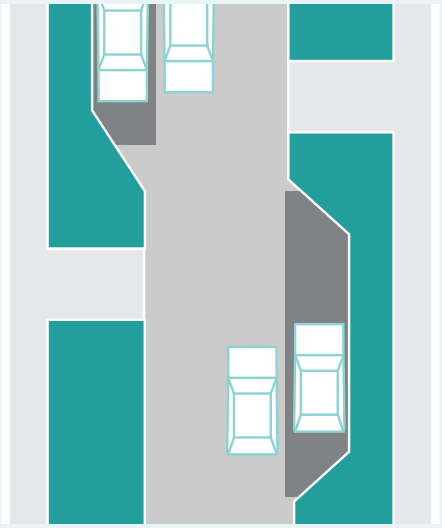


### Smart Street (L.2/L.4/L.5)

- Parking one side, may present challenges if along street with alternating overnight parking restrictions
- 26ft to 29ft street width based on context
- 50% parking capacity and up to 13% less impervious surface than parking on both sides

Applications:

- Average to low parking demand
- Constrained space due to narrow ROW, utilities, or existing street trees



### Alternating Smart Street

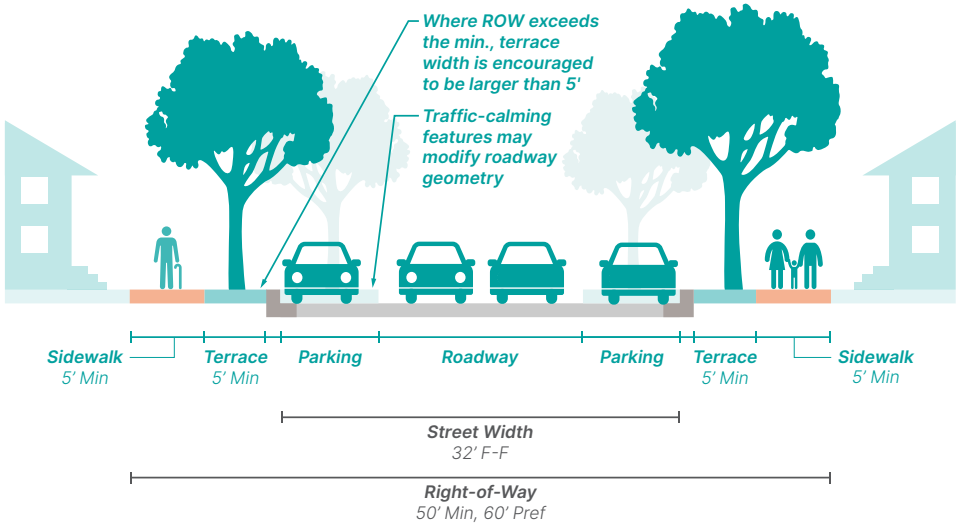
- Modified version of the Smart Street with alternating parking on both sides
- 25% to 50% parking capacity and up to 19% less impervious surface than parking on both sides

Applications:

- Low parking demand
- Locations where parking is desired on both sides

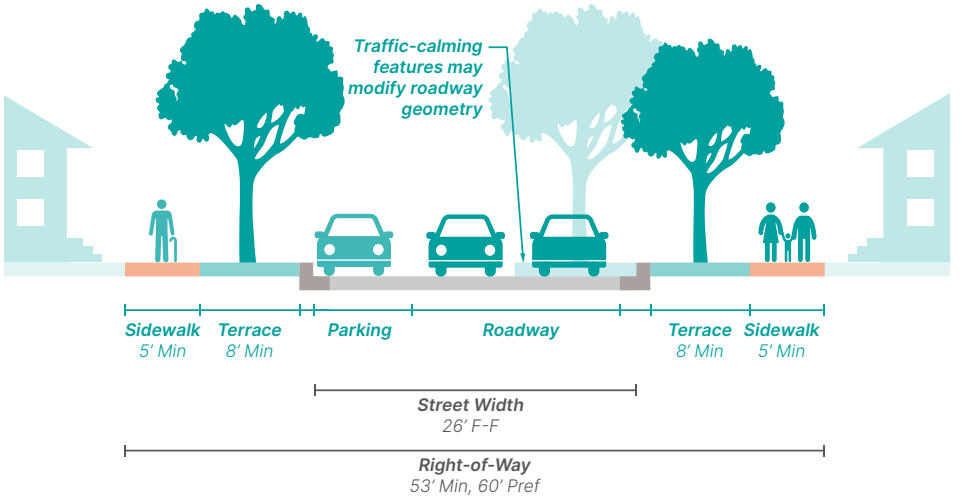
## L.1 Residential Traditional Local

| | |
|---|---|
| Street Width | 32ft F-F |
| ROW | 50ft Min, 60ft Preferred |
| Parking | 2 sides |
| Context | R |
| Description | Residential local street with parking along both sides. |
| Use | • High parking demand on both sides of the street |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Speed humps<br>• Speed tables<br>• Street trees |



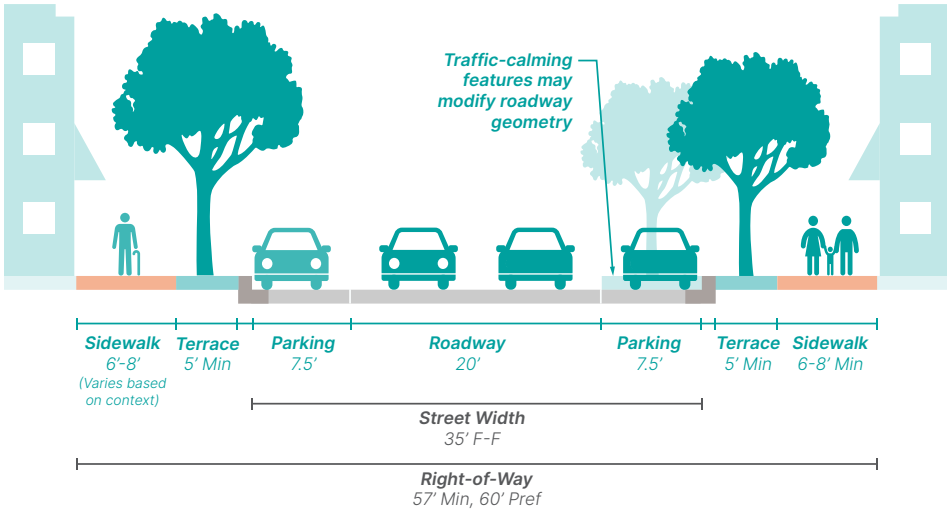

## L.2 Residential Smart Local

| | |
|---|---|
| Street Width | 26ft F-F |
| ROW | 53ft Min, 60ft Preferred |
| Parking | 1 side |
| Context | R |
| Description | Residential local street with parking along one side. Cross-section features widened tree terraces and reduced impervious surface. |
| Use | • Average to low parking demand<br>• Constrained space due to narrow ROW, utilities, or existing street trees |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Chicanes<br>• Speed humps<br>• Speed tables<br>• Street trees |



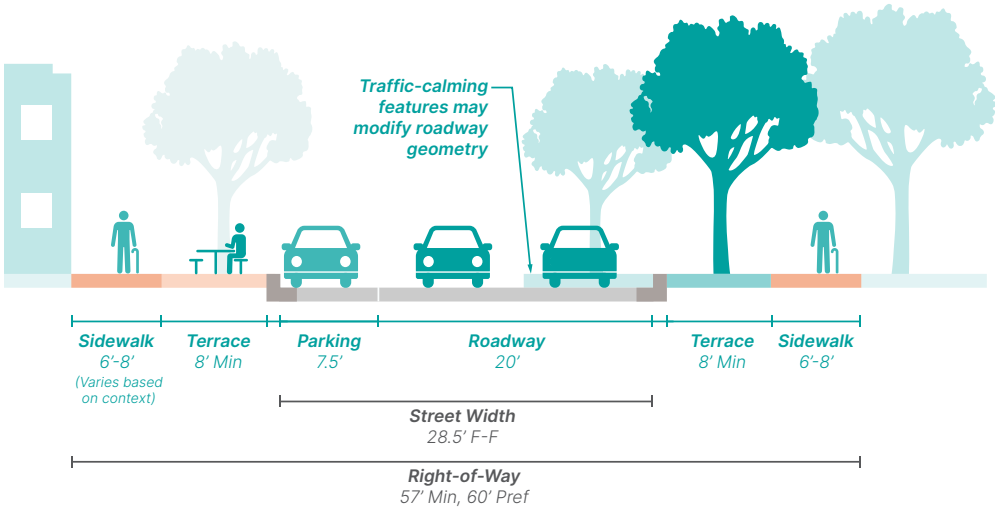
## L.3 Generic Traditional Local

| | |
|---|---|
| Street Width | 35ft F-F |
| ROW | 57ft Min, 60ft Preferred |
| Parking | 2 sides |
| Context | C M P I |
| Description | Local street with parking along both sides. |
| Use | • High parking demand on both sides of the street |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Speed humps<br>• Speed tables<br>• Street trees |



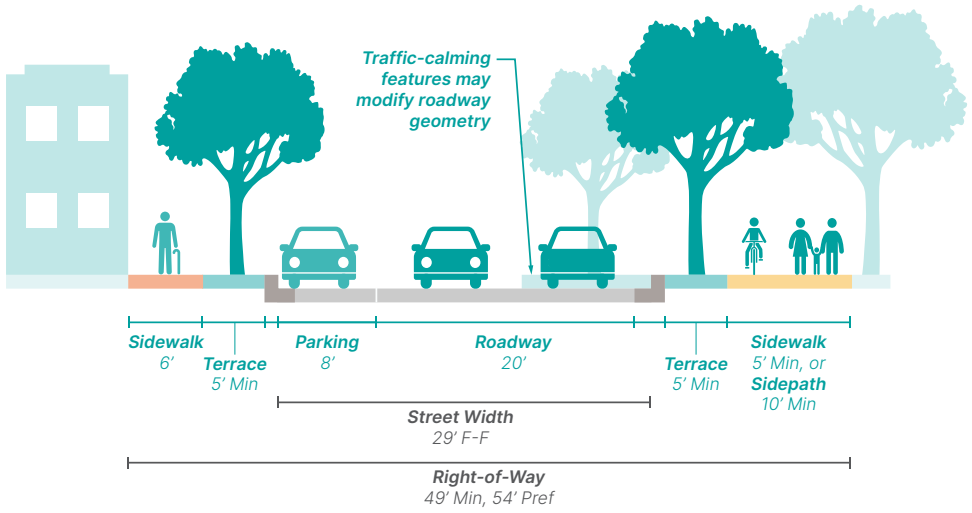

## L.4 Generic Smart Local

| | |
|---|---|
| Street Width | 28.5ft F-F |
| ROW | 57ft, 60ft Preferred |
| Parking | 1 side |
| Context | C M P |
| Description | Local street with parking along one side. Cross-section features widened tree terraces and reduced impervious surface. |
| Use | • Average to low parking demand<br>• Constrained space due to narrow ROW, utilities, or existing street trees |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Chicanes<br>• Speed humps<br>• Speed tables<br>• Street trees |



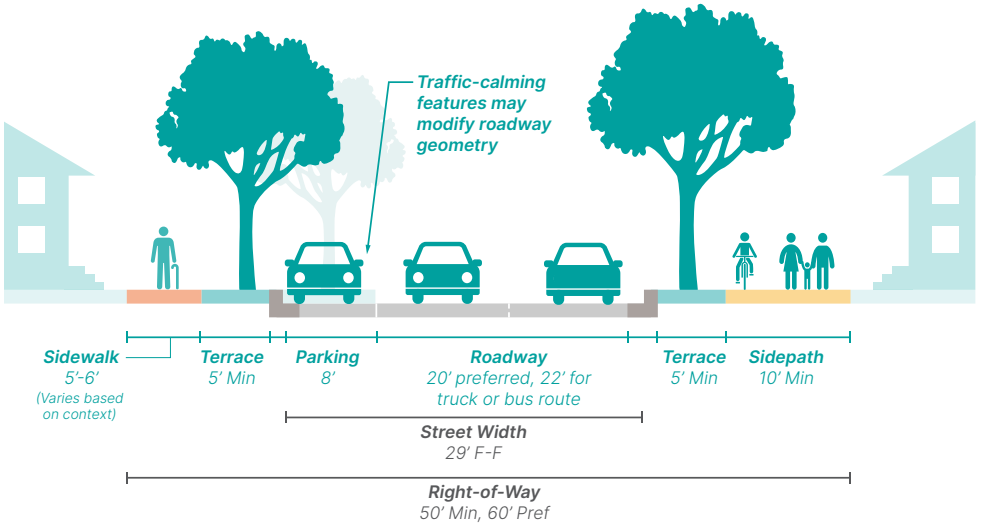
## L.5 Industrial Smart Local with Sidepath

| | |
|---|---|
| Street Width | 29ft F-F |
| ROW | 49ft, 54ft Preferred |
| Parking | 1 side |
| Context | I |
| Description | Industrial local street with parking along one side. Cross-section features widened tree terraces and reduced impervious surface. |
| Use | • Average to low parking demand<br>• Constrained space due to narrow ROW, utilities, or existing street trees<br>• Critical corridor for bike connectivity |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Chicanes<br>• Speed humps<br>• Speed tables<br>• Street trees |



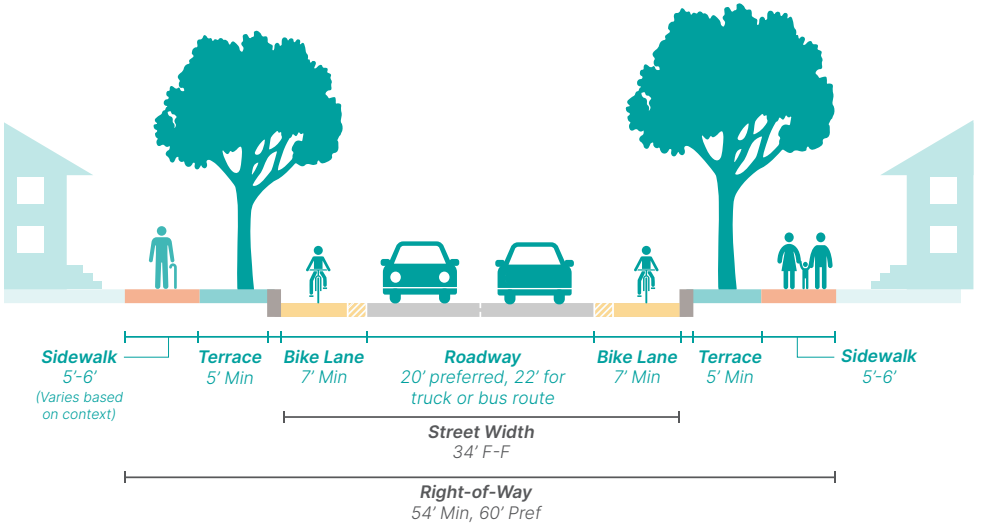
## C.1 Low-Density Residential Collector

| | |
|---|---|
| Street Width | 29ft F-F |
| ROW | 50ft Min, 60ft Preferred |
| Parking | 1 side |
| Context | R P I |
| Description | Residential collector street with parking along one side and a sidepath along the opposite side. |
| Use | • Residential collectors in outlying lower-density neighborhoods<br>• Low parking demand<br>• May also apply to park/school and industrial contexts in outlying areas |
| Traffic Calming Features | • Curb extensions<br>• Mid-block crossings<br>• Street trees |



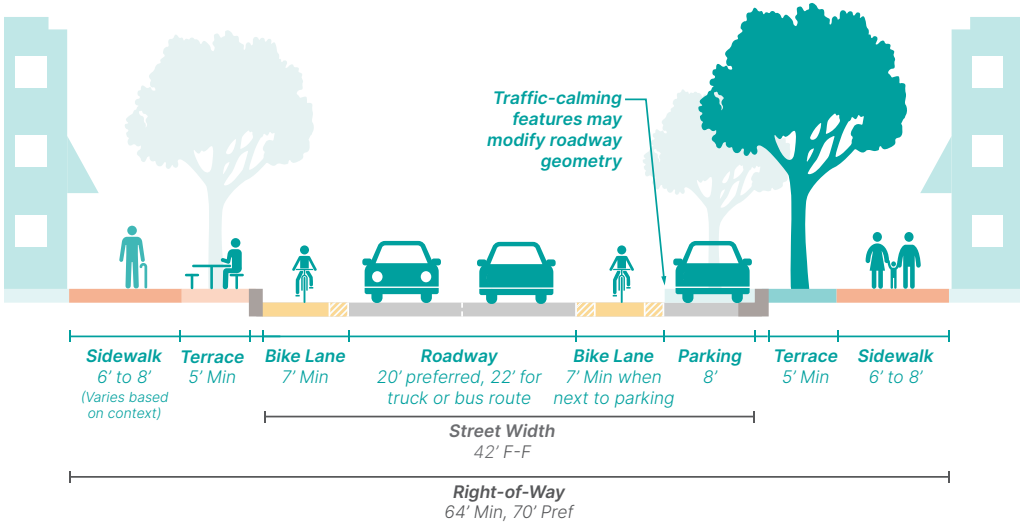

## C.2 Bike Priority Collector

| | |
|---|---|
| Street Width | 34ft F-F |
| ROW | 54ft Min, 60ft Preferred |
| Parking | None |
| Context | R P I |
| Description | Residential collector street with buffered bike lanes on both sides. Cross-section features widened tree terraces and reduced impervious surface. |
| Use | • Critical corridor for bike connectivity<br>• Average to low parking demand |
| Traffic Calming Features | • Speed tables<br>• Mid-block crossings<br>• Street trees |



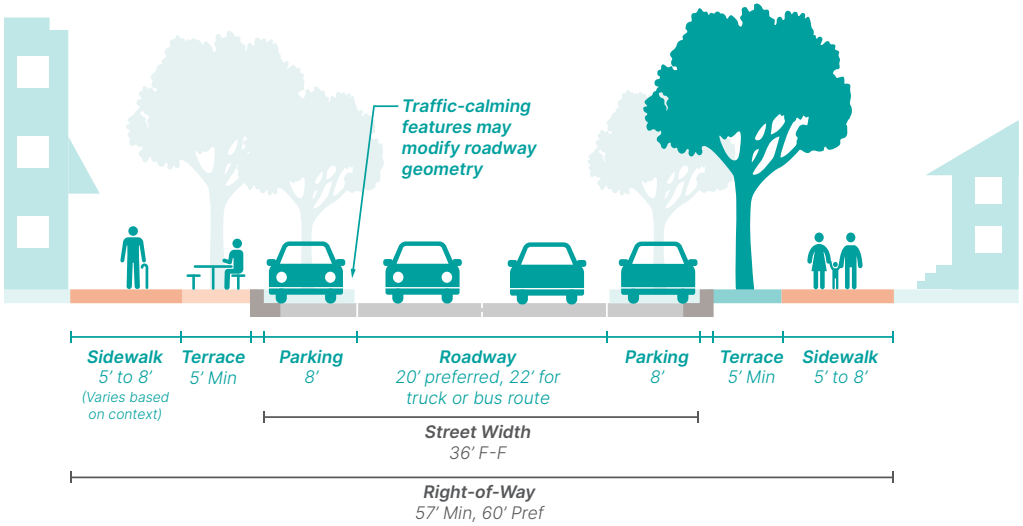
## C.3 Multimodal Collector

| | |
|---|---|
| Street Width | 42ft F-F |
| ROW | 64ft Min, 70ft Preferred |
| Parking | 1 side |
| Context | C M P I |
| Description | Commercial collector with parking along one side and bike lanes along both sides. |
| Use | • Critical corridor for bike connectivity<br>• Average to low parking demand |
| Traffic Calming Features | • Curb extensions<br>• Speed tables<br>• Mid-block crossings<br>• Street trees |



