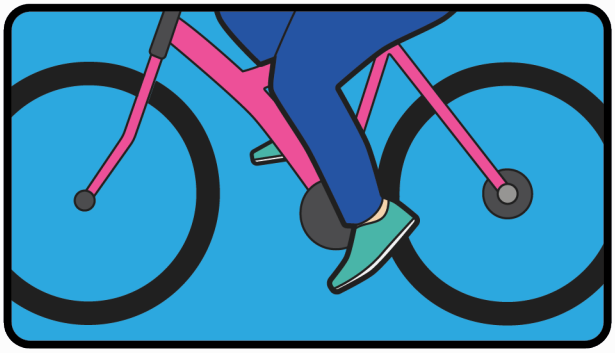
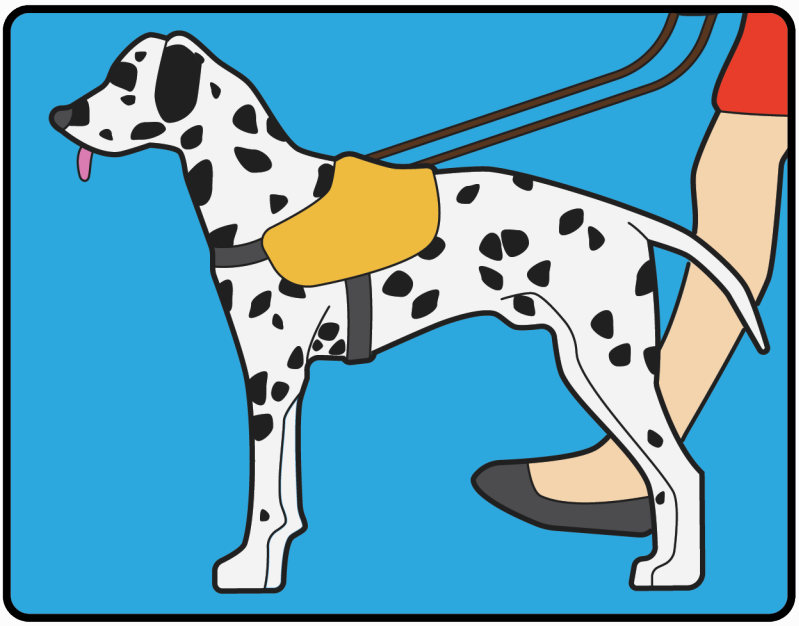
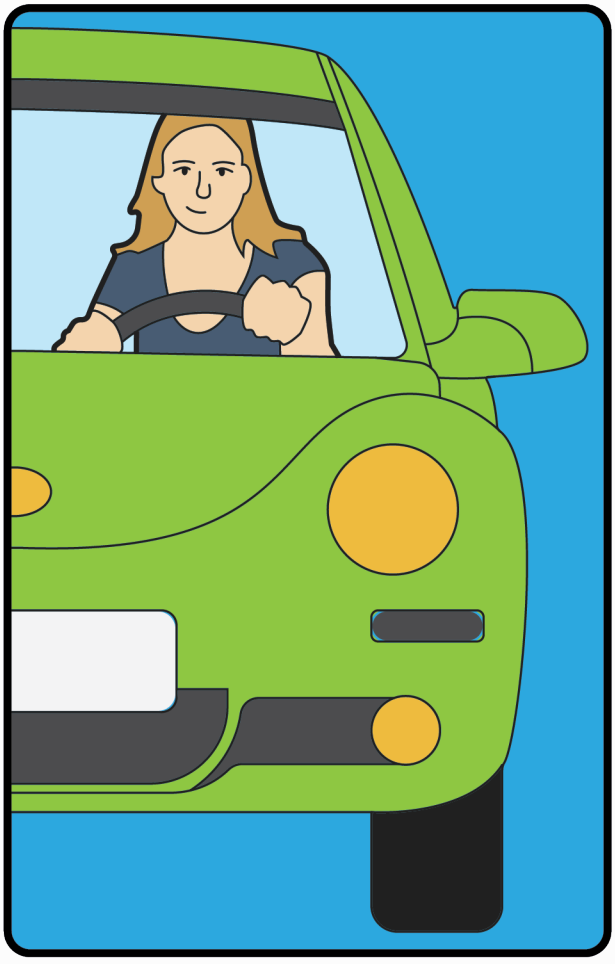
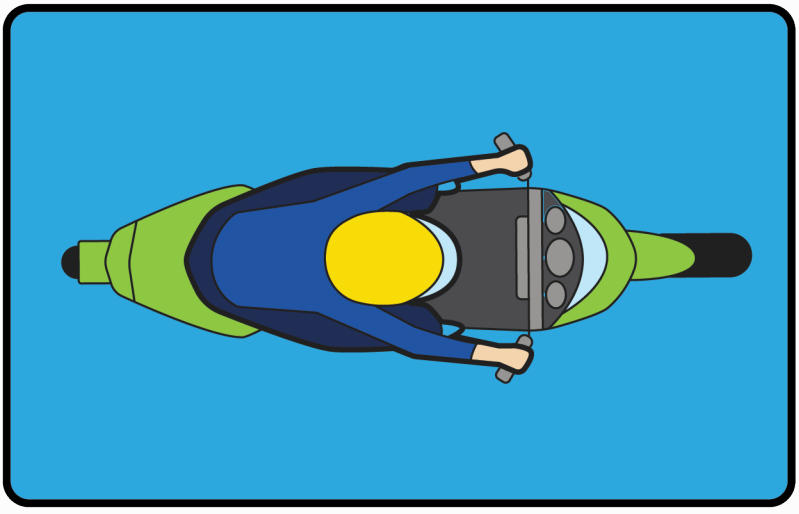
BLOOMINGTON

# SAFE STREETS FOR ALL









## Appendix C: Proven Safety Countermeasures

November 2024

# 4-to-3 Lane Conversions

**Purpose:**
Reduce the speed of traffic, reduce crossing distances and optimize available roadway space to improve levels of safety and comfort for pedestrians and bicyclists.

**Description:**
Reduce the number of lanes (road diets), the width of lanes (lane width reductions), or both. The additional space created is typically combined with other elements such as bike lanes, transit lanes, widened sidewalks, pedestrian refuge islands, and/or curb extensions. Typically, road diets are utilized on undivided, four-lane roadways, which in turn are converted into two through lanes and a center turn lane or painted median.

**Estimated Cost:**
**$$$ per mile (no additional cost with paving work)**

## Applicable Locations

- Multi-lane roads are eligible for lane reconfiguration.
- Emphasis should be placed on roads with priority pedestrian and bicyclist routes.
- Lane reconfiguration can be done in urban, suburban, and rural areas.

## Applicable Street Types

- Use INDOT collector/minor arterial

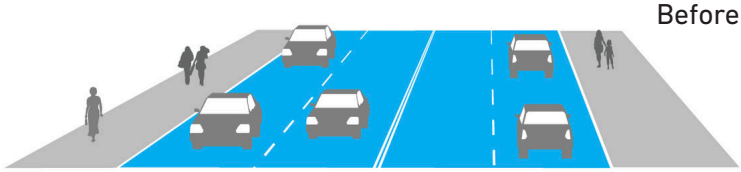
## Safety Benefits

- Increase available space for additional safety infrastructure for pedestrians or bicyclists.
- May reduce the number of potential conflict points.
- May slow motor vehicle operating speeds on average, but will reduce "high-end" speeders (10 mph +) up to 90% per Seattle DOT.
- May reduce crossing distances by eliminating a lane or through provision of a pedestrian median island.
- Remove possibility of "double-threat" crashes from vehicles passing stopped vehicles.
- Improve sight distance for turning vehicles.
- Reduce emergency vehicle response timers per FHWA. (https://safety.fhwa.dot.gov/road_diets/resources/pdf/fhwasa17020.pdf)

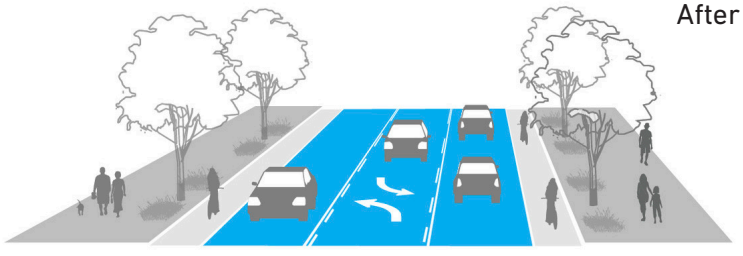
## Expected Crash Reduction

- 47% reduction in total crashes in suburban areas (Pawlovich, et al., 2006)
- 19% in urban areas (FHWA, 2008)

Before

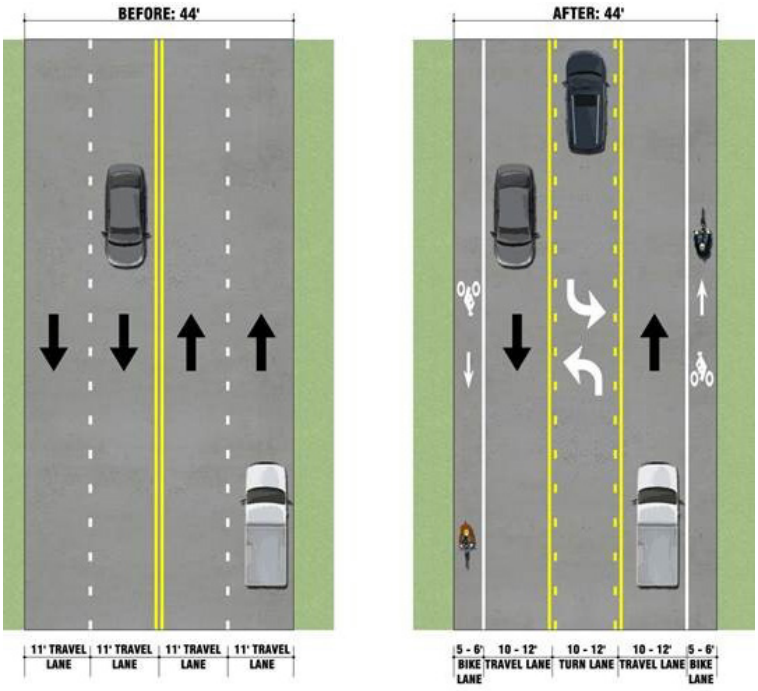


After



## Design Guidance

- Eliminating a travel through lane can make room for a bicycle lane, turn lanes, wider sidewalks, median island, curb extensions, on-street parking, transit lane, landscaping, or other uses.
- Road diets are most successful on roadways with daily volumes of 8,000 to 20,000 motor vehicles.
- Road diets can be supplemented with painted, textured, or raised center islands or green infrastructure to reduce storm runoff.
- A conversion to a three-lane road can be compatible with a single-lane roundabout.




## Considerations

- Eliminating a travel through lane may increase congestion and vehicle queuing and blocking during peak travel hours.
- Evaluate impact of a road diet on all road users, not just vehicles. Consideration should be given to Level of Traffic Stress.
- Consider implementing a road diet in conjunction with pavement overlay.
- Outreach should be conducted to determine if a candidate street is meeting the needs of the community.
- A traffic study may be necessary to determine if high-traffic streets are candidates for removing one or more parking or travel lanes.
- The FHWA recommends considering factors including:
  - Volume thresholds, such as average daily traffic
  - Vehicle speed
  - Trip generation estimates
  - Level of Service
  - Quality of Service
  - Pedestrian and bicyclist volumes
  - Transit and freight operations
  - Peak hour and peak direction traffic flow

## Systemic Safety Potential

This is a systemic corridor recommendation that improves road conditions for all roadway users.

Before four to three lane conversion

After four to three lane conversion

**Additional Information**

- Evaluation of Lane Reduction "Road Diet" Measures on Crashes
- PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System
- Road Diet Informational Guide

# Chicanes

**Purpose:**
Slow motor vehicles speeds by diverting the path of travel.

**Description:**
Horizontal treatments to restrict vehicle movement and reduce speeds. Chicanes are often made of curb extensions or islands that create "S" curves along a roadway.

**Estimated Cost:**
$$ to $$$$ (depending on design)

## Applicable Locations

- Most effective at midblock locations on one-way and two-way streets

## Applicable Street Types

- Neighborhood Residential Street
- General Urban Street
- Neighborhood Connector Street

## Safety Benefits

- Improves speed limit compliance.
- Certain designs increase the amount of sidewalk width, buffer width, or both on corridors.

## Expected Crash Reduction

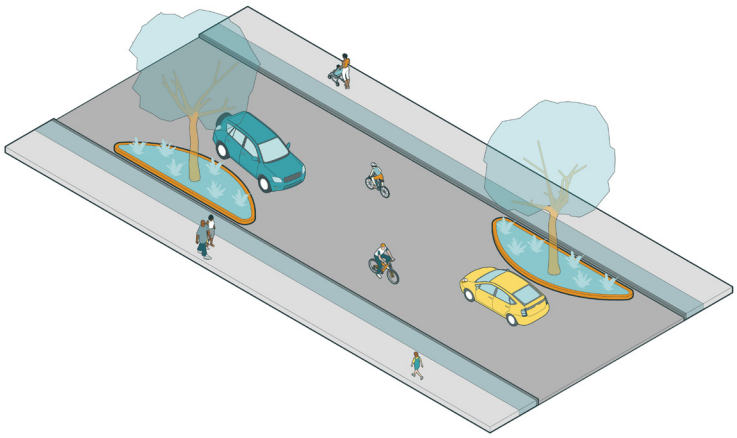
- 32% reduction of crashes (Elvik, R. and Vaa, T., 2004).

## Design Guidance

- Interim treatments use striping and flex posts and temporary curb materials.
- Permanent treatments use curb extensions or islands and may include vegetation.
- Maintain sight lines by landscaping chicanes with lower shrubs and plants.
- Multiple treatments may be placed on alternating sides of the roadway.
- Drainage and utility location should be considered when implementing.
- Additional signing or pavement markings may be needed to ensure drivers and maintenance vehicles are aware of the bend in the roadway.

## Considerations

- Vehicles and bicyclists must carefully maneuver around fixed objects. Traffic may be slowed when vehicles attempt to pass bicyclists.
- If drainage impacts are a concern, curb extensions may be designed as edge islands with a 1–2-foot gap from the curb.
- Neighborhood traffic circles should be considered at intersections of local roads.
- May reduce on-street parking depending on the design.
- Emergency vehicle and school bus access must be maintained.



## Systemic Safety Potential

Best suited as a spot treatment.

**Additional Information**

- PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System
- NACTO Urban Street Design Guide

# Curb Extensions

**Purpose:**
Shorten crossing distances and increase pedestrian comfort and visibility.

**Description:**
Also called bulb outs or neck downs, curb extensions extend a section of sidewalk into the roadway at intersections and other crossing locations. In addition to shortening crossing distances, curb extensions create more compact intersections, resulting in smaller corner radii and slower turns by people driving.