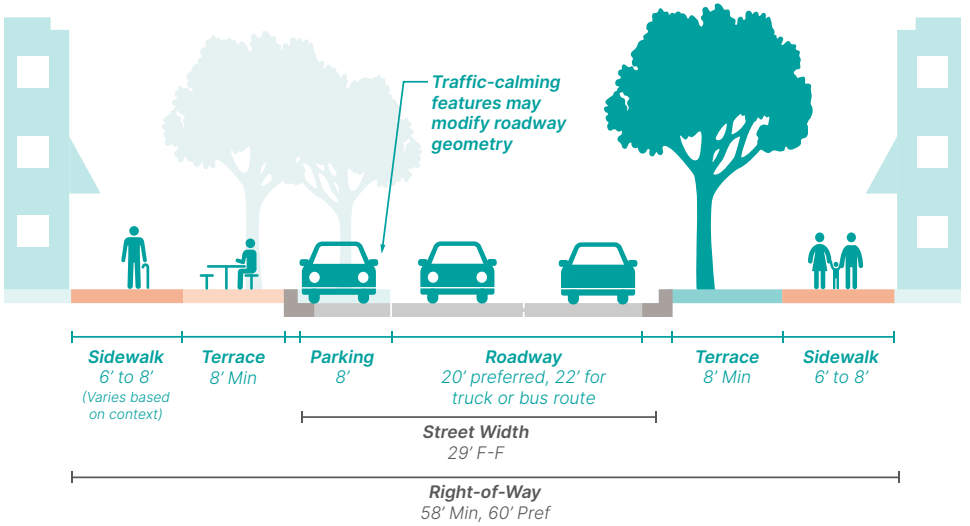

## C.4 Generic Traditional Collector

| | |
|---|---|
| Street Width | 36ft F-F |
| ROW | 57ft Min, 60ft Preferred |
| Parking | 2 sides |
| Context | R C M P I |
| Description | Adaptable collector with parking along both sides. Cross-section can be adapted to multiple contexts. |
| Use | • High parking demand areas only, particularly in commercial or mixed-use areas |
| Traffic Calming Features | • Curb extensions<br>• Pinch points<br>• Speed tables<br>• Mid-block crossings<br>• Speed tables, Street trees |



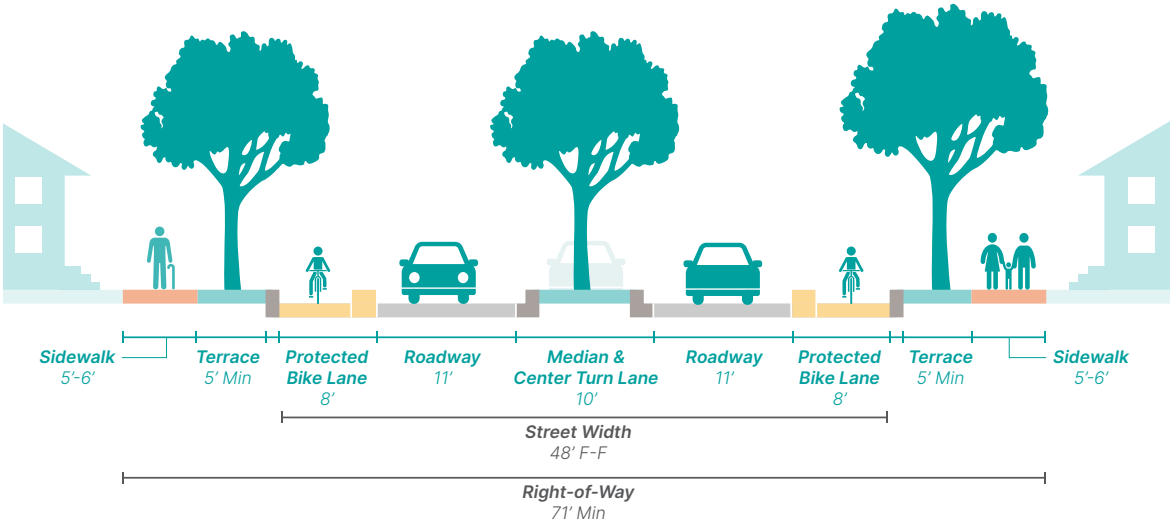
## C.5 Generic Smart Collector

| | |
|---|---|
| Street Width | 29ft F-F |
| ROW | 58ft Min, 60ft Preferred |
| Parking | 1 side |
| Context | R C M P I |
| Description | Adaptable collector with parking along one side. Cross-section features widened tree terraces and reduced impervious surface, and can be adapted to multiple contexts. |
| Use | • Corridors that are not critical for bike connectivity<br>• Average to low parking demand<br>• Commercial or mixed-use streets with demand for widened amenity zone |
| Traffic Calming Features | • Curb extensions<br>• Chicane<br>• Speed tables<br>• Mid-block crossings<br>• Street trees |



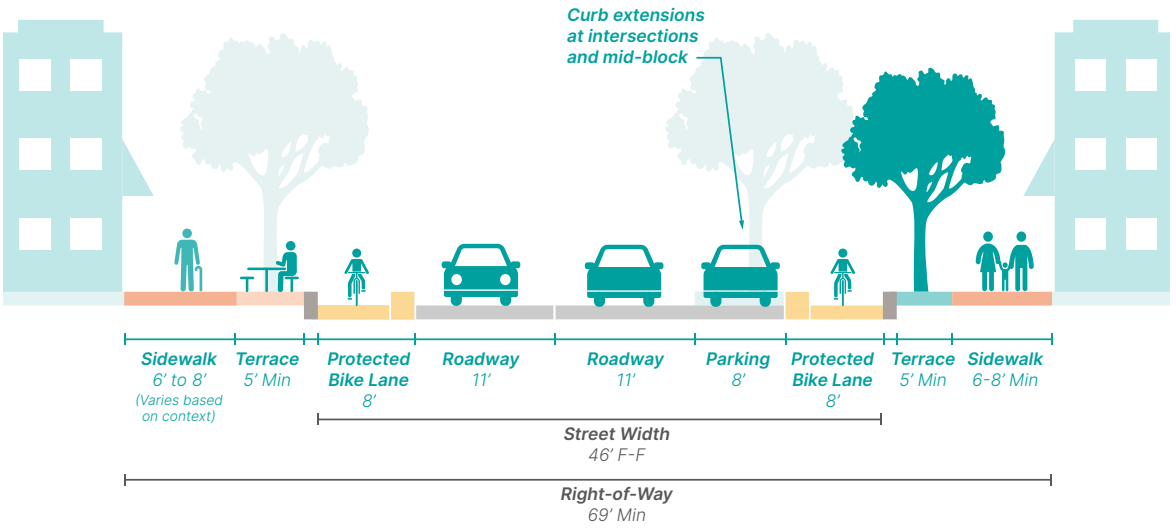
## A.1 Boulevard

| | |
|---|---|
| Street Width | 48ft F-F |
| ROW | 71ft Min |
| Parking | None |
| Context | R P I |
| Description | Arterial with center median and protected bike lanes. |
| Use | • Critical corridor for bike connectivity<br>• Road diet and impervious surface reduction |
| Traffic Calming Features | • 4 to 3 road diet<br>• Mid-block crossings<br>• Median<br>• Street trees |



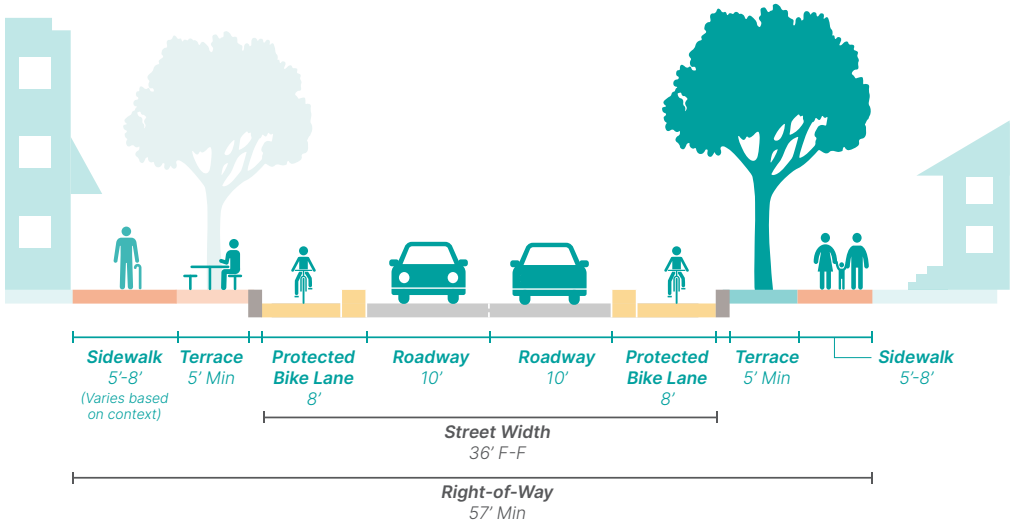

## A.2 Multimodal Arterial

| | |
|---|---|
| Street Width | 46ft F-F |
| ROW | 69ft Min |
| Parking | 1 side |
| Context | C M P I |
| Description | Arterial with parking on one side and protected bike lanes. |
| Use | • Critical corridor for bike connectivity<br>• High to average parking demand, particularly in commercial, mixed-use, or school contexts |
| Options Traffic Calming Features | • Curb extensions<br>• Mid-block crossings<br>• Street trees |



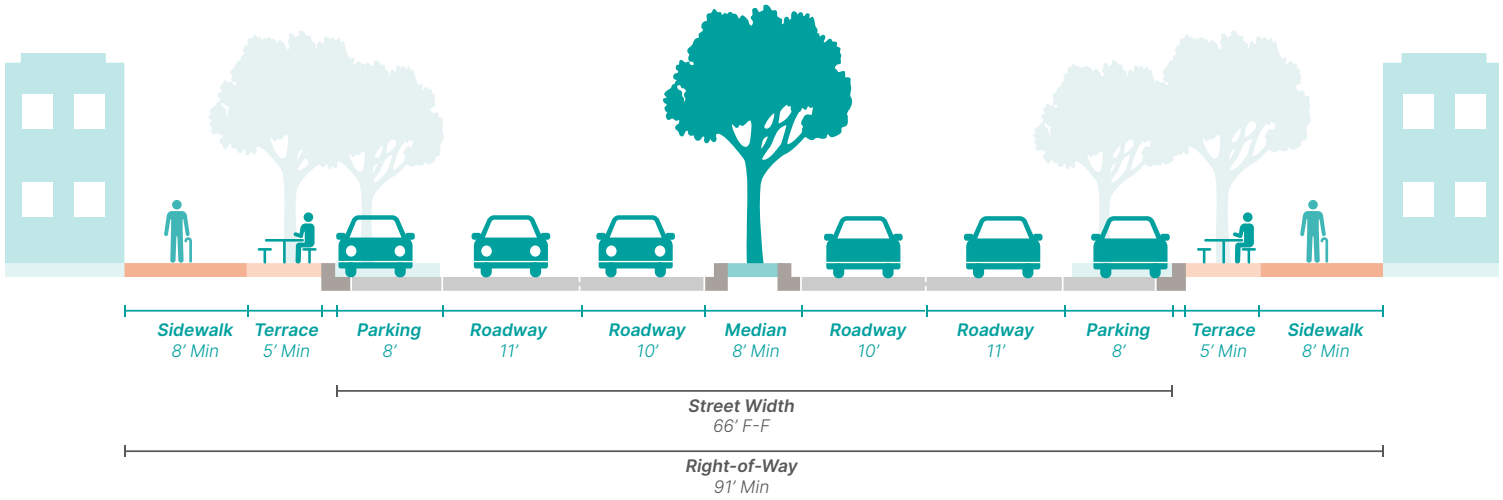
## A.3 Constrained Arterial

| | |
|---|---|
| Street Width | 36ft F-F |
| ROW | 57ft Min |
| Parking | None |
| Context | R C M P I |
| Description | Arterial with protected bike lanes. |
| Use | • Critical corridor for bike connectivity<br>• Constrained ROW |
| Traffic Calming Features | • Mid-block crossings<br>• Street trees |



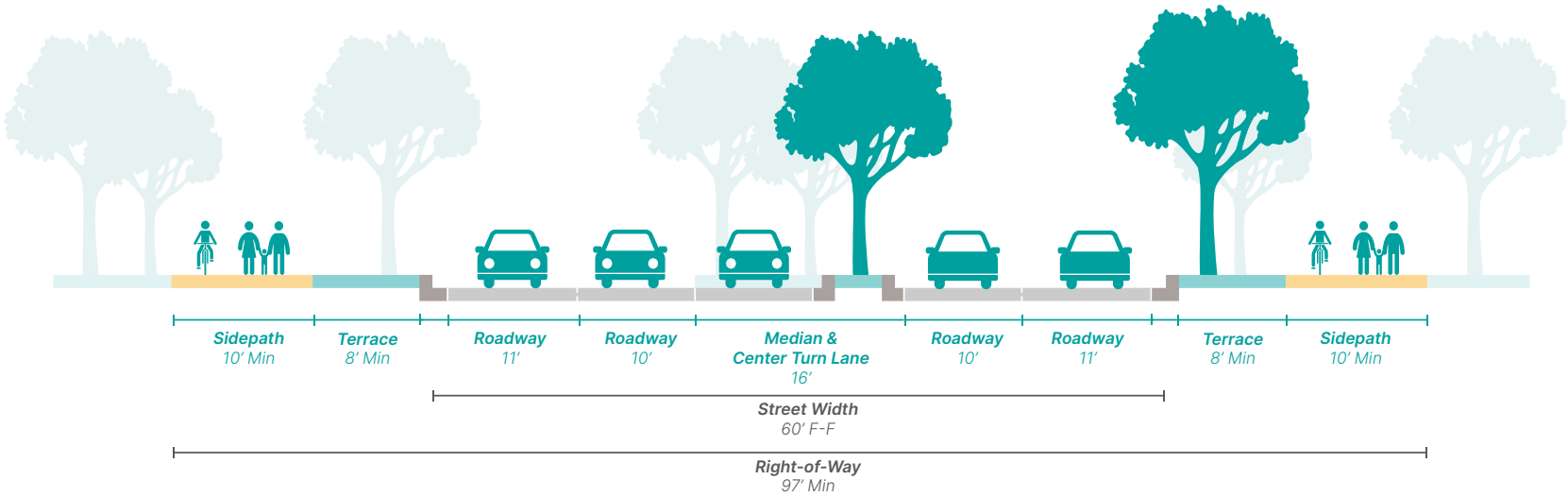
## A.4 Multi-Lane Commercial Destination

| | |
|---|---|
| Street Width | 66ft F-F |
| ROW | 91ft Min |
| Parking | 2 sides |
| Context | C M |
| Description | Multi-lane arterial with parking on both sides and wide street terrace. |
| Use | • Multi-lane arterials should be minimized<br>• Only appropriate for commercial areas where multiple lanes are necessary<br>• Only appropriate for areas with wide ROW<br>• High parking demand for commercial services |
| Traffic Calming Features | • Curb extensions<br>• Median<br>• Pedestrian refuge island<br>• Street Trees |



## A.5 Multi-Lane Boulevard

| | |
|---|---|
| Street Width | 60ft F-F |
| ROW | 97ft Min |
| Parking | None |
| Context | C M P I |
| Description | Multi-lane arterial with center median and sidepaths. |
| Use | • Multi-lane arterials should be minimized<br>• Only appropriate for outlying areas where multiple lanes are necessary<br>• Only appropriate for areas with wide ROW |
| Traffic Calming Features | • Median<br>• Pedestrian refuge island<br>• Street Trees |



# 02

# DESIGN GUIDE TOOLKIT

# HOW TO USE THE DESIGN GUIDE TOOLKIT

**Traffic calming elements slow drivers and improve the street function and experience for all users.**

This chapter includes detailed cutsheets for a wide range of traffic calming elements. There is no one-size-fits-all approach to traffic calming, and each element has specific locations for use, design features, and maintenance considerations. Traffic calming features are organized by:

1. **General Traffic Calming Treatments**: Geometric traffic calming features that feature a wide range of uses along a street.
2. **Intersection & Mid-block Crossing Treatments**: Geometric modifications for intersections and mid-block crossings.
3. **Multimodal Street Improvements**: Street infrastructure for bikes and transit.
4. **Intersection Operations & Signal Modifications**: Signal and operational modifications to intersections and mid-block crossings.

# DESIGN ELEMENTS OVERVIEW

Table 3 below highlights the design elements that can be used in complete street cross-sections. While this list is not exhaustive, it presents a starting place for most streets in Appleton.

| Category | Design Element | Pg | Location | Classifications | Quick-Build Option |
|---|---|---|---|---|---|
| **General Traffic Calming Treatments** | Curb Extensions | 34 | Segment, Intersection | Arterial, Collector, Local | Yes |
| | Speed Tables | 35 | Segment | Collector, Local | - |
| | Speed Humps | 36 | Segment | Collector, Local | - |
| | Speed Cushions | 37 | Segment | Collector, Local | - |
| | Median Chokers | 38 | Segment | Collector, Local | Yes |
| | Pinchpoints | 39 | Segment, Intersection | Collector, Local | Yes |
| | Chicanes | 40 | Segment | Collector, Local | Yes |
| | Four- to Three-Lane Conversion | 41 | Segment, Intersection | Arterial, Collector | - |
| | Street Trees | 42 | Segment | Arterial, Collector, Local | - |
| **Intersection & Mid-block Crossing Treatments** | Corner Radii Design | 44 | Intersection | Arterial, Collector, Local | Yes |
| | Raised Crosswalks | 45 | Segment, Intersection | Collector, Local | Yes |
| | Raised intersections | 46 | Segment, Intersection | Collector, Local | Yes |
| | Mini Traffic Circles | 47 | Intersection | Local | Yes |
| | Mountable Truck Aprons | 48 | Intersection | Arterial, Collector, Local | - |
| | Pedestrian Refuge Islands | 49 | Segment, Intersection | Arterial, Collector | Yes |
| | One-way Diverter | 50 | Intersection | Arterial, Collector, Local | Yes |
| | Diagonal Diverter | 51 | Intersection | Collector, Local | Yes |
| **Multimodal Street Improvements** | Bus Stops | 53 | Segment, Intersection | Arterial, Collector, Local | Yes |
| | Bicycle Boulevard | 54 | Segment, Intersection | Collector, Local | Yes |
| | Bike Lanes | 55 | Segment, Intersection | Arterial, Collector | Yes |
| | Protected Bike Lanes | 56 | Segment, Intersection | Arterial, Collector | Yes |
| | Sidepath | 57 | Segment, Intersection | Arterial, Collector, Local | - |
| **Intersection Operations & Signal Modifications** | No Right Turn on Red | 59 | Intersection | Arterial, Collector, Local | - |
| | Rectangular Rapid Flashing Beacon (RRFB) | 60 | Segment, Intersection | Arterial, Collector | - |
| | Pedestrian Hybrid Beacon (PHB) | 61 | Segment, Intersection | Arterial, Collector | - |
| | Hardened Left Turns | 62 | Intersection | Arterial, Collector | Yes |
| | Exclusive Pedestrian Phase | 63 | Intersection | Arterial, Collector | - |

**Table 3:** *Design elements reference guide.*

## APPLICATION OF DESIGN ELEMENTS

The design elements in this section can be utilized to address specific challenges, as illustrated in Table 4. The specific distribution and application of design elements will vary based on a variety of factors including context and project budget.

| Design Element | Traffic calming and high-speed reduction | Increase pedestrian priority and reduce crossing distances | Expand multimodal access & mobility | Increase pervious surfaces and urban greening |
|---|---|---|---|---|
| Curb Extensions | Yes | Yes | | Yes |
| Speed Tables | Yes | Yes | | |
| Speed Humps | Yes | | | |
| Speed Cushions | Yes | | | |
| Median Chokers | Yes | | | Yes |
| Pinchpoints | Yes | Yes | | Yes |
| Chicanes | Yes | | | Yes |
| Four- to Three-Lane Conversion | Yes | Yes | | Yes |
| Street Trees | Yes | | | Yes |
| Corner Radii Design | Yes | Yes | | |
| Raised Crosswalks | Yes | Yes | | |
| Raised intersections | Yes | Yes | | |
| Pedestrian Refuge Islands | Yes | Yes | | Yes |
| Mini Traffic Circles | Yes | | | Yes |
| Mountable Truck Aprons | | | Yes | |
| One-way Diverter | Yes | | | |
| Diagonal Diverter | Yes | | | |
| Bus Stops | | | Yes | |
| Bicycle Boulevard | | | Yes | |
| Bike Lanes | | | Yes | |
| Protected Bike Lanes | Yes | | Yes | |
| Sidepath | | | Yes | |
| No Right Turn on Red | | Yes | | |
| Hardened Left Turns | | Yes | | |
| Rectangular Rapid Flashing Beacon (RRFB) | | Yes | | |
| Pedestrian Hybrid Beacon (PHB) | | Yes | | |
| Exclusive Pedestrian Phase | | Yes | | |

**Table 4:** *Design elements application guide.*

# WINTER MAINTENANCE

Elements of complete streets may increase equipment and labor costs associated with snow removal. In general, standard maintenance equipment (e.g. large truck-mounted plows) moving in a straight line represent the least-cost conditions for snow removal. For complete street elements that modify the roadway geometry, plows may need to slow down to avoid causing damage to curb heads or other infrastructure.