**Estimated Cost:**

$$ to $$$$ (depending on design)

## Applicable Locations

- Curb extensions can make pedestrian, bicycle, or other crossings safer and more comfortable everywhere from a mid-block crosswalk to a large signalized intersection.
- Curb extensions can be built in all-day parking lanes or wide shoulders.
- Transitions to lower-speed areas.
- Curb extensions are particularly valuable in locations with high volumes of pedestrian traffic, near schools, bicycle/trail crossings at unsignalized pedestrian crossings, or where there are demonstrated needs.

## Applicable Street Types

- Neighborhood Residential Street
- Main Street
- General Urban Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Slow the speed of motorists making turns at intersections.
- Create additional space for directional curb ramps.
- Provide opportunity to create accessible parking spaces.
- Improve visibility between crossing pedestrians and other street users.
- Prevent people from parking too close to or on crosswalks or blocking fire hydrants.
- Create space for utilities, signs, and amenities such as bus shelters or waiting areas, bicycle and micromobility parking, public seating, street vendors, and greenscape elements.

## Design Guidance

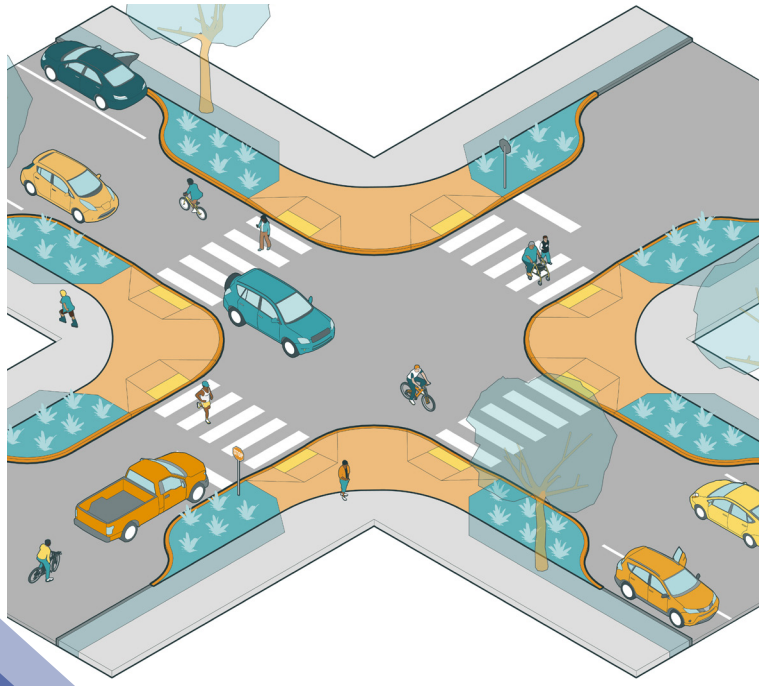
- Limit planting and street furniture height within curb extensions to preserve sight lines.
- Consider expanding curb extensions at bus stops to produce bus bulbs.
- Where curb extension installation on one side is infeasible or inappropriate (i.e., no parking lane), this should not preclude installation on the opposite side.
- A typical curb extension extends about 6 feet from the curb, or no further into the street than the parking lane.
- Protected bike lanes can go over or behind curb extensions, if present.
- The minimum width of a curb extension should match the existing NO PARKING requirements. The length of a curb extension can vary depending on the intended use (i.e., stormwater management, bus stop waiting areas, restricted parking).
- NO PARKING signs or yellow curb can be used to deter parking.

## Considerations

- Curb extensions should not extend into travel lanes or bicycle lanes. Generally designed with one foot of shy distance between the face of curb and the edge of travel lane.
- When designing the corner radius on a curb extension, consider the appropriate large vehicle turning path to prevent encroachment into the pedestrian space.
- Consider the turning needs of emergency and larger vehicles in curb extension design and include mountable areas if necessary.
- Curb extensions can require modifications to or relocation of drainage structures. Consider drainage slots with solid surface plating at pedestrian crossings as an alternative.
- Temporary curb extensions may be created using paint, flexible delineators, and other temporary materials to speed installation or as a pilot project before permanent construction.

## Systemic Safety Potential

Spot treatment or systemic safety improvement. Consider at all locations with on-street parking and as a gateway treatment to slow vehicle speeds.




**Additional Information**

- NACTO Urban Street Design Guide
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

# High-Visibility Crosswalk

**Purpose:**
Providing marked crosswalks communicates to drivers that pedestrians may be present and helps guide pedestrians to locations where it is best to cross the street.

**Description:**
High-visibility crosswalks are distinguishable from other crosswalk designs by use of longitudinal, ladder, or continental-style markings more readily visible to approaching motorists as opposed to parallel, or transverse, lines which are more difficult to distinguish from a distance.

**Estimated Cost:**

$ (per crossing)

## Applicable Locations

- High-visibility crosswalks are appropriate at all signalized intersections or at high pedestrian volume or busy street intersections as noted in City of Bloomington PM-6: Standard Traffic Crosswalk Details.
- Uncontrolled intersections should meet requirements in MUTCD Section 3B.18.

## Applicable Street Types

- All street types

## Safety Benefits

- Increase motorist awareness of crosswalk location.
- Reduce crashes between pedestrians, bicyclists, and motor vehicles.
- Designate pedestrian right-of-way, and may reduce pedestrian crossings at unmarked locations.

## Express Crash Reductions

- 40% reduction for pedestrian-motor vehicle crashes. (Elvik, R. and Vaa, T., 2004).

## Design Guidance

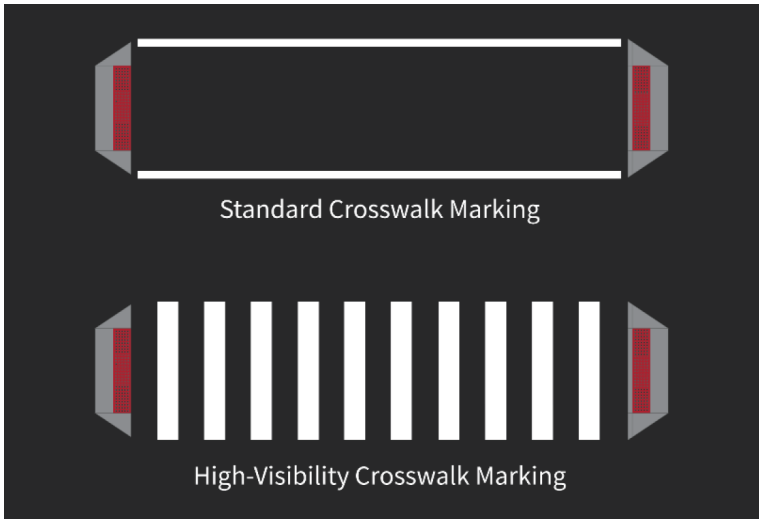
- Marking pattern should be continental: a series of wide stripes parallel to the travel lanes for the entire length of the crossing.
- Crosswalks should be as wide as the sidewalk width plus 1-2' either side (e.g., for a 6' sidewalk, mark the crosswalk 8-10' wide).
- Install with directional ADA compliant curb ramps.
- Stop lines at stop-controlled and signalized intersections should be located at least 8 feet in advance of crosswalks. At uncontrolled crossings, yield lines may be included 8 feet in advance of the crosswalk.
- Parking should be restricted in advance of a crosswalk to provide adequate sight distance.

## Considerations

- Crosswalk location should be convenient for pedestrian access.
- Width may be wider than 10 feet at crossings with high pedestrian or bicycling demand.
- Crosswalk markings should consist of non-skid, retroreflective material.

## Systemic Safety Potential

Apply as a systemic countermeasure at all controlled crossings. At uncontrolled crossings, apply in accordance with FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, Table 1.




**Additional Information**

- Manual on Uniform Traffic Control Devices
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

# Floating Bus Stops

**Purpose:**
To eliminate the conflict between bicyclists traveling in bike lanes and transit vehicles that must pull into conventional bike lanes to load and unload passengers. Also to eliminate the conflict when buses merge back into mixed traffic.

**Description:**
Floating Bus Stops consist of a bus stop platform island extending into the street from the curb with a bicycle lane routed behind the stop on or adjacent to the curb, eliminating bus and bike conflicts at stations and reducing bus travel times.

**Estimated Cost: $$$ to $$$$ (depending on design)**

## Applicable Locations

- Where bike lanes (separated, conventional, etc.) run along a transit stop. This treatment is compatible with near-side, far-side and midblock transit stop locations.

## Applicable Street Types

- General Urban Street
- Suburban Connector Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Eliminates conflict between transit vehicles and bicyclists.
- Island stops maintain continuity of bike lanes.

## Design Guidance

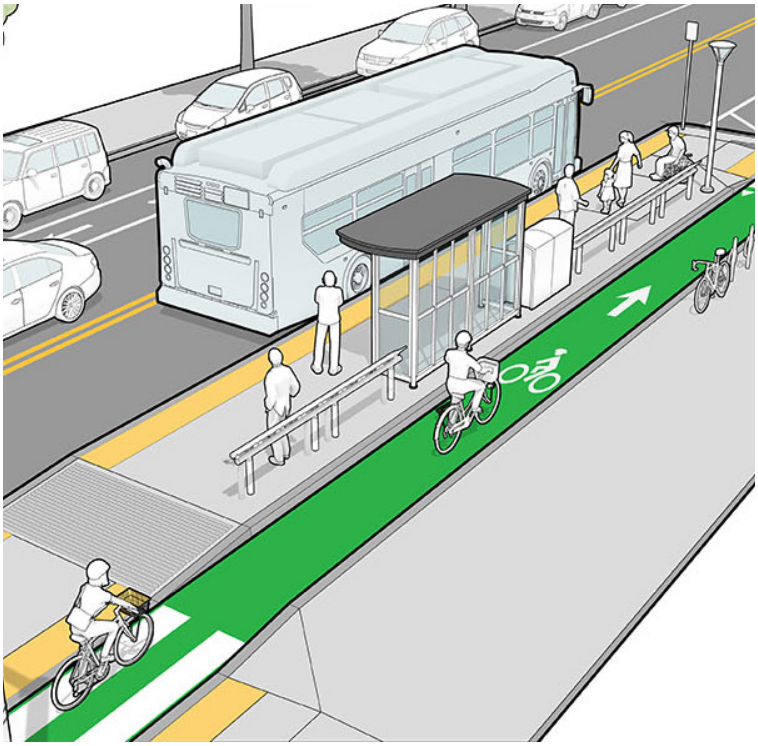
- Provide a buffer of 6 to 12 inches between the transit shelter and the bike lane. This buffer is narrower than the shy distance normally used for vertical surfaces (2 feet), but this is okay for short distances in constrained spaces.
- Channelizing railings, planters or other treatments can be used to help direct people to the crossing location(s).
- Bus shelters should be located away from pedestrian crossings to minimize bicyclist conflicts with pedestrians.
- Multiple pedestrian crossings are recommended, but not required.
- Provide a minimum 4-foot-wide walkway between the curb and the transit shelter.
- Minimum 8 feet of clear width at the location where the bus doors will open to accommodate people in wheelchairs.

## Considerations

- The space between the bike lane and the sidewalk must have a detectable edge so pedestrians with vision disabilities can distinguish between the two. The bike lane may be located at street level, intermediate level, or sidewalk level. The bike lane elevation can affect the treatment used and can itself be a treatment for creating the detectable edge. The following design treatments can help provide this tactile cue:
  - Street furniture or other vertical objects.
  - A curb.
  - Curb height changes.
  - Continuous low landscaping.
  - A directional indicator installed linearly on the sidewalk adjacent to the edge.
  - Consider transit queuing and vehicle length to determine island length and pedestrian crossing placement.
  - Ensure visibility between bicyclists and pedestrians for safety.
- Consider raised pedestrian crossings between the floating transit island and the sidewalk to prioritize pedestrians and alert and slow bicyclists at the pedestrian crossing.

## Systemic Safety Potential

Potential for systemic safety application at bus stops located along separated bike lanes. Best suited as a spot treatment along buffered bike lanes and conventional bike lanes.



**Additional Information**

- NACTO Transit Street Design Guide
- FHWA Achieving Multimodal Networks

# Lighting

**Purpose:**
Increase visibility for all road users at dusk and darkness, especially at crossings.

**Description:**
Overhead lighting to illuminate crossings, signs, and street markings. Well-placed lighting improves visibility for all road users. Lighting can be placed overhead or in pavement, depending on the needs of each individual corridor. Pedestrian-scale lighting is often seen in commercial districts as it enhances the environment at night, while also enhancing security.

**Estimated Cost:**
$$ to $$$$ (depending on design)

## Applicable Locations

- Controlled and uncontrolled intersections.
- On crossing approaches.
- Along sidewalks, paths, and trails.
- Beneficial at intersections in areas with high volumes of pedestrians, such as commercial or retail areas and at major bus stops.
- Near schools, parks, and recreation centers.
- On both sides of arterial streets.

## Applicable Street Types

- All street types

## Safety Benefits

- Improves visibility for all parties.
- May reduce crashes and injuries for all road users.
- May increase yielding and compliance with traffic control devices.
- Higher sense of personal security for pedestrians and bicyclists.

## Expected Crash Reduction

- 42% for nighttime injury pedestrian crashes at intersections. (Elvik, R. and Vaa, T., 2004).
- 33-38% for nighttime crashes at rural and urban intersections. (Ye et al. 2008).
- 28% for nighttime injury crashes on rural and urban highways. (Elvik, R. and Vaa, T., 2004).

## Design Guidance

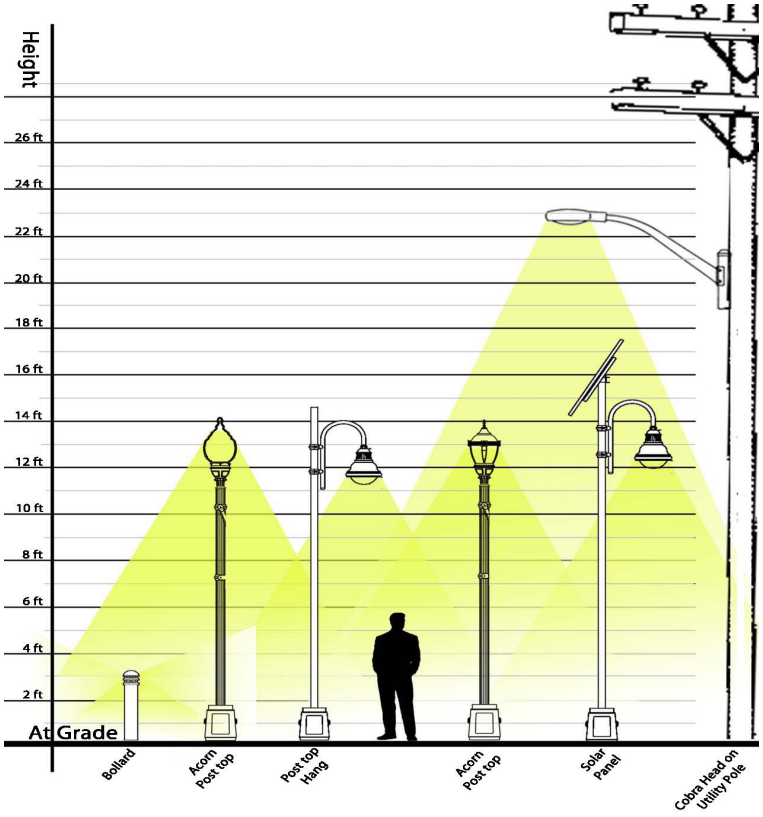
- Use 3000K shielded LED lights wherever possible.
- Lighting should be consistent and uniform.
- Consider placement of existing buildings and trees to reduce spillover.
- Install lighting to meet UDO requirements and minimize effects of light pollution.
- Lights should be placed in advance of a midblock or intersection crosswalk in both directions to illuminate the pedestrian in the front and avoid a silhouette.
- Should be co-located with traffic signs and signals to reduce clutter along or near sidewalks, paths, and trails especially at intersection corners.