Some complete streets elements, such as sidepaths, are too narrow to use the most cost-efficient large-scale equipment for snow removal. These elements may also limit the space available to store snow while maintaining pedestrian and bike access. This can result in a greater need for snow hauling, and associated labor and equipment cost increases.

## MAINTENANCE VEHICLES

As mentioned above, complete street traffic calming features may present new challenges for winter maintenance. Turning movements of winter maintenance vehicles are critical to consider in all complete street designs, and have been factored into the guidance of each element.

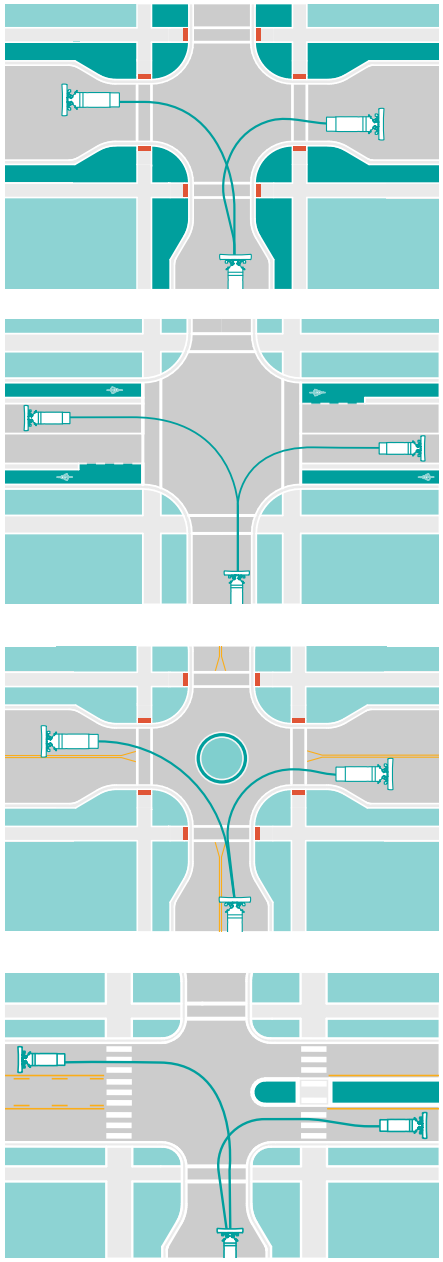


**Figure 4:** *Turning movements for 3-axle snow plow, based on auto-turn analysis.*

**Assumptions:**

At local intersections, plows may curve outside of their lane when making left or right turns. Reference corner radii design on pg. 44.

At most collector and arterial intersections, streets should be design for plows to turn without impacting oncoming travel lanes. Reference corner radii design on pg. 44.

At traffic circles, it is expected that plows will be allowed to short-cut the circuit when making a left turn. Reference traffic circles on pg. 47.

At pedestrian refuge islands on narrow arterials or collectors, it is expected that plows turning right from a local street may curve outside of their lane. Reference pedestrian refuge islands on pg. 49.

## WINTER MAINTENANCE CONSIDERATIONS

*Snow on mini traffic circle. Post Crescent.*

### Navigating Traffic Calming Features

Various traffic calming features in this section modify the horizontal and vertical geometry of the roadway. Features should be designed with slopes, grades, and radii that ensure that winter maintenance can occur. Maintenance considerations have been included for each traffic calming element in the design guide beginning on page 33, where applicable.

*Recessed thermoplastic bike lane symbol. Alta.*

### Recessed Thermoplastic Pavement Markings

Milling the area of pavement 3mm in depth where durable pavement markings are applied has shown to be effective in reducing damage as a result of snowplows. This method increases installation costs but reduces long-term maintenance costs and maintains roadway function.

*Snow stored in ROW. Minnesota Dept. of Health.*

### Plan Roadways with Sufficient Right of Way

On new roadways or full reconstructions, the street design should provide adequate for snow storage space. Street designs should provide street terraces or buffers for snow storage to ensure that plows can clear the entire roadway, bike lanes, and sidewalks.

*Striping, paint, and curb cues. SF Bike Coalition.*

**Edge-of-roadway Visual Cues**

Pavement markings, striping, curbs, and other visual cues at ground-level are indicators of a bicycle travel way when the ground is clear, but they lose their utility, and can become hazardous after snow. For these reasons, it is important to provide alternative visual cues. Piling snow in the buffer of protected bikeways to deter parking in protected bike lanes, and along the sidewalk furnishing zone helps visually define path of travel and helps snow plow operators identify curb lines. This is especially critical when a bike facility bends in/out around curb extensions, median islands or other transitions.

*Snow stored in bike lane buffer. Henry Pan.*

**Store Snow in The Bike Lane Buffer**

Where bike lanes have a wide, painted buffer, snow may be able to be stored in the buffer between the motor vehicle lane and bike lane. This requires the roadway plow to plow snow to the right, and the bike lane plow to plow snow to the left. This method may be useful where there is insufficient snow storage areas between the bike lane and the sidewalk. While this method creates a de-facto protected bike lane, snow melt should be considered. During the day, stored snow can melt and flow across the bike lane, resulting in an icy bikeway surface condition. This needs to be countered with a deicing operation.

*Cycle track plowing. Streets.mn.*

**Small Snow Plow Vehicles**

Many cities use specialized plows referred to as ‘downsized street maintenance vehicles’. These smaller vehicles are able to clear confined travelways such as separated bike lanes, sidewalks, and trails. Cities can also use existing maintenance vehicles with mounted snow blades as a more cost-effective and time-efficient solution.

# GENERAL TRAFFIC CALMING TREATMENTS

A variety of geometric interventions can be added to a roadway to slow traffic while also improving the look, feel, and function of the roadway. These treatments include both horizontal and vertical treatments and both physically and psychologically encourage slower traffic speeds. Treatments include:

### Curb Extensions

Curb extensions are a traffic calming & pedestrian safety measure that help delineate parking and shorten crossing distance.

### Speed Tables

Speed tables share the same characteristics as raised crossings, but are placed mid-block instead of at an intersection.

### Speed Humps

Speed humps provide vertical deflection to slow vehicles down and facilitate uninterrupted bicycle and emergency vehicle access.

### Speed Cushions

Speed cushions are speed humps with cut-throughs that allow emergency vehicles to pass through while still requiring standard vehicles to slow down.

### Median Chokers

Median chokers are horizontal traffic calming devices that narrow or deflect vehicle paths to reduce speed.

### Pinchpoints

Pinchpoints narrow the roadway, restricting motorists from operating at high speeds when driving on local streets while providing a widened pedestrian realm along the street.

### Chicanes

Chicanes are a series of raised/delineated curb extensions or parking bays on alternating sides of a street forming an S-shaped travel way to reduce motor vehicle speeds.

### Four- lane to Three-Lane Conversion

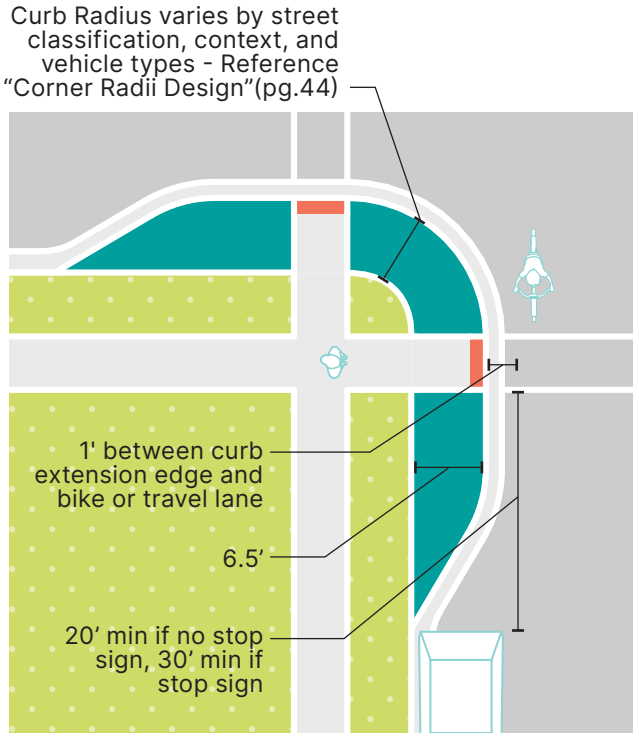
A four-lane to three-lane conversion, also commonly referred to as completing a “Road Diet” or “right-sizing the road” is generally described as the removal of travel lanes from a roadway to utilize the space for other uses or travel modes.

### Street Trees

While street trees increase pedestrian comfort by providing shade and a barrier to moving traffic, they also encourage motorists to slow down as they make the roadway feel narrower.

## CURB EXTENSIONS

Curb Extensions are a traffic calming and pedestrian safety measure that help delineate parking, maximize landscaping, and shorten crossing distance, giving pedestrians and bicyclists a better chance to see and be seen before committing to crossing. In addition to shortening crossing distances and slowing traffic, they protect parked cars and provide space for trash receptacles and other amenities without blocking the sidewalk.




### Typical Application

- Arterial, Collector, and Local Roads.
- May be placed mid-block or at an intersection.
- May be combined with crossing treatments.
- Most effective on streets with parking lanes.

### Features

- In most cases, the curb extensions should be designed to transition between the extended curb and the running curb to approximately match the existing no parking/no standing area design standards.
- Curb extensions are most appropriate where there is an on-street parking lane and where transit and bicyclists would be traveling outside the curb edge for the length of the street.
- The turning needs of larger vehicles, such as school buses or emergency vehicles, need to be considered in curb extension design at intersections. For curb radii requirements, reference Table 6 (on page 44).
- Curb extensions should not block bicycle lanes or shoulders being used by bicyclists. In locations with protected bike lanes next to a parking lane, the curb extension begins at the inside edge of the bike lane and occupies the parking lane.
- Curb extensions can contain grass, landscaping, decorative concrete, public art, and tree grates in larger curb extensions.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, and flexible posts.

### Maintenance Considerations

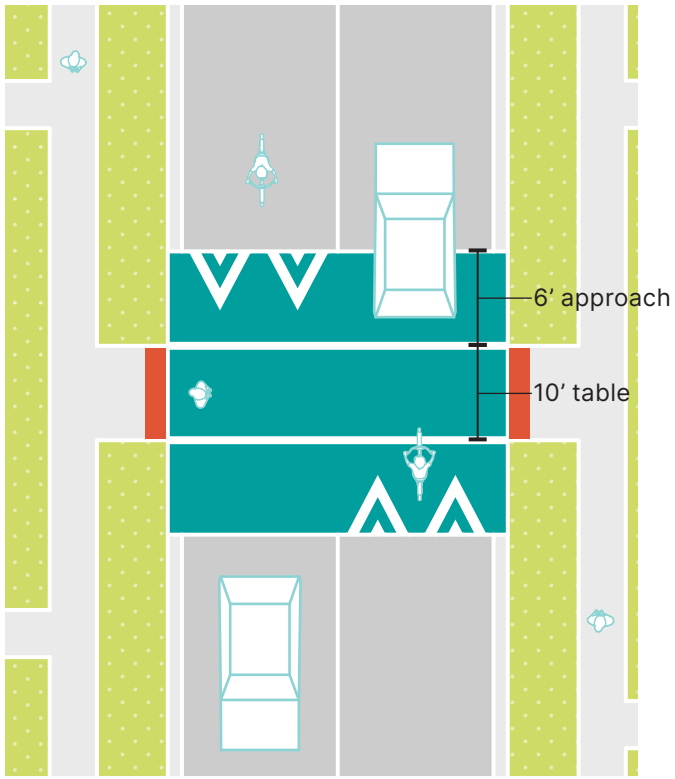
- For efficient street sweeping and snow plowing, minimum radius for the reverse curves of the transition is 10 feet and the two radii should be balanced to be nearly equal.

### SOURCES

NACTO Urban Street Design Guide: curb-extensions
FHWA Pedestrian Safety Guide and Countermeasure Selection System
Appleton Downtown Streetscape Design Guide

## SPEED TABLE

Speed tables share the same characteristics as raised crossings, but are placed mid-block instead of at an intersection. With this placement, they are often applied in conjunction with curb extensions. They work by raising the entire wheelbase of a vehicle to reduce its traffic speed. Speed tables may be used on collector streets and/or transit and emergency response routes.




### Typical Application

- Collector, Local and in some circumstances, Arterial Roads.
- Applied mid-block to reduce vehicle traffic speed.
- May be used on collector streets.

### Features

- Speed tables should be designed to the following criteria:
  - » Slopes should not exceed 1:10 or be less steep than 1:25
  - » Speed tables may be built at 3-6" in height, with 3-4" most commonly recommended
- Speed tables should not be applied on streets wider than 50 feet. If applied on two-way streets, speed tables may be applied in both directions.
- Locate vertical speed control elements where sufficient visibility and lighting is available.
- Speed tables can be installed using unit pavers or other differentiating materials as a strategy to help highlight and define the speed table for motorists, bicyclists, and pedestrians.
- Speed tables shall be accompanied by a warning sign (MUTCD W17-1).

### Maintenance Considerations

- Use of differentiating materials, such as unit pavers, may require additional maintenance responsibilities.

### SOURCES

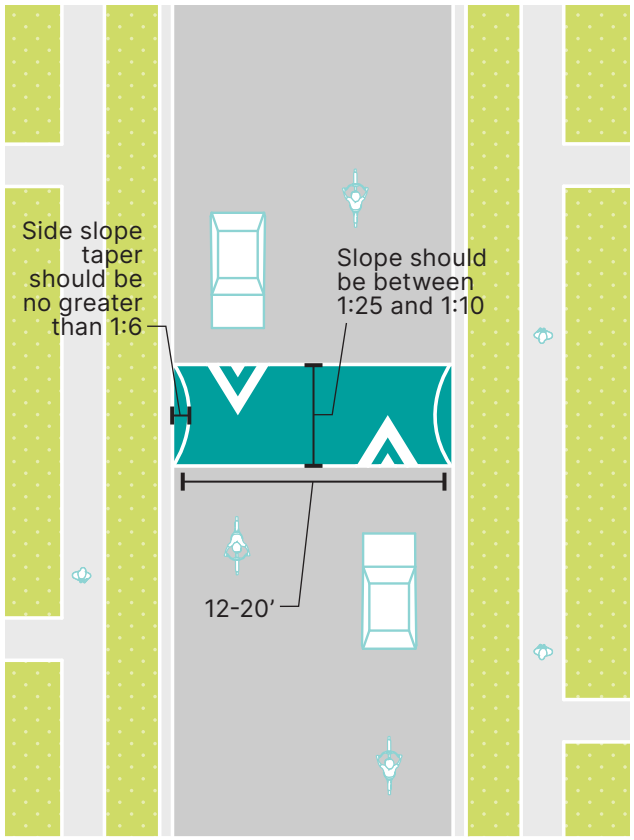
NACTO Urban Street Design Guide: Speed Table

FHWA Pedestrian Safety Guide and Countermeasure Selection System: Speed Table/ Humps/Cushions

FHWA Traffic Calming ePrimer: Module 3: Toolbox of Individual Traffic Calming Measures Part 2: Speed Table

## SPEED HUMP

Speed humps provide vertical deflection requiring vehicles to slow down. They facilitate uninterrupted bicycle travel & emergency vehicle access.




### Typical Application

- Residential Local Street or any street where the primary function is to provide access to abutting residential property, school, park, or community center.
- Also appropriate for Residential Collectors.
- Along roadways where speed management is needed.

### Features

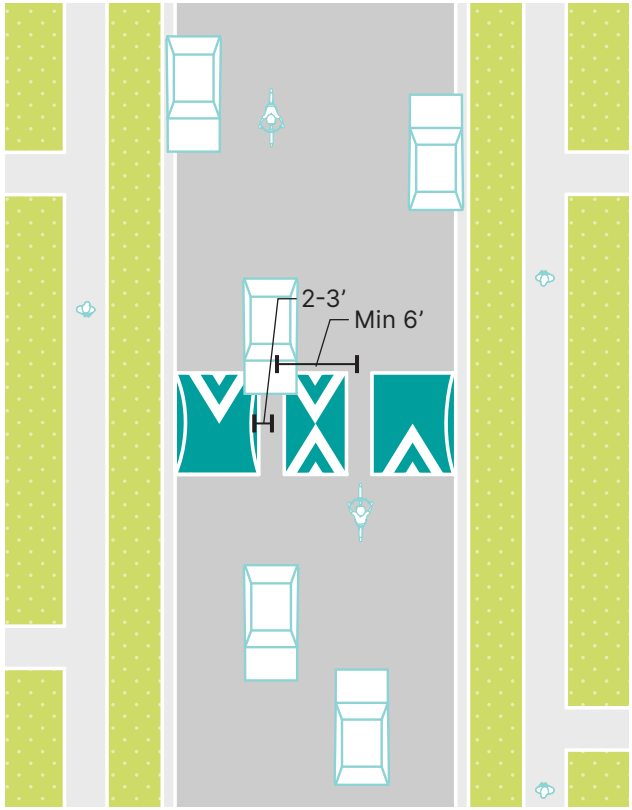
- Speed Humps should be designed to the following criteria:
  - » Slopes should not exceed 1:10 or be less steep than 1:25
  - » Side slopes on tapers should be no greater than 1:6
- Speed humps are elongated mounds with a parabolic cross section.
- Spacing to be determined based on individual project constraints and target speeds. Humps should be spaced no more than a max 500' apart to achieve an 85th percentile speed of 25-35mph.
- Vertical speed devices may be paired with curb extensions or chokers that also narrow the traversable roadway for greater impact.
- Design is an elongated mound in the street that is between 12 and 20 feet in length and 3-4 inches tall.
- Vertical speed devices are typically designed with sides that taper off at the gutter for drainage. This design may be modified to end the taper further from the gutter to create a wide, flat surface for a bicycle bypass lane, if desired.
- Avoid placement in sharp horizontal or vertical curves.
- Speed humps should be paired with warning signage (MUTCD W17-1).

### SOURCES

NACTO Urban Street Design Guide: Speed Hump
FHWA Pedestrian Safety Guide and Countermeasure Selection System: Speed Table/Humps/Cushions
FHWA Traffic Calming ePrimer: Module 3: Toolbox of Individual Traffic Calming Measures Part 2: Speed Hump

## SPEED CUSHION

Speed cushions are speed humps with cut-throughs that allow emergency vehicles to pass through unimpeded while still requiring typical passenger vehicles to slow down (emergency vehicles have wider wheel bases than typical cars). Speed cushions provide vertical deflection that forces vehicles to slow down.




### Typical Application

- Collector and Local Roads.
- Along roadways where speed management is needed.
- As a preferred alternative to a speed hump on a primary emergency response route or on a transit route with frequent service.
- Locate speed cushions where there is sufficient lighting and clear visibility.

### Features

- Speed Cushions should be designed to the following criteria:
  - » Slopes should not exceed 1:10 or be less steep than 1:25
  - » Side slopes on tapers should be no greater than 1:6
- Cutouts in the speed cushions are positioned such that a passenger vehicle cannot pass it without traveling over a portion of the raised pavement.
- Short centerlines and/or traversable features such as flexposts will allow emergency vehicle passage while preserving the full impact of the hump to non-emergency vehicles.
- Speed cushions may be paired with curb extensions or chokers that also narrow the traversable roadway for greater impact.
- A speed cushion is typically designed with sides that taper off at the gutter for drainage. This design may be modified to end the taper further from the gutter to create a wide, flat surface for a bicycle bypass lane, if desired.
- Speed cushions should be paired with warning signage (MUTCD W17-1.)

### SOURCES

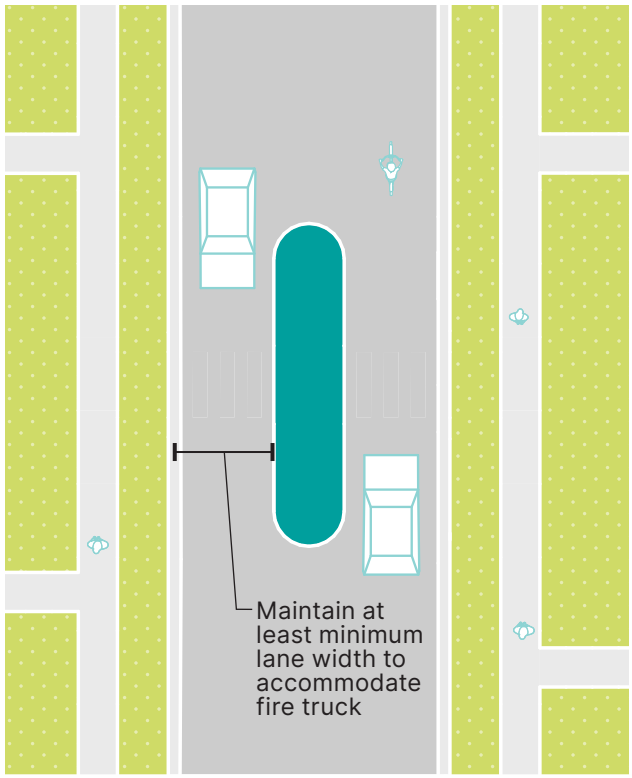
NACTO Urban Street Design Guide: Speed Cushion

FHWA Pedestrian Safety Guide and Countermeasure Selection System: Speed Table/ Humps/Cushions

FHWA Traffic Calming ePrimer: Module 3: Toolbox of Individual Traffic Calming Measures Part 2: Speed Cushion

## MEDIAN CHOKER

Median chokers are horizontal traffic calming devices that narrow or deflects vehicle paths to reduce speed. They can be combined with a pedestrian crossing to allow pedestrians and/or bicyclists to cross a roadway in stages, reducing exposure, increasing visibility and improving overall safety. Additionally, trees/landscaping can be integrated within medians to improve the appearance of the roadway.




### Typical Application

- Arterial, Collector, and Local Roads.
- As traffic calming along roadway, possibly where excess width is present.
- As a mid-block or a “gateway” treatment from a collector or arterial street to a lower speed neighborhood street.
- Can be used as a pedestrian refuge if placed at a crosswalk.

### Features

- Lane widths should be wide enough to accommodate emergency vehicles.
- May require removal of some on-street parking to accommodate median and horizontal shifts.
- Can be combined with raised crosswalks/curb extensions to improve speed reduction.
- Avoid blocking driveway access with this treatment.
- May be painted or constructed from temporary materials, but they are most effective when defined by a raised curb and landscaped.
- May be partially or fully mountable in some cases. See “Mountable Aprons” on pg. 48.
- May be continuous through an intersection and configured to allow pedestrian and bicycle traffic to pass but divert motor vehicles as a volume control method. See “One-Way Diverter” on pg. 50.
- Generally will not impact roadway drainage as main feature is in the center.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, and flexible posts.

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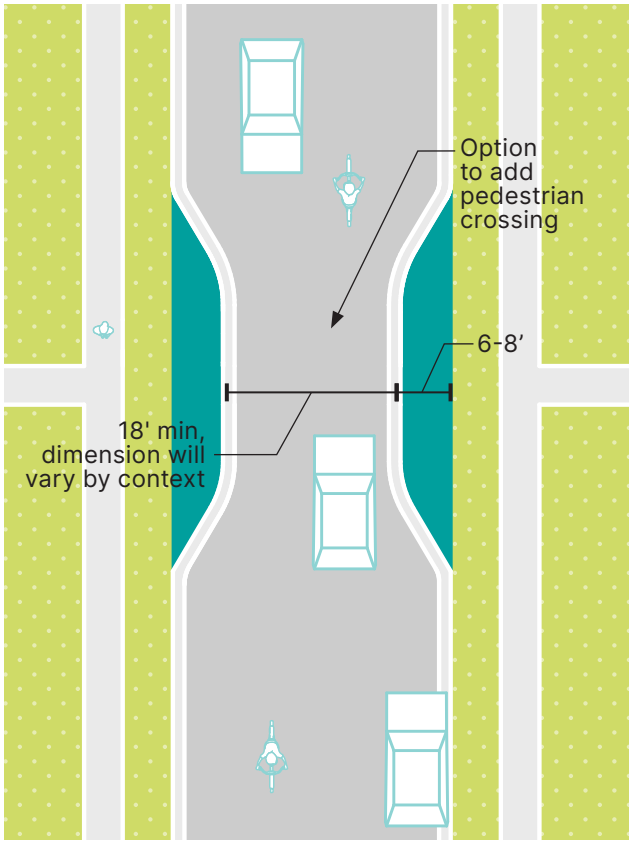
### SOURCES

NACTO Urban Street Design Guide: Speed Reduction Mechanisms
FHWA Traffic Calming ePrimer - Module 3: Median Island

## PINCHPOINT

When used as a traffic-calming treatment, mid-block curb extensions are often referred to as “pinchpoints” or “chokers.” Pinchpoints narrow the roadway, restricting motorists from operating at high speeds when driving on local streets while providing a widened pedestrian realm/ opportunity for the addition of trees/landscaping along the street.




### Typical Application

- Arterial, Collector, and Local Roads.
- Can be spaced along the roadway as needed.
- Can be used on a one-lane or two-lane two-way street.
- Can be used on arterial, collector, or local streets in an urban or suburban setting at all levels of traffic volume.
- Can be used to facilitate mid-block pedestrian crossings of low-volume streets. These crossings don’t need to be marked unless volumes exceed 3,000 vehicles per day, or if mid-block destinations warrant a more visible treatment.

### Features

- The goal of a pinchpoint is to narrow the road, effectively reducing vehicle speeds.
- Width of pinchpoint will vary based on street context and classification. For two-way roads, the width of pinchpoint should align with lane width minimums. For example, a local residential minimum width is 18ft.
- A pinchpoint can be created using roadside islands that do not connect to the curb.
- Street trees can be planted in curb extensions that are aligned with the parking lane of a roadway to narrow the profile of the road. Bike racks can be added in curb extensions.
- In some cases on wider roadways, pinchpoints can be paired with a median to reduce the possibility of opposing vehicle conflicts.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, and flexible posts.

### Maintenance Considerations

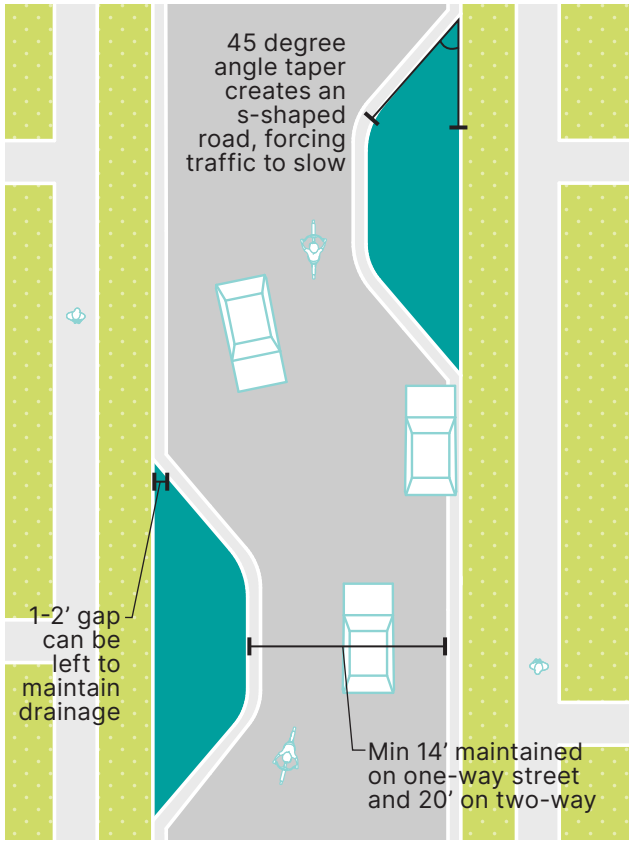
- For efficient street sweeping and snow plowing, minimum radius for the curves and reverse curves of the transition is 10 feet.

### SOURCES

NACTO Urban Street Design Guide: Pinchpoint
NACTO Urban Street Design Guide: Speed Reduction Mechanisms
FHWA Traffic Calming ePrimer: Module 3: Toolbox of Individual Traffic Calming Measures Part 2: Choker

## CHICANE

Chicanes are a series of raised/delineated curb extensions, or parking bays on alternating sides of a street forming an S-shaped travel way. Speed is reduced for motor vehicles by requiring drivers to shift horizontally through narrowed travel lanes. Chicanes can allow for both directions of traffic to pass at a time or just one direction. Trees/landscaping can also be added to chicanes.




### Typical Application

- Local or low-volume Collector Roads.
- As a traffic-calming treatment option along a mid-block section of a low-volume roadway.
- Can be used on a one-lane or two-lane, two-way road.
- Can be installed with urban (curb/gutter) or rural (ditch) contexts.
- Chicanes could include stormwater collection features.

### Features

- On wider streets, bicycle bypasses in one or both directions can be added to the outside.
- The turning needs of larger vehicles, such as school buses or emergency vehicles, may need to be considered through the chicane. Mountable curbs may be necessary.
- Curb extensions (if used) must be designed to provide adequate drainage. Floating islands may be used to maintain existing drainage.
- Crosswalks should not be integrated with this treatment as motorists should be only concerned with horizontal deflection.
- May impact on-street parking if curb extensions displace parking.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, and flexible posts.

### Maintenance Considerations

- For efficient street sweeping and snow plowing, minimum radius for the curves and reverse curves of the transition is 10 feet.

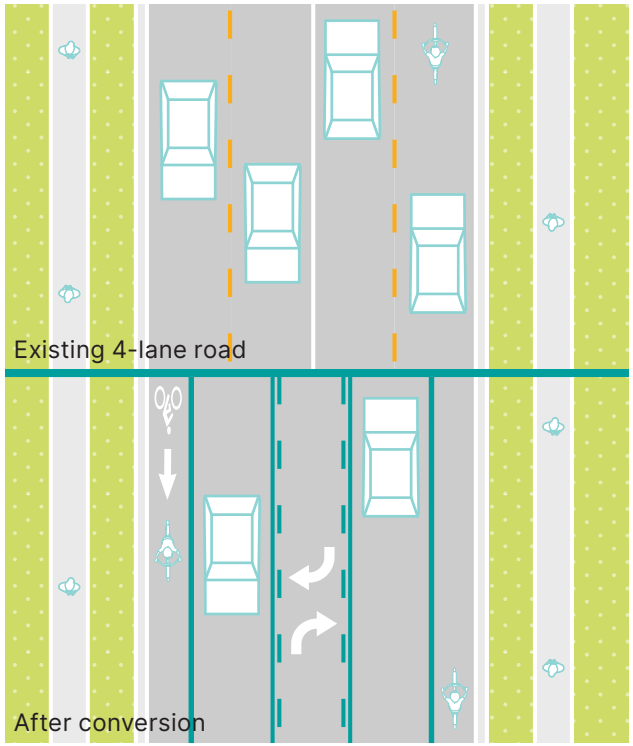
---

**SOURCES**

NACTO Urban Street Design Guide: Chicane
FHWA Pedestrian Safety Guide and Countermeasure Selection System: Chicanes

## 4-LANE TO 3-LANE CONVERSION

A four-lane to three-lane conversion, also commonly referred to as completing a “Road Diet” or “right-sizing the road” is generally described as the removal of travel lanes from a roadway to utilize the space for other uses or travel modes. This most commonly takes the form of a 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, transit uses, and/or parking.




### Typical Application

- Arterial, Collector, and Local Roads.
- This treatment can be applied on four-lane undivided roads, including along transit and emergency response routes. The following volumes can be considered:
  - Less than 10,000 ADT: Great candidate in most cases. Capacity most likely will not be affected.
  - 10,000-15,000 ADT: Good candidate in many cases. Intersection analyses should be conducted and signal re-timing should be considered in conjunction with implementation.
  - 15,000-20,000 ADT: Good candidate in some instances; however, capacity could be affected depending on conditions. A corridor analysis should be conducted before implementing.
  - Greater than 20,000 ADT: A feasibility study should be completed to determine if the location is a good candidate. Some agencies have had success with these conversions on high-volume roads.

### Features

- Conversion may create additional space for bike lanes, wider sidewalks or amenity zones, or add street parking (if not previously existing).
- If street parking is existing, a conversion won't necessarily impact it.
- Factors that must be considered before completing a conversion:
  - Speeds, Level of Service (LOS)
  - Quality of Service (perceived level of safety)
  - ADT
  - Peak hour and peak direction
  - Turning volumes and patterns
  - Vehicle traffic that is frequently stopping/moving slow

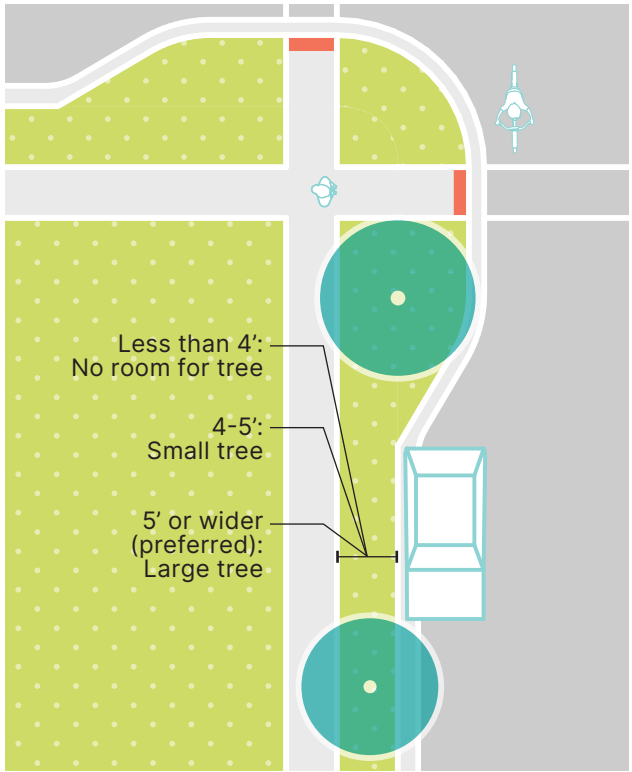
### SOURCES

FHWA Highway Safety Program - Proven Safety Countermeasures: Road Diets (Roadway Configuration)

FHWA Safety Program - Road Diet Informational Guide

## STREET TREES

Street trees (managed through the Stormwater Utility) can increase comfort for pedestrians and bicyclists by lowering temperatures, filtering air and water, and helping with stormwater management. The presence of trees can make walking and biking facilities feel more comfortable and appealing, contributing to mode shift and reducing greenhouse gas emissions. On tree-lined streets people tend to drive more slowly, reducing the risk of collisions.




### Typical Application

- Trees may be planted in the right-of-way if they do not negatively impact sight lines and where adequate soil volume is available.

### Features

- Provide as much soil volume as feasible to extend life/increase health of street trees. As a rule of thumb, a small tree (20-30ft), medium tree (30-60ft), and large tree (60ft+), should be provided a minimum of 600, 900, and 1200 cubic feet respectively of high-quality rootable (loose, aerated, water storing) soil.
- In commercial areas, tree grates and raised planters may be considered to provide additional space for amenities. In most other locations, tree grates are discouraged due to the reduction in tree health, needed maintenance, and lack of accessible pedestrian space provided.
- The City Forester will determine suitable tree species.

### Maintenance Considerations

- Irrigate if feasible to help trees survive drought or heat stress.
- Salt spray can damage trees. Injury to evergreen trees is apparent in the late winter, while it takes longer to manifest in deciduous trees. Avoid salt damage by selecting salt-tolerant trees, using road salt alternatives, and covering smaller trees in burlap.
- Select trees that won't interfere with overhead lines.

---

**SOURCES**

Wisconsin DNR Urban Tree Planting Resources
Minneapolis Street Design Guide: Boulevards and Furnishing: Street Trees

# INTERSECTION & MID-BLOCK CROSSING TREATMENTS

Modifications at intersections and mid-block crossings provide safer pedestrian and bike crossings, and encourage slower speeds by vehicles. These treatments modify intersection and mid-block geometry to shorten crossing distances, make pedestrians more visible to vehicles, and control vehicular turning movements. Treatments include:

**Corner Radii Design**

A smaller curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crossing distance and requires vehicles to slow more on the intersection approach.

**Raised Crosswalks**

Raised crosswalks allow pedestrians and bicyclists to cross at sidewalk level while forcing vehicles to slow down.

**Raised Intersections**

Raised intersections provide vertical deflection at an entire intersection, forcing vehicles to slow down.

**Pedestrian Refuge Islands**

Pedestrian refuge islands are used at mid-block crossings or at intersections that allow pedestrians/bicyclists to cross a roadway in stages, reducing exposure and increasing visibility while providing the same traffic-calming effects as a median choker.

**Mini Traffic Circles**

Mini traffic circles are raised or delineated islands placed at minor street intersections to encourage slower vehicle movements and manage conflicts at the intersection.

**Mountable Aprons**

Mountable aprons limit turning speed for passenger vehicles while still allowing larger vehicles to complete the turn.