## Considerations

- Uniform lighting can suggest pedestrian use and create a sense of enclosure.
- Lighting should be provided on crosswalk approaches.
- If a crossing has a crossing island, additional lighting may be provided.
- Consider energy usage and environmental impacts.
- Consider quality and color of light.
- Nationwide, Black and Latino Americans have substantially higher pedestrian fatality rates at night (GHSA Pedestrian Traffic Fatalities by State), therefore pedestrian lighting should be prioritized equitably so neighborhoods that have not included pedestrian lighting in the past can be made safer.

## Systemic Safety Potential

Potential for systemic safety application at all controlled and uncontrolled crossings.




**Additional Information**

- FHWA Lighting Handbook
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- ANSI/IES RP-8 Standard Practice for Roadway Lighting
- International DarkSky Association Outdoor Lighting Guidelines

# Leading Pedestrian Intervals

**Purpose:**
Extends crossing time for pedestrians at signalized intersections. Also allows people walking to enter an intersection first to establish presence before turning drivers begin moving.

**Description:**
Leading pedestrian intervals (LPIs) are adjustments to traffic signals to give pedestrians a three to seven second head start before motorists enter the intersection.

**Estimated Cost:**

$

## Applicable Locations

- Signalized intersections.
- Intersections with a significant number of turning vehicles and pedestrian volumes.
- At locations with protected bicycle lanes where people bicycling cross on the "Walk" signals.
- Locations with seniors or school children who tend to walk slower.

## Applicable Street Types

- Main Street
- General Urban Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Increase visibility of pedestrians and bicyclists.
- Increase motorist yielding when turning across a parallel pedestrian or bicycle crossing.
- Provide exclusive crossing time for pedestrians and bicyclists.
- Prioritize pedestrian safety and convenience at intersections.
- Reduce conflicts between pedestrians and motorists.
- Can further enhance safety for pedestrians who need more time to cross the intersection by adding more time to the WALK phase.

## Expected Crash Reduction

- 13% for pedestrian involved crashes (Goughnour, E., D. Carter, C. Lyon, B. Persaud, B. Lan, P. Chun, I. Hamilton, and K. Signor 2018),

## Design Guidance

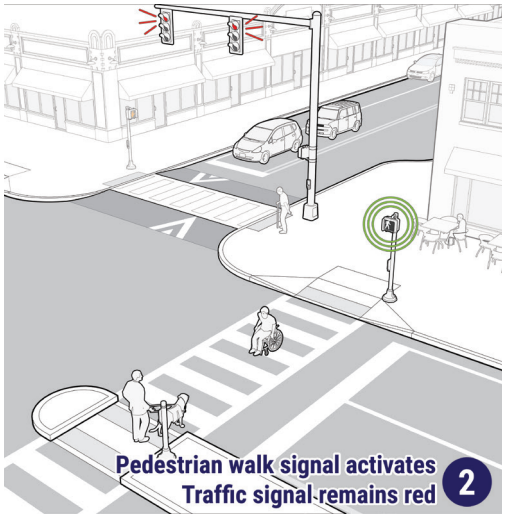
- LPIs should be installed with high-visibility crosswalk markings, curb ramps, accessible pedestrian signals, and "No Turn on Red" "(NOTR)" sign (MUTCD R10-11). NOTR should be considered, not required, unless the LPI is pedestrian actuated. Can include blankout signs that operate only during the LPIs.

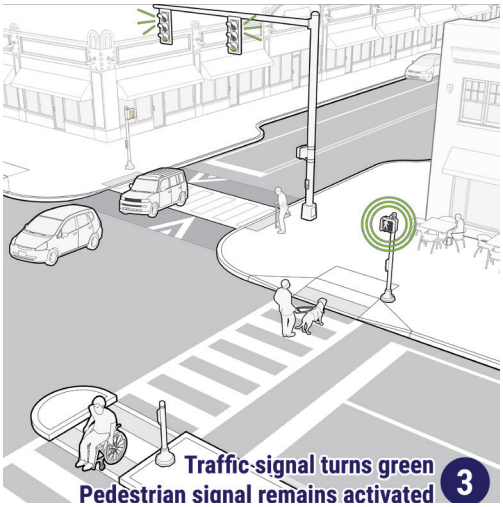
## Considerations

- LPIs can be provided actively or provided only when actuated. Active detection requires an accessible pushbutton.
- The length of LPIs can be increased where pedestrian or bicyclist volumes are high or pedestrian only phasing should be used to eliminate conflicts.
- LPI may be accompanied with an audible noise for visually-impaired pedestrians.
- NO TURN ON RED signs should be considered with LPIs.
- Concurrent pedestrian phasing should appropriately match the motorist signal phasing.

## Systemic Safety Potential

LPIs are suited for systemic use in areas with existing or planned pedestrian signals and high pedestrian and turning volumes.


## Additional Information

- Pedestrian and Bicycle Information Center — Signals and Signs
- PEDSAFE: Pedestrian Safety Guide and Countermeasure Selection System

# Pedestrian Refuge Island

**Purpose:**
Protect pedestrians and bicyclists crossing by slowing motor vehicle speeds, increasing motor vehicle yielding, increasing pedestrian visibility, providing a pedestrian waiting area, and allowing two-stage crossings for slower pedestrians.

**Description:**
Pedestrian islands are raised medians placed in the middle of a street that provide a protected space for people trying to walk across the street. Median crossing islands have a cut-out area for pedestrian and bicyclist refuge and are used as a supplement to a crosswalk.

**Estimated Cost:**
**$$ to $$$$ (depending on design)**

## Applicable Locations

- Crossings at the midblock or at intersections.
- Most beneficial at uncontrolled crossings, multilane roads, wide signalized crossings, or complex intersections.
- On roads with two or more lanes of through traffic.
- Roads with insufficient gaps in traffic.
- Roads with high pedestrian crossing volumes.

## Applicable Street Types

- All street types

## Safety Benefits

- Reduce maximum distance and time pedestrians exposed to crash risk.
- Allow pedestrians to cross the street one direction of travel or fewer lanes at a time.
- Ease crossing for slower pedestrians (e.g. youth, elderly, and disabled).
- Provide space for additional lighting at the crossing.
- May slow motorist through speed.
- May slow motorists turning left.

## Expected Crash Reduction

- 32 for vehicle-pedestrian crashes[1]

1 Zegeer, C., C. Lyon, R. Srinivasan, B. Persaud, B. Lan, and S. Smith. 2017. "Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments." Transportation Research Record: Journal of the Transportation Research Board 2636. Transportation Research Board of the National Academies. Washington, D.C.