**One-way Diverter**

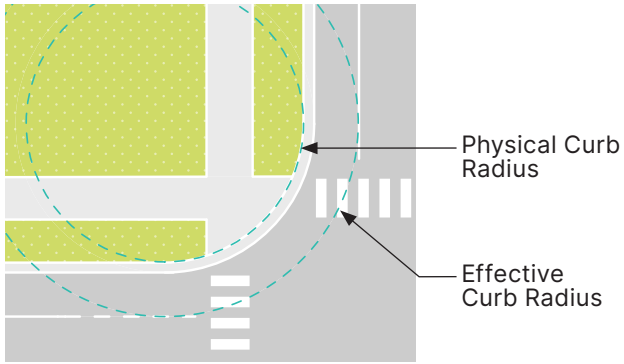
One-way diverters, also known as “half closures,” block vehicle travel for motor vehicles in one direction while preserving two-way bicyclist access.

**Diagonal Diverter**

Diagonal diverters may be placed at a local road to local road four-way intersection and require all motor vehicle traffic to turn, while allowing bicyclist and pedestrian through movements.

## CORNER RADII DESIGN

The size of a curb's radius can have a significant impact on pedestrian comfort and safety. A smaller curb radius provides more pedestrian area at the corner, allows more flexibility in the placement of curb ramps, results in a shorter crossing distance and requires vehicles to slow more on the intersection approach. During the design phase, the chosen radius should be the smallest possible for the circumstances and consider the effective radius in any design vehicle turning calculations.




| Intersection Type | Minimum Effective Curb Radius (ft) |
|---|---|
| No turning movement | 2 |
| Local-Local | 12 |
| Local-Collector | 15 |
| Collector-Collector | 18 |
| Collector-Arterial | 18 |
| Arterial-Arterial | 18 |

**Table 5:** *Effective corner radii reference table*

### Typical Application

- All corners have a radius, but size varies on context. Size is related directly to the length of the crosswalk.
- Standard curb radii are 10-15 ft, but the curb radius may be as small as 2 ft where there are no turning movements.
- Wide outside travel lanes, on-street parking and bike lanes create a larger effective turning radius and therefore allow a smaller physical curb radius.
- Turning speeds should be limited to 15mph or less.
- Minimize effective turning radius by employing of the following techniques:
  - » Select smallest possible design vehicle
  - » Accommodate trucks and buses on designated truck/bus routes
  - » Restrict right turn on red to minimize interaction between turning vehicles and crossing pedestrians and cyclists. Reference "No Right Turn on Red", page 59
  - » Design so emergency vehicles may use full intersection to turn

### Features

- Corners have two critical dimensions which must be considered together.
  - » The physical radius controls the pedestrian experience.
  - » The effective radius is the widest turning arc that a vehicle can take through the corner and is larger than the physical radius.
  - » Curb radius choice involves desired pedestrian area of the corner, street classifications, design vehicle turning radius, intersection geometry, and if on-street parking/bike lane (or both) are between the travel lane and curb.

### Quick-Build Option

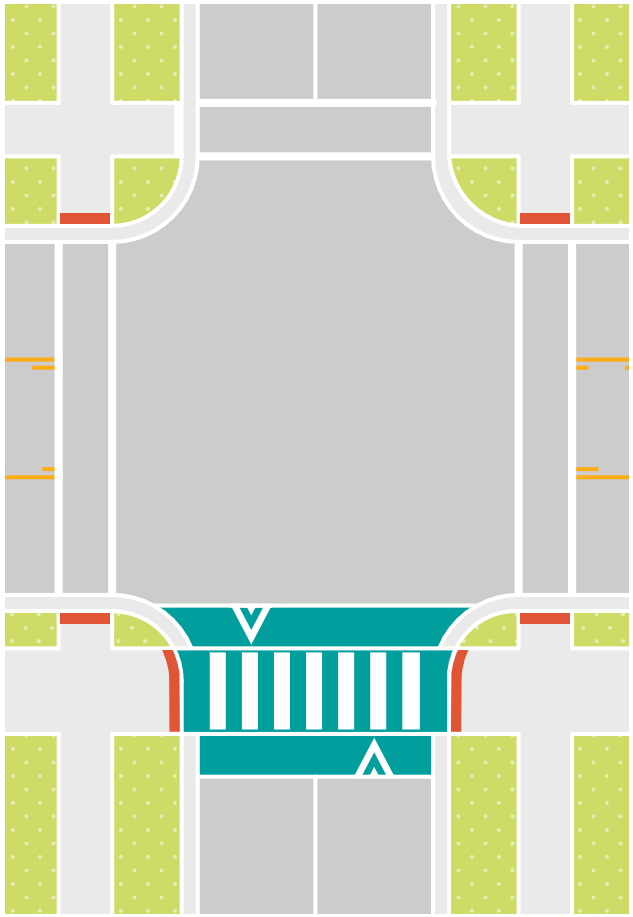
- Quick-build implementation with paint, traffic tape, and flexible posts.

### SOURCES

NACTO Urban Street Design Guide: Corner Radii
Global Street Design Guide: Corner Radii

## RAISED CROSSWALK

Raised Crosswalks give priority to pedestrians and bicyclists, allowing them to cross at sidewalk level, and require vehicles to slow down. They can be implemented at mid-block crossings, intersections, or along the major street at side streets.



### Typical Application

- Residential Collector and Local Roads. Can be applied on a low-speed Arterial Road through a commercial district.
- Along roadways where speed management is needed.
- At an intersection within a school zone, local business district or on a walking route.
- Can be placed mid-block or at an intersection.
- May not be appropriate for primary emergency vehicle routes or streets that provide access to emergency medical services.
- Appropriate for bus transit routes if speeds are low.
- Avoid using raised crosswalks on steep streets as they can act as ramps for bicyclists and vehicles.

### Features

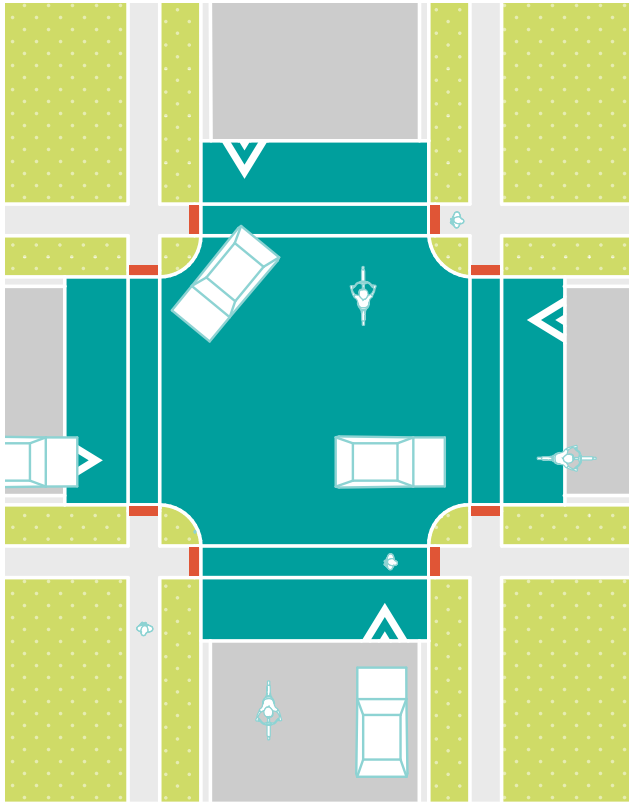
- Crosswalk markings will depend on context.
- In most cases, vertical transition will be designed similar to a speed table with heights of 3-6".
- Drainage must be adequately accommodated through inlet relocation or open channels along the sides. These designs allow for a fully raised crosswalk, which is preferable for pedestrians with disabilities.
- Raised crosswalks can also be provided with an open section on the sides utilizing a conventional curb ramp though this design does not provide all of the benefits of the fully raised design.
- Raised crosswalks may be paired with curb extensions or chokers that also narrow the traversable roadway and provide improved sight distance to pedestrians.

### SOURCES

NACTO Urban Street Design Guide: Intersections of major and minor streets
FHWA Traffic Calming e-Primer: speed management/traffic calming

## RAISED INTERSECTIONS

Raised intersections provide vertical deflection at an entire intersection requiring vehicles to slow down. The road level is raised to the sidewalk level and the surface can be built with a variety of materials such as asphalt, concrete, or pavers. The crosswalks are also elevated. The pedestrians space is often differentiated with bollards, materials, and detectable warnings.



### Typical Application

- Intersections of Collector and Local Roads. Can be applied on a low-speed Arterial Road in a business district with significant pedestrian activity.
- At smaller signalized, or unsignalized intersections.
- At residential and smaller business district contexts.
- At offset intersections as a shared lane/street treatment.
- At junctions of multiple bicycle boulevards where slowing vehicles in all directions is desirable.
- At an intersection within a school zone on a walking route.

### Features

- Raised intersections are typically raised to be flush with the sidewalk, typically between 3-6".
- Crosswalks do not need to be marked, however this is recommended.
- Bollards may be used at corners to keep motorists from crossing into the pedestrian space. Bollards should be strategically placed to avoid impacting the movement of pedestrians and cyclists.
- To make the division between the raised intersection and the sidewalk clear, contrasting colors and/or materials from the sidewalk should be used to construct the raised crosswalk.
- Users with visual impairments may have trouble if they cannot detect the edge of the pedestrian space; therefore, truncated domes should be used.
- The turning needs of larger vehicles, such as school buses or emergency vehicles, may need to be considered in raised intersection design, especially at intersections with significant truck/bus traffic.
- The raised transitions must be designed to provide adequate drainage.
- The vertical transition will be designed similar to a speed table.

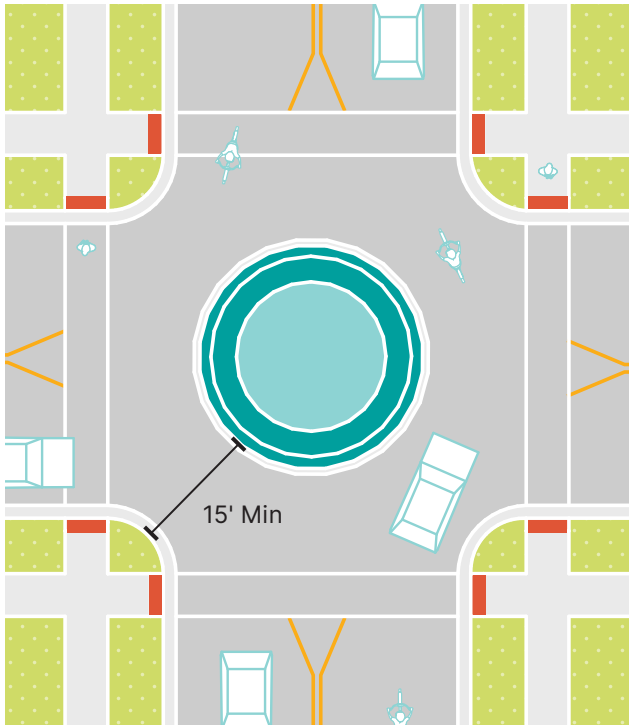
---

### SOURCES

NACTO Urban Street Design Guide: Raised Intersections
NACTO Urban Bikeway Design Guide: Major Street Crossings
FHWA Traffic Calming e-Primer: Raised Intersection

## MINI TRAFFIC CIRCLES

Mini Traffic Circles are raised or delineated islands placed at minor street intersections. They encourage slower vehicle movements and manage conflicts at the intersection so that users may enter in all directions with a yield on entry control. Raised island design can vary and may include mountable curbs or aprons, landscaping, and signage.




### Typical Application

- Junction of two Local Roads or of a Local and Collector Road.
- At low-volume uncontrolled intersections that may not justify signalization.
- At junctions of multiple bicycle boulevards where slowing vehicles in all directions is desirable.
- Where it is desirable to maintain bicycle momentum and a stop sign would otherwise be needed.

### Features

- Maintain 15’ min clear from the corner to the edge of the circle.
- Crosswalks not needed at most local road to local road intersections.
- Signage is not required. For traffic circles with specific safety issues, an MUTCD warning sign may be placed in the middle.
- Traffic circles may include a mountable apron to accommodate the turning radii of larger vehicles like fire trucks or school buses (see pg. 48). The island may be fully mountable if needed at constrained intersections.
- Consider drainage and if there is a valley gutter along one of the streets, this may make the vehicle path uncomfortable.
- Non-mountable portion of traffic circle may include landscape, public art, and permanent signage, contingent on meeting required horizontal offsets and maintaining sight triangles.
- Shared lane markings may be provided within the intersection in the center of the circulating lane to encourage proper bicyclist lane positioning and discourage vehicle passing.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, flexible posts, and/or plastic or rubber curbs.

---

**SOURCES**

Bikesafe Bicycle Safety Guide and Countermeasure Selection System: Mini-Circles

## MOUNTABLE APRONS

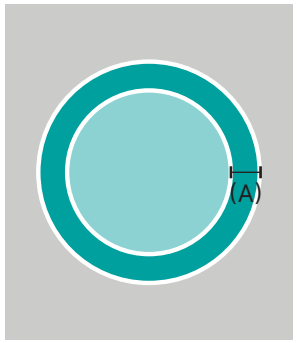
Mountable aprons limit turning speed for passenger vehicles while still allowing larger vehicles to complete the turn. This creates a tighter effective radius for smaller vehicles while still accommodating large trucks without endangering other road users.

Curb Height

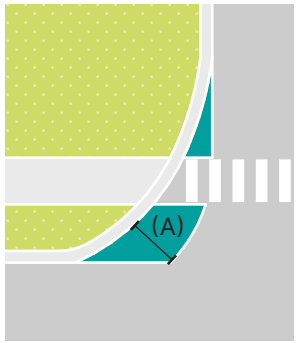
Mountable Area

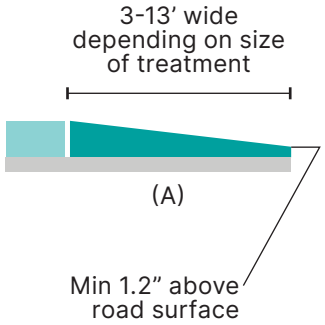
**Mountable Apron Examples:**

Traffic Circle




Intersection Corner




### Typical Application

- Single radius curb aprons with mountable zone are designed to be usable for the vast majority of vehicles. Only vehicles such as fire trucks or design vehicles (e.g.,DL-23 delivery truck) are expected to mount the curbs. Dual radius curb aprons with a defined apron area are intended for encroachment by larger vehicles on a more frequent basis, while providing a tighter radius for managed vehicles.

### Features

- To be effective as a pedestrian safety measure, a truck apron must:
  - » Deter smaller vehicles from turning across it
  - » Clearly convey to drivers of larger control vehicles that it is traversable
  - » Be traversable by large vehicles without threatening stability
  - » Deter pedestrians and bicyclists from stopping or queuing on it
- A surface the same color as the sidewalk reinforces distinction from the roadway for drivers, but may encourage pedestrians to stand on it. A more differentiated apron distinguishes it from the roadway and sidewalk, but if the surface looks too "nice" it may be unclear that it can be driven over.
- For raised aprons, the profile of the edge of the mountable element determines how easily a vehicle can mount it.
- A ***traversable curb*** is better for the stability of larger design and control vehicles, but may not provide enough deterrence for some managed passenger vehicles. A ***mountable curb*** typically has a steeper bevel, providing more deterrence to passenger vehicles.

### Maintenance Considerations

- The ability of the apron to function during and after snow events and its compatibility with snow removal equipment should be considered in design.

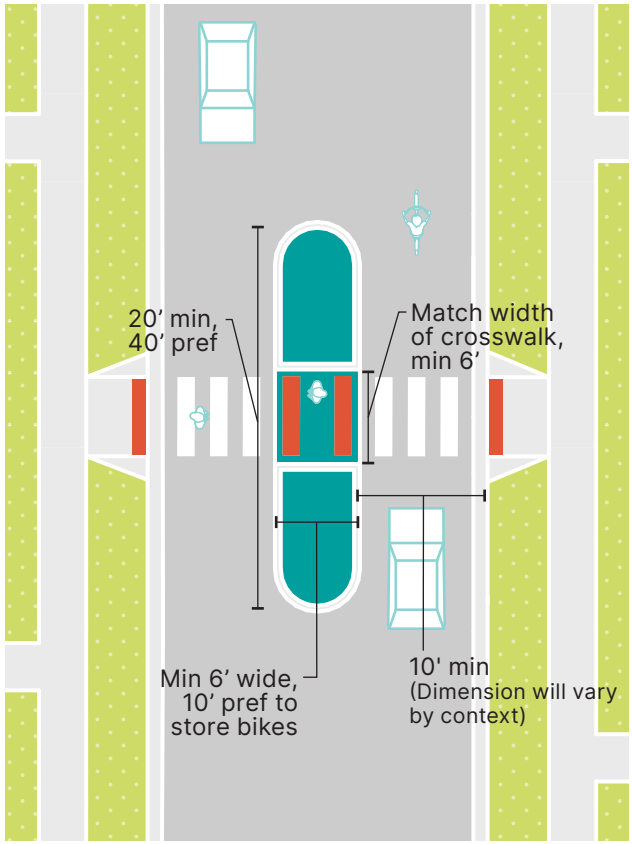
---

### SOURCES

Corner Design for All Users - Alta
USDOT Roundabouts: An Informational Guide
NACTO - Don't Give Up at the Intersection

## PEDESTRIAN REFUGE ISLANDS

Pedestrian Refuges or “islands” are protected areas across a roadway or in an intersection that allow pedestrians and/or bicyclists to cross a roadway in stages, reducing exposure, increasing visibility and improving overall safety. They also slow traffic down as cars navigate between the median and the curb, and provide a space for trees/landscaping.




### Typical Application

- Arterial, Collector, and Local Roads.
- Applied on roadways with center turn lanes or medians that are at least 6’ wide (to accommodate wheelchair users), at least 20’ long (40’ preferred), and are appropriate at signalized or unsignalized crosswalks.
- At low-volume uncontrolled intersections that may not justify signalization but would benefit from additional gaps by breaking the crossing into two stages.
- Where center turn lanes or existing raised medians already exist.

### Features

- One goal of a pedestrian refuge island is to narrow the road, effectively reducing vehicle speeds.
- For bicycles, 10’ of storage is desirable as some bikes may be longer than 6'. Angled refuges may be used to increase storage length.
- For pedestrians, the refuge island must be accessible, preferably with an at-grade passage through the island rather than ramps and landings.
- Narrow medians with bicycle/pedestrian cut-throughs can be used on streets without turn lanes to provide volume reduction without acting as a refuge.
- Refuge Islands should be paired with crosswalks, and include advance pedestrian warning signage if installed at uncontrolled crossings.
- When crossing multi-lane roadways, consider configuration with overhead RRFBs for improved yielding compliance.
- Turning vehicles should be able to navigate around the refuge without mounting it.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, signs, and flexible posts.

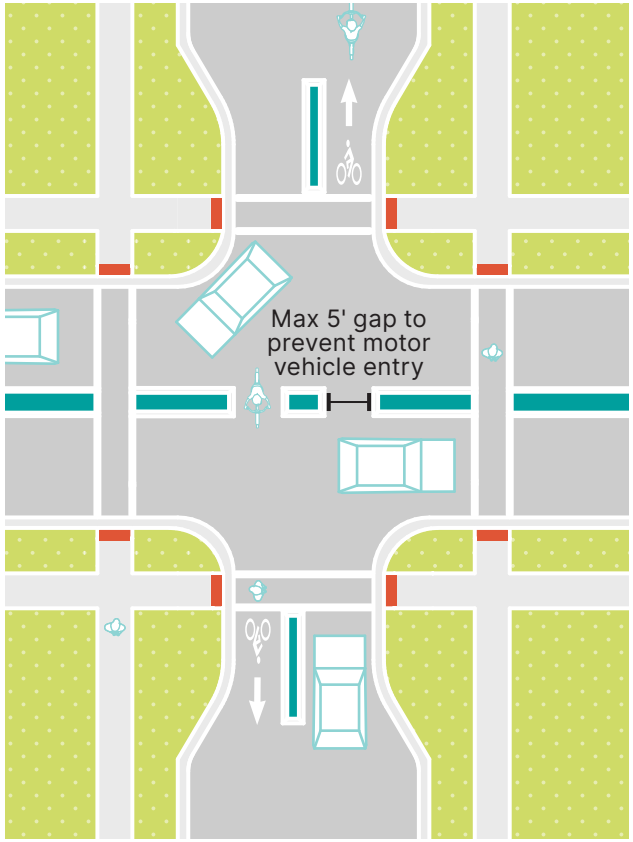
---

### SOURCES

NACTO Urban Street Design Guide: Pedestrian Safety Islands
FHWA Bicycle Safety Guide and Countermeasure Selection System: Medians and Crossing Islands

## ONE-WAY TRAFFIC DIVERTER

One-way diverters also known as “half closures” block vehicle travel for motor vehicles in one direction while preserving two-way bicyclist access. This treatment may help reduce motor vehicle volumes where they exceed target volumes. Through this treatment, pedestrian exposure while crossing is reduced and comfort/ priority is increased for bicyclists.




### Typical Application

- Local Roads, or Local Road/Collector or Arterial Road intersection.
- Where motor vehicle volume reduction may be desirable to meet thresholds.
- To increase comfort and bicycle priority along a designated bike route, like a bicycle boulevard.

### Features

- Crosswalk markings will depend on context.
- The island or curb extension may be partially or fully mountable if needed at constrained intersections.
- May be combined with an optional median diverter on the major street to further physically restrict vehicle access.
- May include a large curb extension or a median island to channelize entering bicyclists and exiting vehicles.
- Emergency response vehicles can maneuver around a one-way diverter when responding to an emergency.
- Consider width of opening and type of access in design to ensure motorists comply with restrictions.
- May shift traffic to adjacent streets.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, signage, and flexible posts.

---

**SOURCES**

FHWA Traffic Management: Diverters
NACTO Urban Bikeway Design Guide: Volume Management

## DIAGONAL DIVERTER

Diagonal diverters may be placed at a local road to local road four-way intersection and require all motor vehicle traffic to turn, while allowing bicyclist and pedestrian through movements. This treatment creates two smaller unconnected intersections. Diverters provide an opportunity for landscaping, stormwater management, benches, or other streetscape features.


### Typical Application

- Minor Collector and Local Roads.
- Also appropriate for Subdivision Roads.
- At intersections of two designated bike routes, like bicycle boulevards where traffic diversion is desirable.
- Where motor vehicle volume reduction may be desirable to meet thresholds.

### Features

- Crosswalk markings (if provided) will depend on context.
- Stop controlled approaches recommended in all directions for safety.
- Integrate trees/landscaping to improve appearance of the roadway.
- May include a large curb extension or a median island to channelize entering bicyclists and exiting vehicles.
- Bike access channels may be designed to be traversable by emergency response vehicles.
- Bicyclist access may be directional on the sides or central in the middle through diverter and can be level with the road or ramped to curb level.
- May shift traffic to adjacent streets.
- Diverter reduces overall network connectivity for motor vehicles.
- Vehicle lane widths should not be narrowed to more than 10 feet with larger widths preferred to accommodate larger turning vehicles.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, signage, and flexible posts.

---

**SOURCES**

FHWA Traffic Management: Diverters
NACTO Urban Bikeway Design Guide: Volume Management

# MULTIMODAL STREET IMPROVEMENTS

Complete streets aim to make transportation feel comfortable for all roadway users. This means alternative modes to cars, such as bicycles and buses should also be accommodated. Common multimodal street improvements include:

**Bus Stops**

Bus stops with space and amenities to provide a safe and comfortable user experience for transit users. May require additional coordination with federal and regional (Valley Transit) agencies.

**Bicycle Boulevard**

Bicycle boulevards are quiet neighborhood streets with low vehicle volumes & speeds.

**Bike Lanes (Standard and Buffered)**

On-street bike lanes designate an exclusive space for bicyclists through the use of striping, pavement markings, and signage.

**Protected Bike Lanes**

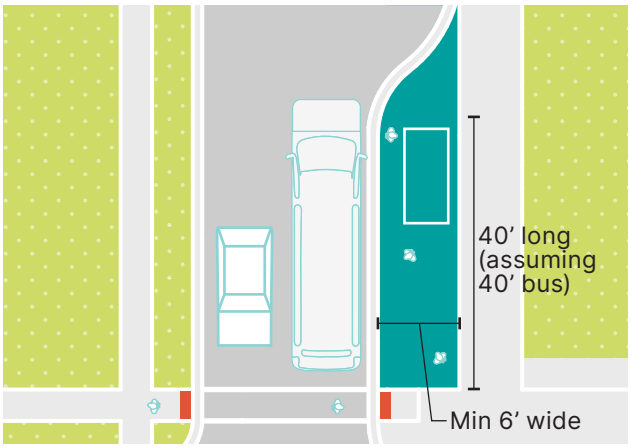
Protected bike lanes are on-street bikeways that are physically separated from vehicle traffic by a vertical element between the bikeway and the vehicular travel lane.

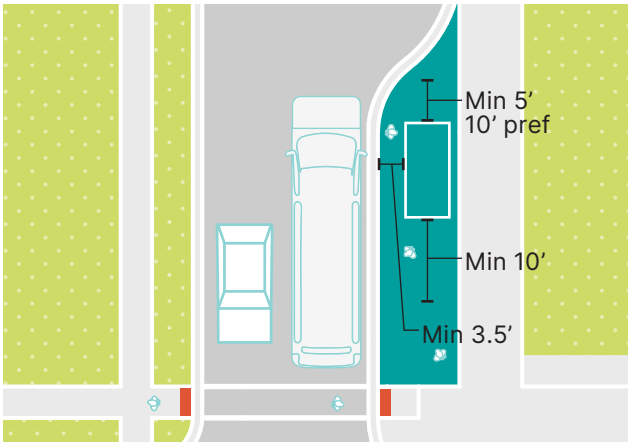
**Sidepath**

Sidepaths provide a travel area separate from motorized traffic for bicyclists, pedestrians, skaters, wheelchair users, joggers, and other users.

## BUS STOPS

Design of bus stops involves thinking about specific placement/location as well as site-specific design features. Bus stops should be planned based on federal and regional (Valley Transit) standards and processes. Specific features may require additional coordination with Valley Transit.




### Typical Application

- Along transit routes - standard bus or Bus Rapid Transit (BRT) routes.

### Features

- Shelters should be provided on routes with high boarding numbers.
- Bus bulbs should be used if offset bus lanes are provided, where merging into traffic may be difficult, or where passengers could benefit from a designated waiting area. If included at the same height as the sidewalk, they should be 40’ long and at least 6’ wide. If there is a step up to the sidewalk, they should extend at least 10’ wide to accommodate a ramp.
- Three categories of bus stop locations:
  - » Far Side Bus Stop: most common type, allows pedestrians to cross the street behind the bus instead of in front. This style also increases the visibility of crossing pedestrians on multi-lane roadways.
  - » Near-Side: Used on long blocks where near-side stop connects well with pedestrian destinations like parks or schools, on one-way, one-lane streets where passing is not allowed, where traffic-calming features, parking, or driveways restrict the potential for far-side stops.
  - » Mid-block Bus Stop: On long blocks with many destinations or at major transit stops with multiple buses queuing.
- Bus stops must be easily accessible by sidewalk, and appropriate street crossings should be included nearby. They must meet ADA standards (landing pads, curb heights) and include sufficient lighting.
- Space around bus stop should meet intended demand/ridership.

### Maintenance Considerations

- Shelters should be composed primarily of steel and with few moving parts; Construct shelter with graffiti, weather, salt, and rust resistant materials.
- Place trash receptacles at/near bus shelters to maintain a clean area.

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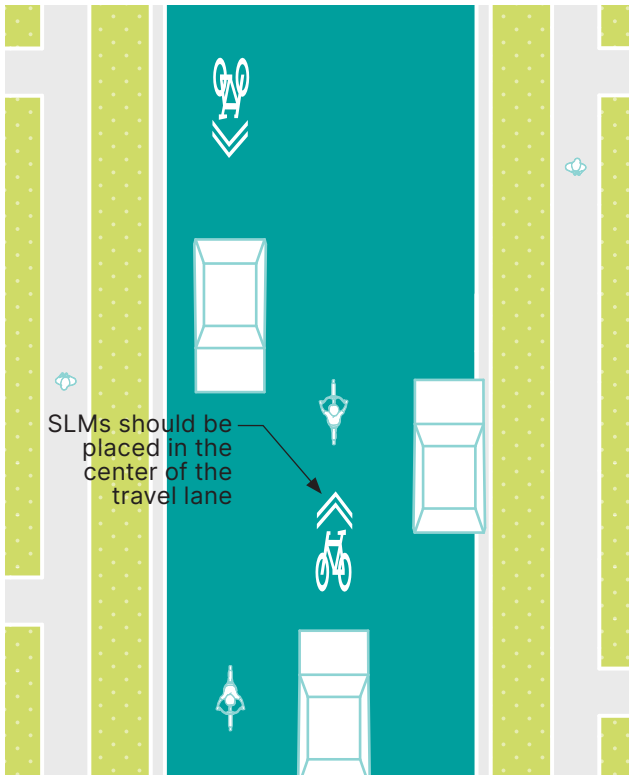
**SOURCES**

NACTO Urban Street Design Guide: Bus Stops
Project for Public Spaces: Bus Shelters

## BICYCLE BOULEVARD

Bicycle boulevards are quiet neighborhood streets with low vehicle volumes & speeds. Bicyclists and pedestrians are prioritized by managing vehicle speeds and volumes (traffic calming elements). Signage and pavement markings are also incorporated. Bicycle boulevard features should be determined on a case-by-case basis, using engineering judgment to achieve appropriate vehicle speeds and volumes.




### Typical Application

- Local Roads.
- Low-volume, low-speed streets. Utilize traffic calming to maintain or establish low volumes and discourage vehicle cut through/speeding.
- Continuous routes that make direct connections, including parallel routes to arterials and collectors that are less suitable for low-stress bikeways.

### Features

- Signs, shared lane markings (SLMs), and traffic calming elements as needed to achieve appropriate vehicle speeds and volumes are the minimum treatments necessary to designate a street as a bicycle boulevard.
- SLMs, also commonly referred to as “sharrows”, have been proven to impact bicyclist riding position. Keep them outside of the “door zone” of parked cars by positioning them in the center of the lane.
- Intersection crossings should be designed to enhance comfort and minimize delay for bicyclists and pedestrians of diverse skills and abilities.
- R4-11 “May Use Full Lane” sign is recommended along the route.
- Use engineering judgment to determine appropriate traffic calming measures.
- Greening, stormwater management, and a robust street tree canopy can contribute to traffic calming and bicyclist & pedestrian comfort.

### Quick-Build Option

- Quick-build implementation with stencils and signage; option to add other traffic-calming quick-build elements (such as curb extensions, mini traffic circles, etc.)

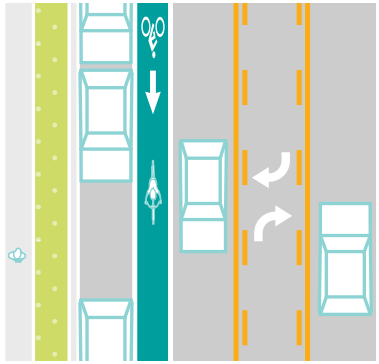
---

**SOURCES**

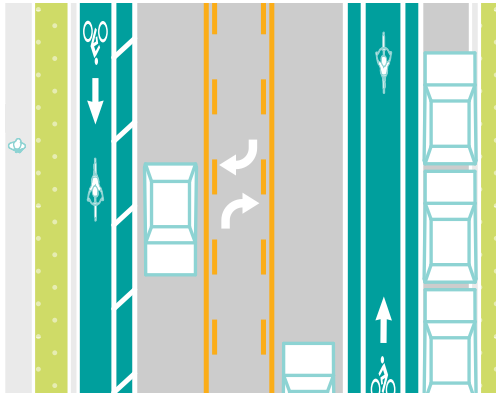
NACTO Urban Bikeway Design Guide: Bicycle Boulevards

## BIKE LANES

On-street bike lanes designate an exclusive space for bicyclists through the use of striping, pavement markings, and signage. Bike lanes are located directly adjacent to motor vehicle travel lanes and are typically used in the same direction as motor vehicle traffic. A buffer of 2' at minimum is recommended to add space between bicycle and motor vehicle traffic.



Standard Bike Lane



Buffered Bike Lane (shown with and without parking lane)

### Typical Application

- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes 3,000-5,000.
- Appropriate for skilled adult riders on most streets. May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

### Features

- Buffered bike lanes features a buffer width of 2' minimum, 3' preferred. A buffer is especially important when parking has high turnover. In general, standard bike lanes should be used in only constrained ROW.
- Minimum width of the bike lane is 5’. However, 7’ is preferred to facilitate safe passing behavior. These widths do not include the gutter pan or buffer.
- Include a bicycle lane pavement legend at the beginning of the bike lane, beginning and end of bike lane pockets, approaches and far side of arterial crossings, and major changes in direction. MUTCD recommends every 80 ft - 1,000 ft depending on land use context. Place markings to minimize wear from turning motor vehicles.
- The R3-17 “Bike Lane” sign is optional, but recommended in most contexts.

### Maintenance Considerations

- Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them at intersections, driveways, parking lanes, and along curved or constrained segments of roadway.
- Bike lanes should be maintained so there are no pot holes, cracks, uneven surfaces or debris. Manhole covers within bike lanes should be adjusted to be flush with the pavement when repaving occurs.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, and signs.

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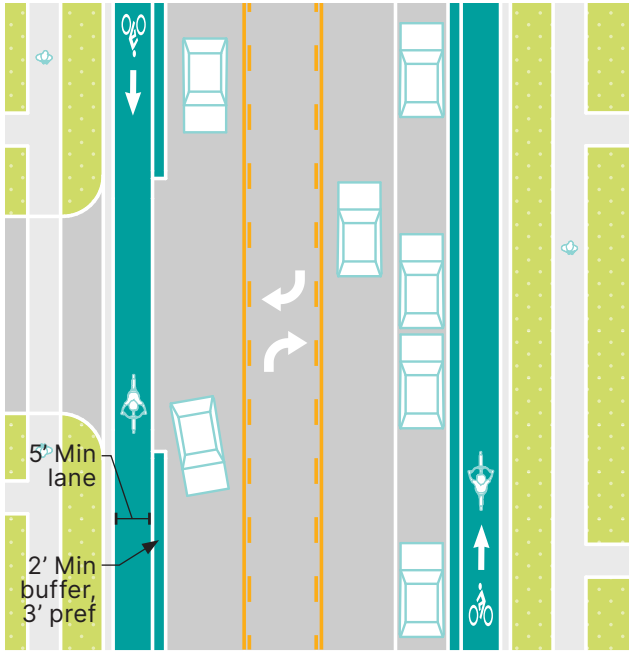
**SOURCES**

NACTO Urban Bikeway Design Guide: Conventional Bike Lanes
FHWA Pedestrian Safety Guide and Countermeasure Selection System

## PROTECTED BIKE LANES

Protected bike lanes are on-street bikeways that are physically separated from vehicle traffic by a vertical element between the bikeway and the vehicular travel lane. Protected bike lanes typically share the same elevation as adjacent travel lanes, but the bikeway could also be raised above street level, either below or equivalent to sidewalk level.




### Typical Application

- Along streets on which conventional bicycle lanes would be stressful because of multiple lanes, high traffic volumes (10,000-15,000 ADT), high traffic speeds (35+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.

### Features

- Pavement markings, symbols and/or arrow markings must be placed at the beginning of the bikeway and at intervals along the facility.
- Maximize effective operating space by placing curbs or delineator posts as far from the through bikeway space as practicable.
- Include green conflict marks at crossing points like intersections/ driveways.
- Use wide bikeway (7’+) in high bicycle traffic areas to allow passing.
- Protected bike lanes may be designed at the street level, at curb level, or at an interim elevation between the top of the curb and street.
- Parking should be prohibited 30’ in advance of intersections and driveways to improve visibility. Clearly mark parking prohibition through red curbs & signage.
- Vehicular turning movement restrictions are strongly encouraged where applicable, including No Right Turn on Red (see pg.58) and dedicated left turn phases.

### Maintenance Considerations

- Bike lane striping and markings will require higher maintenance where vehicles frequently traverse over them.
- Access points along the facility should be provided for street sweeper vehicles to enter/exit the separated bikeway.
- Construct plow-compatible noses when using concrete curb barriers.

### Quick-Build Option

- Quick-build implementation with paint, traffic tape, signage, and flexible posts.

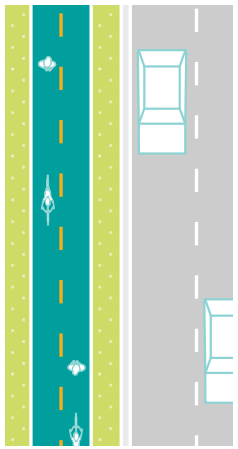
**SOURCES**

FHWA Separated Bike Lane Planning and Design Guide
NACTO One-Way Protected Cycle Tracks

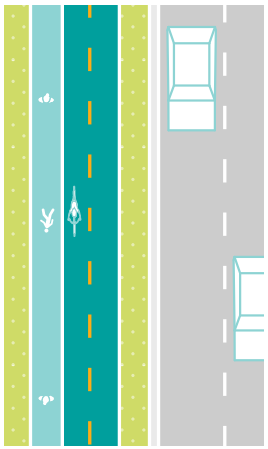
## SIDEPATH

Sidepaths provide a travel area separate from motorized traffic for bicyclists, pedestrians, skaters, wheelchair users, joggers, and other users. They are desirable for bicyclists of all skill levels preferring separation from traffic.

| Treatment | Scenario | Min Width |
|---|---|---|
| Shared-Use Path | Occasional mix of users | 10' Path |
| Separated-Use Path | High concentration of users | 10' Cycle Track, 5' Pedestrian Track |



Shared-Use Path



Separated-Use Path

### Typical Application

- Adjacent to roadways, especially higher volume, higher speed corridors and roadways that are in close proximity to schools.

### Features

- 10’ minimum width. Additional width is recommended along corridors with higher concentration of bicyclists and pedestrians. Consider separate pedestrian track (5’ minimum width) in high-traffic areas.
- 5’ minimum buffer measured from edge of sidepath and edge of roadway.
- Overhead clearance should be 8’ minimum, 10’ recommended.
- A 2’ or greater shoulder on both sides of the path should be provided.
- Provide solid centerlines on tight/blind corners and transitions, on approaches to roadway crossings, or where visibility concerns exist.
- Sidepaths utilize pedestrian walk signals. Vehicular turning movement restrictions are strongly encouraged where applicable, including No Right Turn on Red (see pg. 59) and dedicated left turn phases.

### Maintenance Considerations

- Can be plowed just as a sidewalk would be plowed.
- Per Appleton policy, snow removal on sidepaths is the responsibility of the adjacent residential property owner.