## Design Guidance

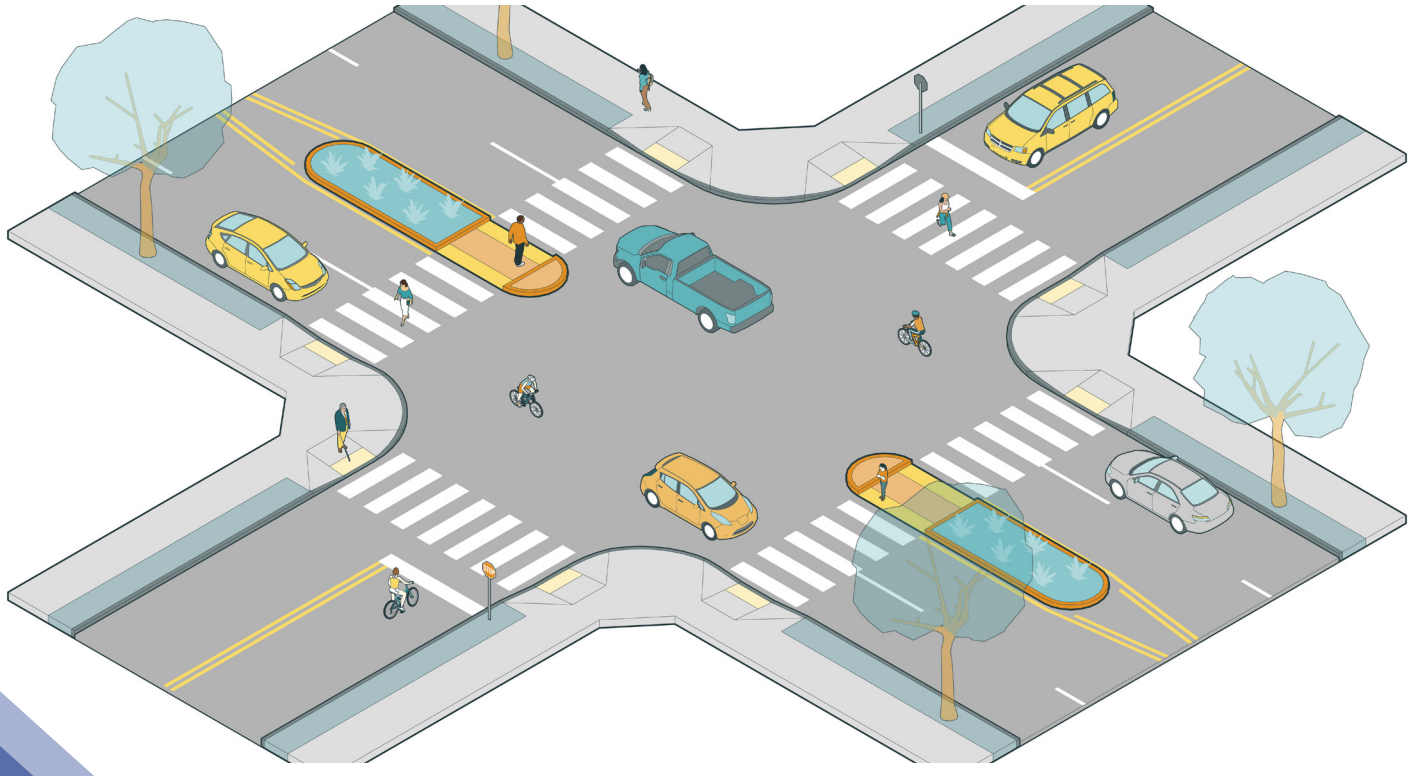
- Median crossing islands should be a minimum of 6 feet wide. To provide bicyclist refuge or for high pedestrian volumes, crossing islands should be a minimum of 8 feet wide. The refuge is ideally 40 feet long.
- Ramps or island cut-throughs are required to meet ADA requirements. They should be the full width of the crosswalk, 6 feet minimum.
- All medians at intersections should have a "nose" which extends past the crosswalk. The nose protects people waiting on the median and slows turning drivers.
- Mark with a high-visibility crosswalk.

## Considerations

- Pedestrians may get caught on the crossing island if motorists do not yield or signal timing is too short.
- Crossing islands at intersections may restrict vehicles turning left without restricting pedestrian or bicycle crossings.
- Curb extensions can be built along with crossing islands to restrict on-street parking and reduce crossing distance.
- Temporary crossing islands can be constructed with temporary curbing or flex posts.
- Pedestrian islands should be considered at locations on busy 2-lane streets and on any street with more than two lanes.
- Where possible, stormwater management techniques should be utilized on pedestrian islands with adequate space, as long as a clear path for pedestrians is maintained.

## Systemic Safety Potential

Potential for systemic safety application at mid-block crossings and at intersections along corridors with poor motor vehicle yielding, operating speeds over 30 mph, or motor vehicle volumes above 9,000 vehicles per day.



## Additional Information

- Chapter 8 of Designing Sidewalks and Trails for Access: Part II of II: Best Practices Design Guide
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

# Raised Crosswalk

**Purpose:**
Reduce drivers' speeds, increase driver yielding, and improve crossing safety for people walking or bicycling.

**Description:**
Raised crosswalks are ramped speed tables spanning the entire width of the roadway or intersection usually at minor locations. Crossings are elevated at least three inches above the roadway, and up to the sidewalk level.

**Estimated Cost:**
**$$ to $$$$ (depending on design)**

## Applicable Locations

- Raised crosswalks are a treatment option often used at the midblock. However, intersections can also have raised crosswalks or the entire intersection can be raised.
- Roadways with a posted speed of 30 mph or lower.
- Common on school campuses, at shopping centers, and in pick up/drop off zones.

## Applicable Street Types

- Main Street
- General Urban Street
- Neighborhood Connector
- Neighborhood Residential Street

## Safety Benefits

- Reduce motor vehicle speeds.
- May reduce the frequency and severity of crashes for all road users.

## Expected Crash Reduction

- 45% for pedestrian crashes. (Elvik, R. and Vaa, T., 2004).
- 36% for all vehicle crash types. (Elvik, R. and Vaa, T., 2004).

## Design Guidance

- Place ramps on each vehicle approach.
- Raised crossings are often demarcated with different paving materials and additional paint markings. See MUTCD sections 3B.29 and 3B.30 for details.
- Mark the crossing with high-visibility crosswalk markings.
- Install with applicable warning sign (MUTCD W11-1, W11-2, W11-15, or S1-1). Consider advance warning signs such as SPEED TABLE or RAISED CROSSWALK (modified W17-1) and advisory speed plaques if applicable or on higher volume roadways.
- Raised crossings do not require curb ramps, though truncated domes should be included at each crossing entrance.

## Considerations

- Raised crossings at sidewalk level are preferred for pedestrian accessibility and comfort, and safety.
- Raised crossings should not be used on steep curves or roadways with steep grades.
- May be used for bicyclists along crossings for shared use paths and multiuse paths including protected bicycle lanes.
- Consider drainage needs.
- Further consideration is needed for roadways heavily used by trucks, buses, and emergency vehicles.

## Systemic Safety Potential

Best suited as a spot treatment.

**Additional Information**

- Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations
- FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations
- A Guide to Vertical Deflection Speed Reduction Techniques: Planning and Design of Speed Humps, Speed Tables and Other Related Measures from ITE.

# Raised Intersection/ Speed Table

**Purpose:**
Raised intersections create a safe, slow-speed crossing and public space at minor intersections. These treatments provide many benefits, especially for people with mobility impairments, because there are no vertical transitions to navigate.