**SOURCES**

NACTO Urban Street Design Guide: Intersections of major and minor streets
FHWA Traffic Calming e-Primer: speed management/traffic calming

# INTERSECTION OPERATIONS & SIGNAL MODIFICATIONS

To calm traffic on roadways, sometimes physical changes are not needed, but rather, signal improvements can be added to improve the flow and safety of traffic on an existing roadway.

**No Right Turn on Red**

Eliminating right turn on red allows pedestrians to cross the street safely during their designated phase without worrying about a motorist pulling out in front of them.

**Rectangular Rapid Flashing Beacon (RRFB)**

RRFBs are generally used on streets with two to three lanes and flash when activated by bicyclists or pedestrians to increase awareness that drivers must yield to crosswalk users.

**Hardened Left Turns**

Left-turn hardening involves the use of modular curbs, vertical delineators, and striping at intersections to slow left-turning vehicles and to prevent “corner cutting.”

**Pedestrian Hybrid Beacon (PHB)**

PHBs, also called High-intensity Activated Crosswalks (HAWKs), are used to improve non-motorized crossings at major roadways.

**Exclusive Pedestrian Phase**

An exclusive pedestrian phase at a signalized crossing, also called a “pedestrian scramble” stops all vehicular movement and gives pedestrians crossing the intersection in all directions a chance to cross.

**Accessible Pedestrian Signal (APS)**

Accessible pedestrian signals are devices that communicate information about the crossing intervals at signalized intersections to pedestrians who are low vision, blind, or have hearing loss through audible, visual, or vibrotactile methods.

## NO RIGHT TURN ON RED

Allowing Right Turn on Red (RTOR) at a signalized intersection makes it so motorists can turn right on a red light so long as the roadway is clear of traffic moving to the right. While this treatment allows for flow of traffic, it has had a negative effect on pedestrians and cyclists legally crossing the roadway. Motorists tend to be focused on watching for traffic approaching from the left and often fail to pay attention to pedestrians and cyclists to their right. Drivers turning right on red tend to pull fully into the crosswalk in order to get a full view of oncoming traffic from the left. Despite the law requiring motorists to come to a full stop and yield to cross street traffic and pedestrians before turning right, many roll through the crosswalk without stopping.


R10-11


R10-11a

### Typical Application

- RTOR restrictions should be strongly considered in areas with high pedestrian traffic volumes. This includes areas like downtowns, school zones, near parks, or in residential neighborhoods.
- RTOR restrictions should be used at all school crossings.
- RTOR should also be banned at intersections with sidepaths or shared use paths.
- Part-time RTOR prohibitions during the busiest times of the day may be sufficient to address the problem. Blankout signs could be used in this instance.

### Features

- The No Turn on Red with the red ball (R10-11) may draw more attention to the sign than the sign with only text (R10-11a or b).

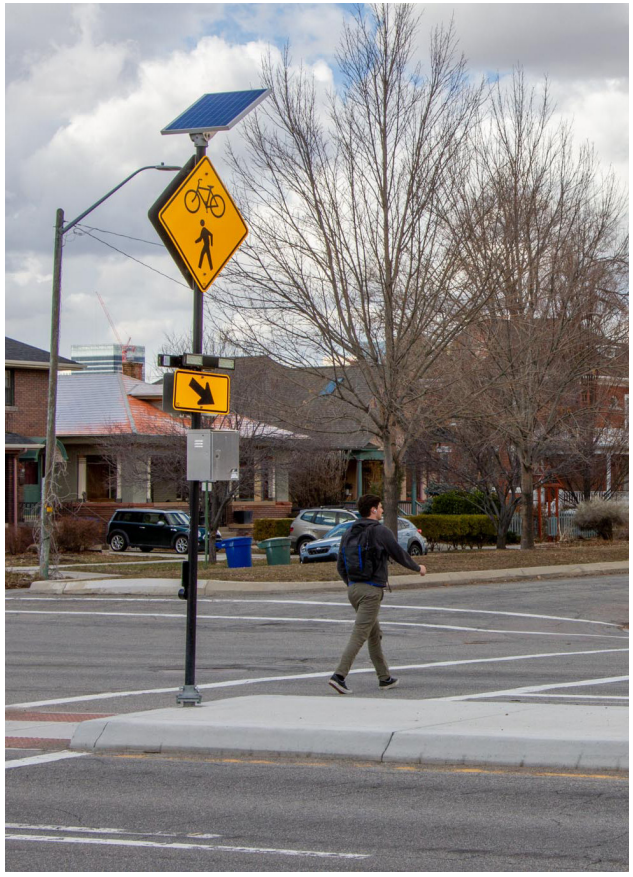
### SOURCES

FHWA Signs and Signal: Right Turn on Red Restrictions

Pedestrian Safety Guide and Countermeasure Selection System: Right Turn on Red Restrictions

## RECTANGULAR RAPID FLASHING BEACON (RRFB)

Rectangular Rapid Flashing Beacons (RRFBs) are placed as a supplemental feature to a combined bicycle/pedestrian crossing, and are generally used on streets with two to three lanes. The beacons are activated by a push button, and flash when activated to increase awareness that drivers must yield to crosswalk users.



### Typical Application

- May be considered at mid-block crossings and intersections where signalization is not warranted.
- May also be considered to cross lower speed (<35mph) streets with up to two travel lanes in each direction with the presence of a median refuge.

### Features

- Bicyclists are directed to mount the corner using a dedicated bicycle ramp and to cross using the existing crosswalk.
- Bicyclists and pedestrians use the same push button.
- Median refuge islands may be paired with RRFB crossings.
- Passive detection may be added to the RRFB system to activate the warning lights even if the button is not pressed.

### SOURCES

NACTO Urban Bikeway Design Guide: Active Warning Beacon for Bike Route at Unsignalized Intersection

Pedestrian Safety Guide and Countermeasure Selection System: Rectangular Rapid Flashing Beacon (RRFB)

## PEDESTRIAN HYBRID BEACON (PHB)

Pedestrian Hybrid Beacons, also called High-intensity Activated Crosswalks (HAWKs), are used to improve non-motorized crossings at major roadways. They also provide a lower-cost signalization option than a full signal.


### Typical Application

- At existing uncontrolled intersections with enough complexity that stopping traffic to provide safe crossings is desirable.
- Existing pedestrian oriented half signals may be modified to Hybrid Beacons to meet current FHWA guidance.
- To provide pedestrian and bicycle priority at a minor street crossing without incentivizing or attracting additional through vehicle traffic.
- At an intersection within a school zone on a walking route.

### Features

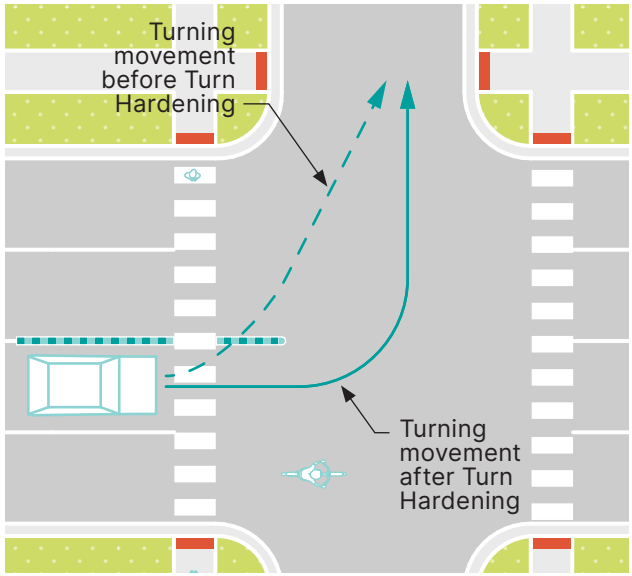
- Vehicles on the cross-street will not receive any signal indication and are controlled by a stop sign.
- Bicycle crossings are typically directional and adjacent to the curb; however, it is also possible to consolidate both directions of bicycle travel to one side of the intersection if geometry is advantageous.
- Per the FHWA, bicycle signals may not be combined with a Hybrid Beacon. Bicycles must use the pedestrian signal indication.
- Blankout signs that restrict conflicting vehicle movements from the minor cross-street are recommended to be present and active during beacon operation to reduce potential conflicts.
- Pedestrian crossings may be included on both sides of the street.

### SOURCES

NACTO Urban Bikeway Design Guide: Hybrid Beacon for Bike Route Crossing of Major Streets
Pedestrian Safety Guide and Countermeasure Selection System: Pedestrian Hybrid Beacon (PHB)

## HARDENED LEFT TURNS

Left-turn hardening involves the use of modular curbs, vertical delineators, and striping at intersections to slow left-turning vehicles and to prevent "corner cutting." Two common treatments are centerline hardening, or placing modular curbs where the centerline meets the intersection, and slow turn wedges, which involve striping and delineators at intersection corners to slow left-turning vehicles at intersections between two one-way streets. These treatments enhance the separation between travel directions, help to guide vehicles into the proper receiving lane, and slow vehicle speeds as the complete a turn.




### Typical Application

- Left-turn hardening is typically installed at intersections where a minor street intersects with a major street, with the elements addressing left-turns from the minor street onto the major street. It is most useful at intersections with high volumes of pedestrians and where high-speed left turns made by vehicles are a major issue.
- Two types:
  - » Hardened centerlines, typically installed using modular curbs and vertical delineators, are installed in line with the centerline approaching an intersection. The installation may extend to the stop bar, crosswalk, or even further into the intersection.
  - » Slow turn wedges are installed at corners of an intersection in line with on-street parking and on the far side of crosswalks. Their installation typically involves pavement markings and vertical delineators.

### Features

- Hardening elements may be installed with different heights of vertical elements to accommodate larger vehicles/different sight lines.
- Elements could include rubber parking stops and/or flex posts.

### Quick-Build Option

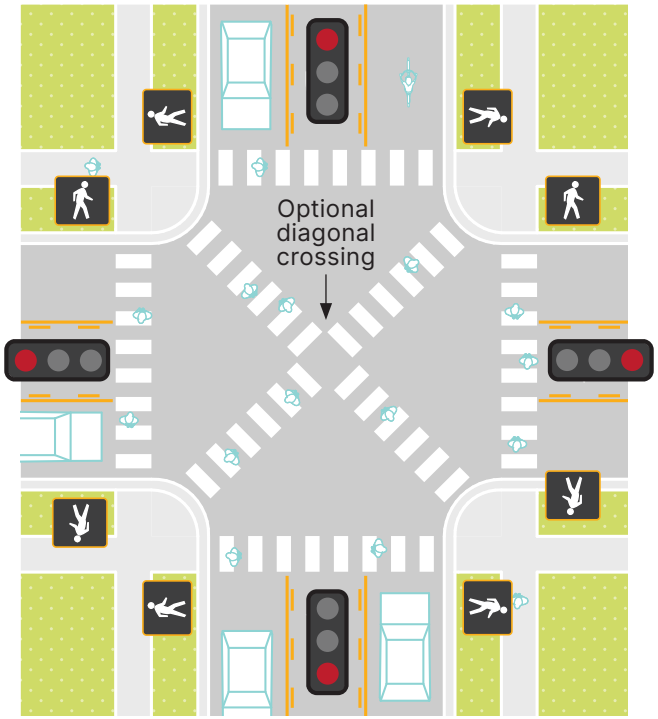
- Quick-build implementation traffic tape and rubber parking stops, flexible posts, and/or plastic curbs.

### SOURCES

NACTO Don't Give Up at the Intersection
VDOT Left-Turn Hardening Brochure

## EXCLUSIVE PEDESTRIAN PHASE

An exclusive pedestrian phase at a signalized crossing, also called a “pedestrian scramble” stops all vehicular movement and gives pedestrians crossing the intersection in all directions a chance to cross, even the opportunity to cross diagonally. Because exclusive pedestrian phasing causes all traffic to stop moving through the intersection, the safety benefit to pedestrians from this technology can be significant due to the elimination of pedestrian-vehicle conflicts.




### Typical Application

- An exclusive pedestrian phase is an established safety measure for downtown areas with high pedestrian crossing movements.
- Exclusive pedestrian phasing, compared with concurrent signal phasing or none at all, yields measurable reductions in collisions only when pedestrian volume exceeds 1,200 persons per day.
- Exclusive phasing is appropriate for intersections where the time ratio of combined through-traffic phases to pedestrian phases is lower than 0.5.
- An alternative to this concept is to prohibit left and right turning vehicles moving in parallel to the crosswalk from turning when a pedestrian is detected in the crosswalk by a passive pedestrian sensor. This system activates LED turn prohibition signs when pedestrians are detected.

### Features

- Prohibiting turning vehicles from moving across the crosswalks when pedestrians are detected using passive pedestrian sensors would decrease the impact on congestion (no queued cars waiting for an opportunity to turn) and eliminate the pedestrian-vehicle conflict that may occur during pedestrian non-scramble phases.
- A UConn study published in 2017 has shown that while the overall number of crashes is reduced with this intervention, crashes involving pedestrians at intersections with exclusive pedestrian phasing tend to be more severe. This is because pedestrians may be unwilling to wait through all the vehicle phases to cross during the pedestrian phase, leading to collisions.

### SOURCES

FHWA Pedestrian Safety - Report to Congress: Assessment of Developmental and Pre-Deployment Advanced Technologies

T2 Center Traffic Signal Brief: Concurrent Pedestrian Phasing and Leading Pedestrian Interval (LPI)

# 03

# TRAFFIC CALMING RETROFIT PROGRAM

# HOW TO USE THE TRAFFIC CALMING RETROFIT PROGRAM?

**The traffic calming retrofit program provides strategies for implementing low-cost and high-impact traffic calming features on an accelerated timeline.**

Traffic calming retrofit, often referred to as "quick-build" or "demonstration projects", utilizes inexpensive materials such as paint, flex posts, planters, and prefabricated traffic control devices to allow for quick implementation of many of the traffic calming elements outlined in Chapter 2. This chapter includes:

1. **Program Overview**: An overview of what quick-build projects are and the process, funding, and staffing needed to guide implementation.
2. **Neighborhood Traffic Calming Study**: Geometric modifications for intersections and mid-block crossings.

# PROGRAM OVERVIEW

## WHAT IS QUICK-BUILD?

Quick-build projects are shorter-term, low-cost, and temporary roadway projects used to improve complete streets for walking, bicycling, and community safety. There are a wide range of street and spot improvement projects that may be considered for quick-build, outlined on pg. 28.

### Project Materials

Common project materials include:

- White and/or yellow traffic paint
- Temporary pavement marking tape
- Stencils
- Signage
- Colorful paint
- Flexible posts
- Plastic curbs
- Planters, boulders, and barriers
- Spot improvements to curbs

## WHAT ARE THE BENEFITS?

**Quick to build.** Quick-build projects have significantly shorter timelines to implement than conventional complete street construction projects; some smaller quick-build projects take less than 24 hours.

**Short-term to long-term.** Quick-build projects can be in place for anywhere from one day to multiple years, depending on the intended purpose and materials used. Longer projects such as those that are in place for multiple years may be more focused on providing long-term traffic calming benefits or for evaluating the success of various complete street elements.

**Low cost.** Quick-build projects are generally a fraction of the cost of conventional complete street construction projects. The cost of quick-build projects will vary depending on the type, size and duration of the project as well as the materials used. In general, material costs range from $100 to $10,000 per installation.

**Desired Outcomes.** Quick-build projects allow communities to evaluate potential infrastructure improvements before investing in permanent changes. Benefits of using a quick-build approach include:

- Test improvements before investing in permanent changes.
- Inspire action, build support for project implementation, and increase public engagement by inviting stakeholders to test out projects.
- Increase understanding of various transportation needs in the community.
- Encourage people to work together in new ways, strengthening relationships between government agencies, elected officials, non-profit organizations, local businesses, and community residents.
- Gather data from real-world use of streets and public spaces.


MnDOT

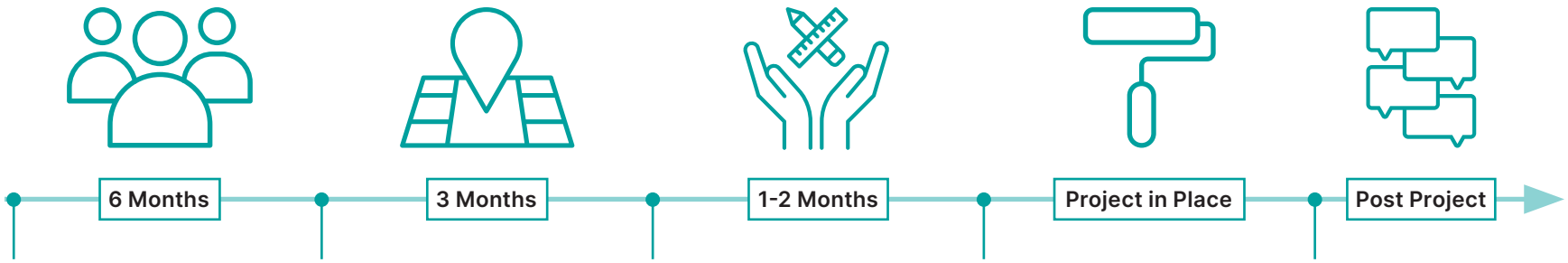

SE Malcom Av

## WHAT IS THE PROCESS FOR IMPLEMENTING QUICK-BUILD PROJECTS?

The process for installing a quick-build project will differ from project to project, but the following timeline in Figure 5 below provides a standard approach for success.

## ARE DEDICATED STAFF REQUIRED TO MANAGE THE PROGRAM?

Implementing a traffic calming retrofit program will require additional staff to be hired to manage the program. These hires will create new ongoing costs.




**Build a Team**

Assemble community and agency stakeholders including the road authority if project sites have been identified. This team should be assembled at least six months prior to the quick-build project installation.

**Choose a Site/Project Type**

Many factors should be considered when choosing a location for a quick-build project. A strong need or desire to make a change at a specific location may have already been identified. This location may be identified in a previous plan, or another planning process that included conversations with community members.

**Planning and Design, Conducting Evaluation**

Designing the site, determining the project's duration, and choosing materials are all critical elements of the development of a quick-build project plan. Once these are in place, determine what initial data will need to be collected, and develop a process for data collection.

**Installing, Maintaining, and Removing the Project**

Quick-build project installation requires a careful breakdown of tasks, roles, and responsibilities to ensure success. Once installed, ensure duties related to maintenance and removal of the project once the project's duration is over are assigned.

**Follow Up**

Before removing the project, debrief with the project team. Develop a summary of the project including data collected, observations made, and lessons learned for the next quick-build project.

**Figure 5:** *Typical quick-build project process*

## WHAT ARE THE FUNDING STRATEGIES FOR QUICK-BUILD PROJECTS?

Funding for quick-build projects may be available from a range of local, state, and federal agencies or non-profit organizations. Many of these funding sources can be used for other types of complete street reconstruction projects in addition to quick-build.

*Non-Profit Sources*

**People for Bikes Community Grants**
Agency: People for Bikes

Funding for projects that make bicycling better. Up to $10,000.

**AARP Community Challenge Grant**
Agency: AARP

Provides small grants to fund quick-action projects that can help communities become more livable for people of all ages. The 2023 rounds of funding included demonstration grants aimed at advancing solutions that build capacity toward Transportation Systems Change. These grant opportunities range from approximately $30,000 to $50,000 per project.

*Local and State Sources*

**Local and Regional Funding**
Local and regional funds such as general fund, sales tax revenue, and Air Quality District funds are often the best sources.

**Community Development Block Grant** (Wisconsin Department of Administration Division of Energy, Housing and Community Resources)

Public facilities funds support infrastructure and facility projects for communities. Examples of eligible projects include improvements, repairs, or expansions of streets, drainage systems, water and sewer systems, sidewalks, and community centers. Up to $1 million.

**State Infrastructure Bank Program** (WISDOT)

Loans for transportation infrastructure improvements that preserve, promote, and encourage economic development or promote transportation efficiency, safety, and mobility. Loans can be used in conjunction with other federal or state programs, or to finance an entire project.

*Federal Sources: FHWA has provided a matrix of funding programs for bicycle and pedestrian project, see* Pedestrian and Bicycle Funding Opportunities: U.S. Department of Transportation Transit, Safety, and Highway Funds.

**SS4A/Safe Streets for All** (FHWA)
Competitive grant; 5-year program at $1 billion/year.

**Active Transportation Infrastructure Investment** (FHWA)
$1 billion over 5 years ($200 million/year); funding for active transportation projects.

**Reconnecting Communities** (FHWA)
$500 million (and up to $1 billion in future appropriation); competitive grant program for planning or construction.

**RAISE** (FHWA)
$1 billion over 5 years ($200 million/year); funding for active transportation projects.

**Transportation Alternatives Program (TAP) Grant** (WisDOT)
Reimbursement program (80% federally funded, 20% match); funding for active transportation projects.

# NEIGHBORHOOD TRAFFIC CALMING STUDY

The following pages illustrate diagrams of quick-build implementation for a 6×6 block neighborhood in Appleton. The recommendations illustrate appropriate applications of complete street elements along streets and at intersections, including local, collector, and arterial streets.

The recommendations are intended to provide general guidance on the types and locations for common quick-build elements. These diagrams may be used as a starting point for designing quick-build interventions for a neighborhood or street, but should be noted that recommendations may vary based on specific context, intended use, and cost limitations.

The following pages include the following:

- Overview Diagram: An entire 6×6 neighborhood including a range of contexts as well as local, collector, and arterial streets. (pg. 71)
- Local Street Diagram: A zoom-in of quick-build interventions for a local street. (pg. 72)
- Collector Street Diagram: A zoom-in of quick-build interventions for a collector street. (pg. 73)
- Arterial Street Diagram: A zoom-in of quick-build interventions for an arterial street. (pg. 74)

## OVERVIEW TRAFFIC CALMING RETROFIT DIAGRAM

### LEGEND:

1. Curb extensions
2. Traffic circle
3. Pinchpoint with mid-block crossings
4. Pedestrian refuge island
5. Buffered bike lanes
6. Protected bike lanes
7. 4-lane to 3-lane conversion
8. No right turn on red
9. Exclusive pedestrian phase

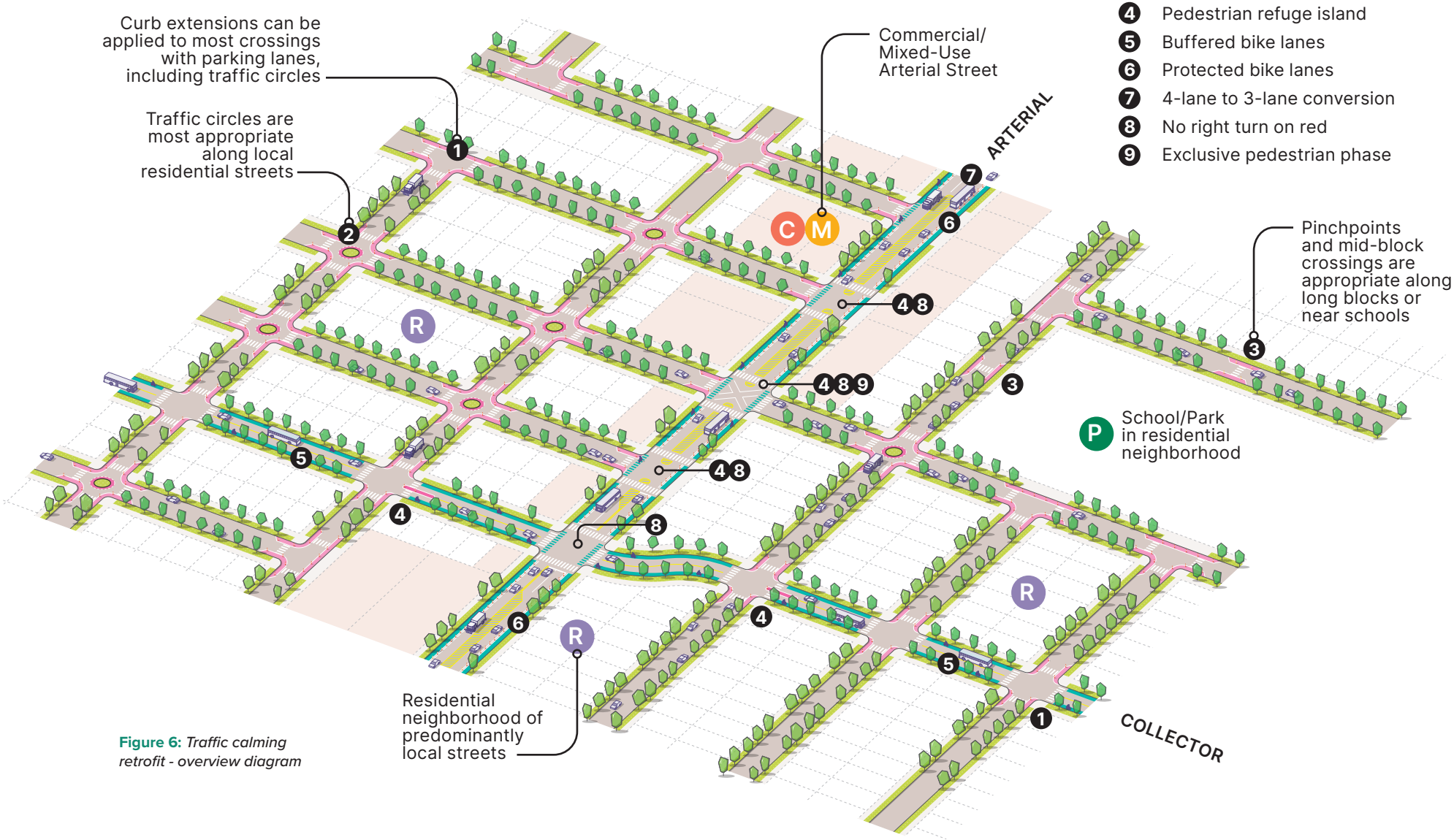
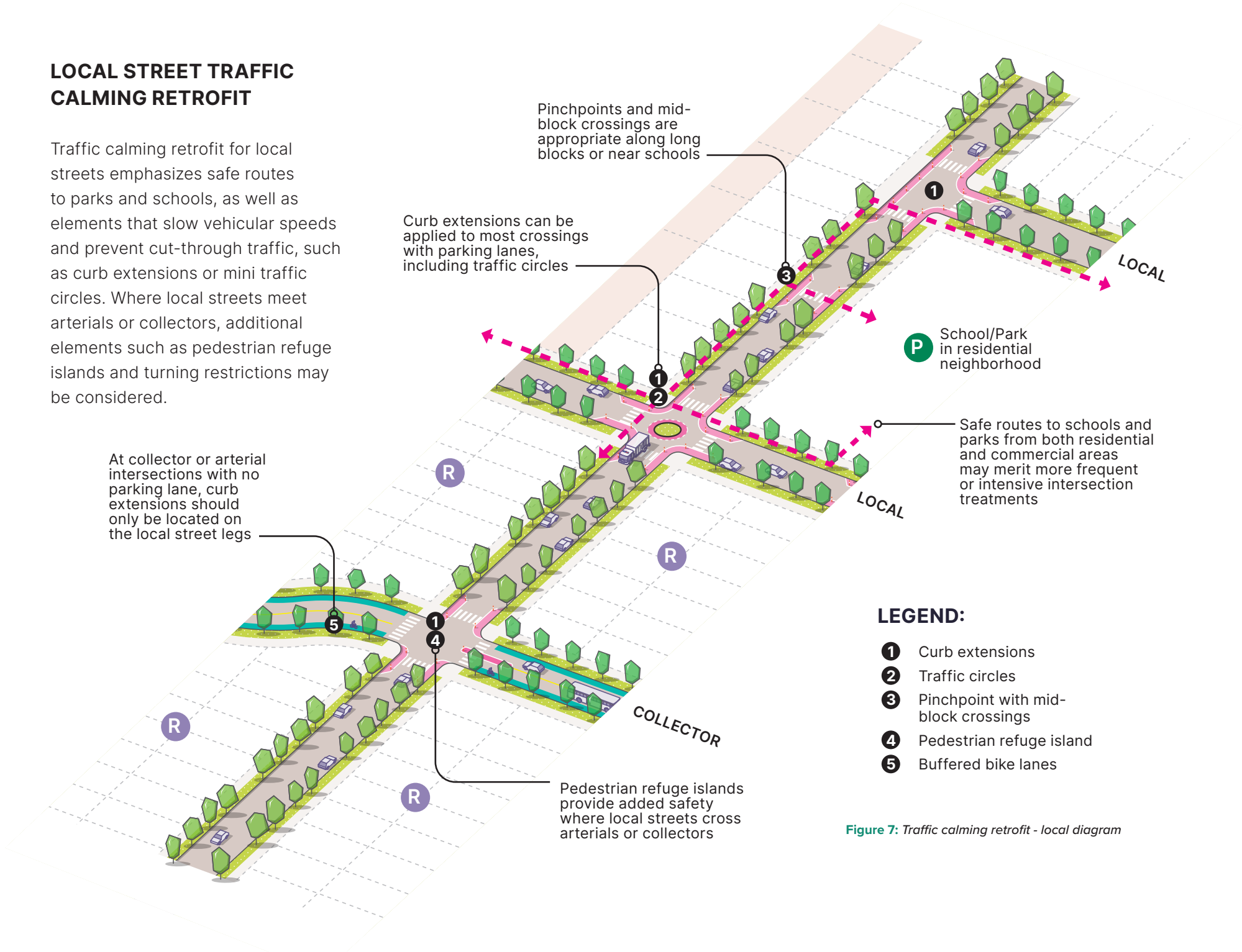



**Figure 6:** *Traffic calming retrofit - overview diagram*

## LOCAL STREET TRAFFIC CALMING RETROFIT

Traffic calming retrofit for local streets emphasizes safe routes to parks and schools, as well as elements that slow vehicular speeds and prevent cut-through traffic, such as curb extensions or mini traffic circles. Where local streets meet arterials or collectors, additional elements such as pedestrian refuge islands and turning restrictions may be considered.



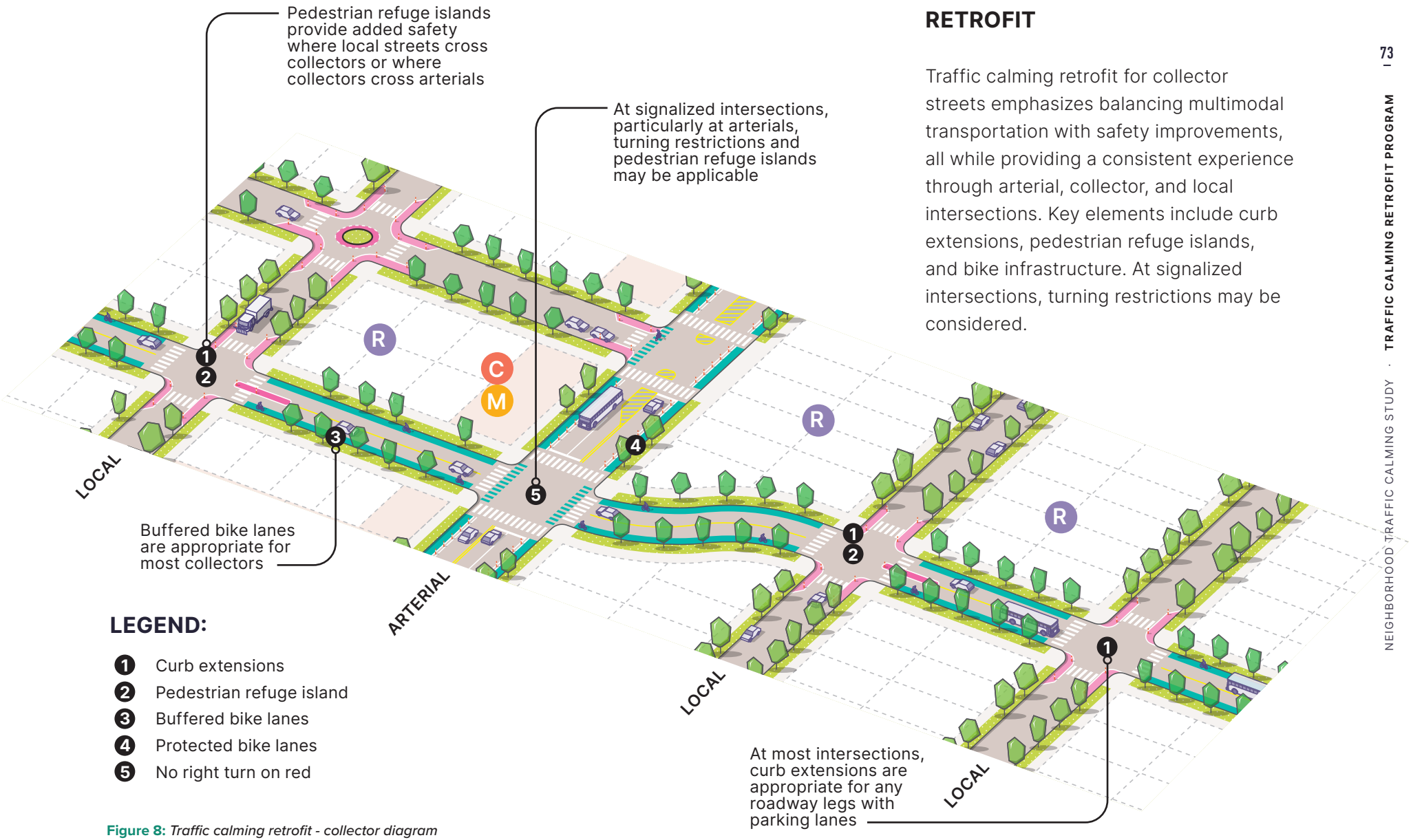

### LEGEND:

1. Curb extensions
2. Traffic circles
3. Pinchpoint with mid-block crossings
4. Pedestrian refuge island
5. Buffered bike lanes

**Figure 7:** *Traffic calming retrofit - local diagram*

## COLLECTOR TRAFFIC CALMING RETROFIT

Traffic calming retrofit for collector streets emphasizes balancing multimodal transportation with safety improvements, all while providing a consistent experience through arterial, collector, and local intersections. Key elements include curb extensions, pedestrian refuge islands, and bike infrastructure. At signalized intersections, turning restrictions may be considered.



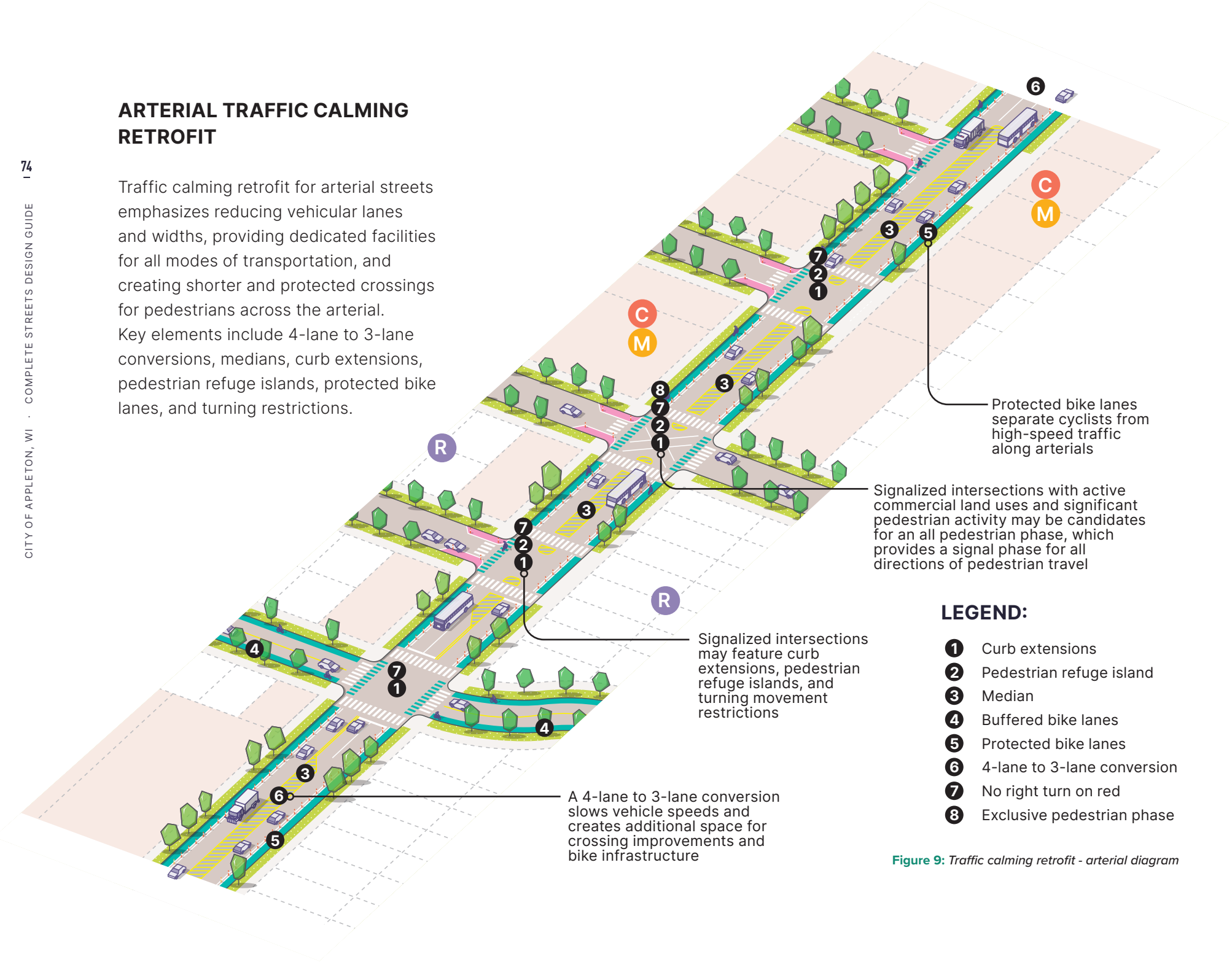

**LEGEND:**

1. Curb extensions
2. Pedestrian refuge island
3. Buffered bike lanes
4. Protected bike lanes
5. No right turn on red

**Figure 8:** *Traffic calming retrofit - collector diagram*

## ARTERIAL TRAFFIC CALMING RETROFIT

Traffic calming retrofit for arterial streets emphasizes reducing vehicular lanes and widths, providing dedicated facilities for all modes of transportation, and creating shorter and protected crossings for pedestrians across the arterial. Key elements include 4-lane to 3-lane conversions, medians, curb extensions, pedestrian refuge islands, protected bike lanes, and turning restrictions.




### LEGEND:

1. Curb extensions
2. Pedestrian refuge island
3. Median
4. Buffered bike lanes
5. Protected bike lanes
6. 4-lane to 3-lane conversion
7. No right turn on red
8. Exclusive pedestrian phase

**Figure 9:** *Traffic calming retrofit - arterial diagram*