**Description:**
Raised intersections are created by raising the street to the same level as the sidewalk.

**Estimated Cost:**

$$$$

## Applicable Locations

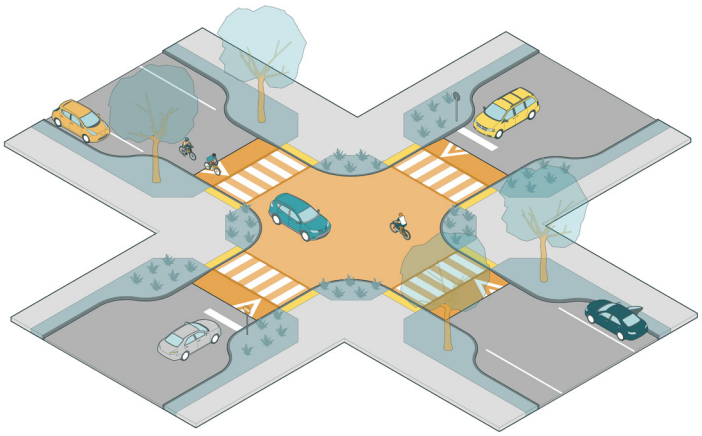
- Raised crosswalks and intersections are appropriate in areas with high pedestrian activity. They should also be considered at locations where poor pedestrian visibility and low motorist yielding have been identified.
- High-visibility or textured paving materials can be used to enhance the contrast between the raised intersection and the surrounding street.
- Raised intersections require detectable warnings at the curb line for people who are blind or have low vision.
- Directional curb ramps are preferred, as shown in the figure to the right.
- Raised intersections can be useful in placemaking where slow traffic speeds and decorative treatments are desirable and in conjunction with curb extensions and are generally best used on narrower, two-lane roadways.

## Applicable Street Types

- Neighborhood Residential Street
- Main Street
- General Urban Street

## Safety Benefits

- Improve motorists' awareness by prioritizing pedestrian crossings and helping define locations where pedestrians are expected.
- Reduce turning speeds of motorists at intersections and driveways.
- Increase visibility between drivers and pedestrians by raising pedestrians in the motorists' field of view and giving pedestrians an elevated vantage point from which to look for oncoming traffic.
- Create pedestrian crossings which are more comfortable, convenient, and accessible since transitioning between the sidewalk and roadway does not require negotiating a curb ramp.



## Design Guidance

- Raised intersections and crosswalks can be used as gateway treatments to signal to drivers when there are transitions to a slower speed, pedestrian-oriented environment.
- Designs should ensure proper drainage.
- Raised intersections are flush with the sidewalk and ensure that drivers traverse the crossing slowly.
- Crosswalks do not need to be marked unless they are not at grade with the sidewalk. ADA-compliant ramps and detector strips are always required.
- Bollards along corners keep motorists from crossing into the pedestrian space. Bollards protect pedestrians from errant vehicles. Bollard placement and dissimilar pavement materials create space for occasional large vehicles similar to an apron.

## Considerations

- Design speeds and emergency vehicle routes must be considered when designing raised crosswalks and intersections; these treatments may not be appropriate for high-speed streets without appropriate advanced markings and signing or other design changes.
- Installation of raised intersections and speed tables may affect snow removal operations. Snow plow operators should be adequately warned and trained.

## Systemic Safety Potential

Best suited as a spot treatment.


**Additional Information**

- A Guide to Vertical Deflection Speed Reduction Techniques: Planning and Design of Speed Humps, Speed Tables and Other Related Measures
- PEDSAFE Countermeasures Guide
- Manual on Uniform Traffic Control Devices
- NACTO Urban Street Design Guide

# Turn on Red Restriction

**Purpose:**
Turn on red restrictions prevent motorists from turning right (or left on intersecting one-way streets) while the traffic signal is red. Restricting this movement eliminates conflicts with pedestrians crossing in front of turning motorists.

**Description:**
Signs or dynamic electronic signs that prohibit motorists from making a right turn on a red signal.

**Estimated Cost:**

$ (for static signs)

## Applicable Locations

Turn on red restrictions should be considered when one or more of the following conditions apply:

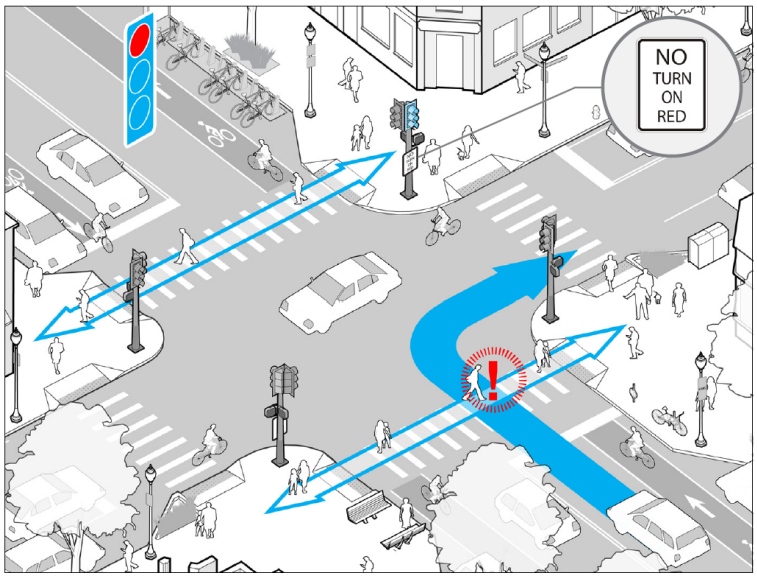
- An exclusive pedestrian phase.
- An LPI.
- High volumes of pedestrians.
- Where bicycle two-stage turn queue boxes are installed; bicycle boxes after two-stage turn queue boxes.
- Poor sight distances and visibility.
- Locations where poor intersection geometry causes unexpected conflicts; or specific cases located from intersections with 5 or more legs.
- Locations with a reported crash history.

## Applicable Street Types

- Main Street
- General Urban Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Reduce conflicts between motorists and pedestrians.
- Prioritize pedestrian safety and convenience at intersections.
- Turn on red restrictions can significantly increase the portion of motorists who stop at marked stop lines and decrease the number of motorists who turn right on red without stopping.

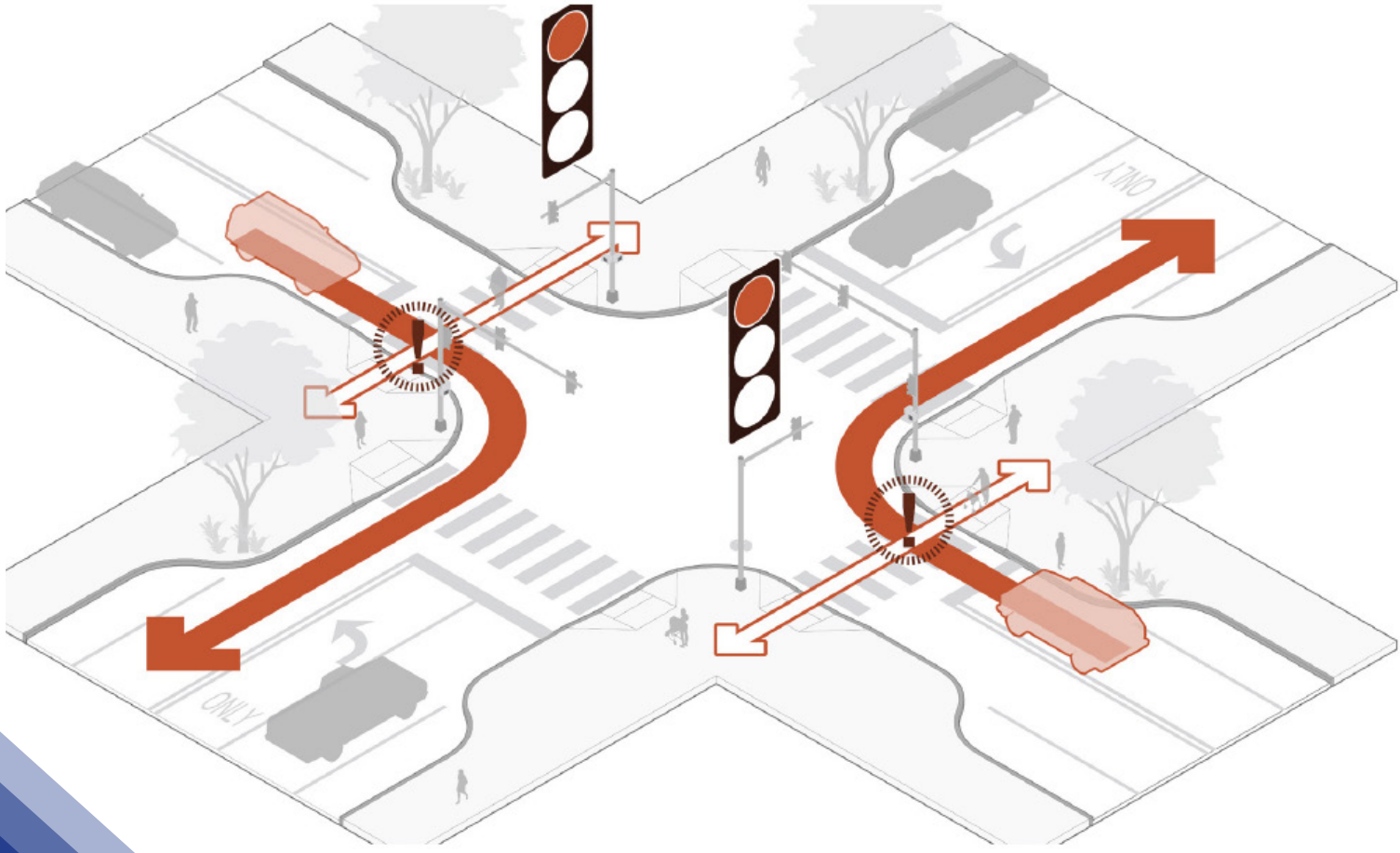


## Design Guidance

- Consider dynamic electronic signs to restrict right turns only during certain times of day or during certain signal phases.
- Consider impacts to bus operations at near-side stops change to far-side if needed.
- Intersection impacts to vehicle operations should be studied.
- When used along a corridor or area of traffic signals, vehicle intrusions into pedestrian crosswalks and aggressive driving will be reduced.

## Considerations

- Should be implemented all hours of the day, but can be considered by time of day in some circumstances.
- Can be used in conjunction with LPIs or bicycle signals that allow through movements when turning vehicular traffic is stopped.




## Additional Information

- Manual on Uniform Traffic Control Devices (MUTCD)

# Roundabout

**Purpose:**
All approaches must yield to traffic already within the roundabout. After yielding, drivers are able to circulate the center island before exiting to turn or continue straight. Eliminates left turning movements and intersection collisions by requiring all traffic to exit to the right of the circle.

**Description:**
Built with a raised circular island, roundabouts take the place of a traditional intersection. Roundabouts allow for traffic to flow and merge through the roundabout without stopping, reducing conflicts and facilitating increased motor vehicle yielding to pedestrians and bicyclists.

**Estimated Cost:**

$$$-$$$$ (depending on design)

## Applicable Locations

- Signalized intersections
- Unsignalized intersections
- Intersections with protected bicycle lanes

## Applicable Street Types

- Neighborhood Residential Street
- General Urban Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Reduces vehicular speeds.
- Facilitates motor vehicle yielding to pedestrians and bicyclists.
- Eliminates angle collisions.

## Expected Crash Reduction

- 78-82% reduction in fatal and injury crashes (AASHTO HSM, 2010).

## Design Guidance

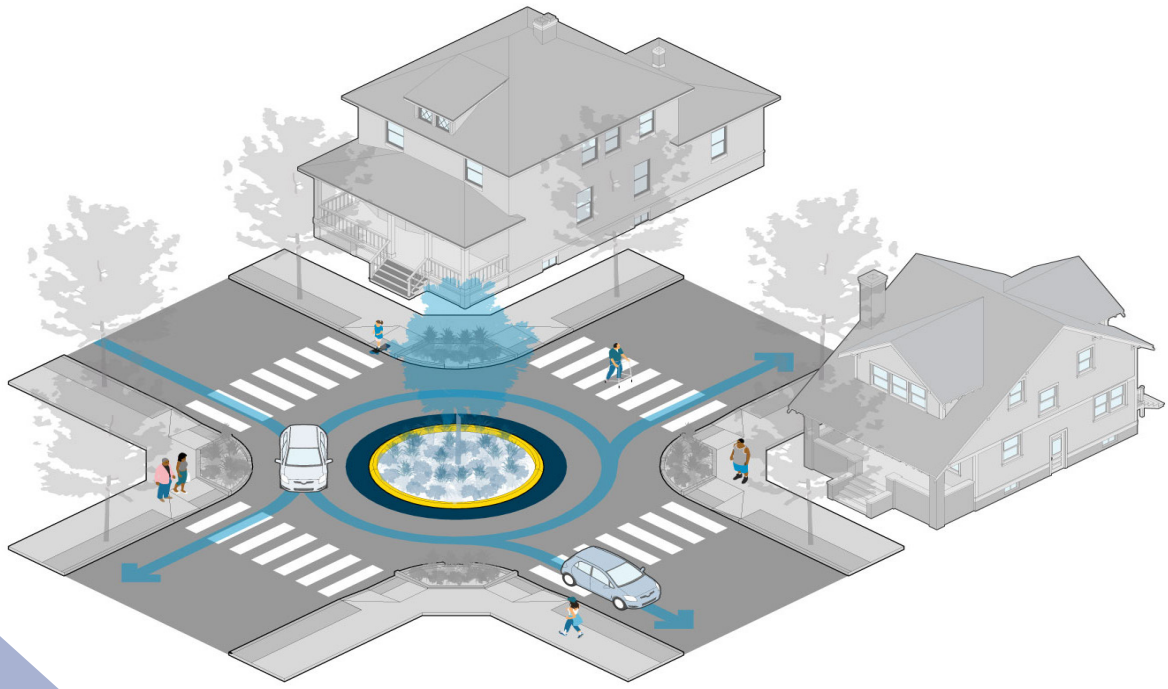
- Roundabouts should be designed for an entry speed of 15-18 mph on each leg.
- On a low speed and volume street, such as a local neighborhood street, consider installing mini-roundabouts, or neighborhood traffic circles.
- Accessible pedestrian signals are required in accordance with the Public Right-of-Way Accessibility Guidelines (PROWAG), particularly at roundabouts with more than one lane.
- Use yield rather than stop controls.
- Install signs to instruct vehicles to proceed to the right of the central shield per MUTCD Figures 2B-21 through 2B-24.
- May be used with shared lane markings, (sharrows) to indicate bicyclist usage.
- May be landscaped with low shrubs or vegetation that does not impede visibility.

## Considerations

- General considerations include pedestrian and bicycle volumes, number of travel lanes, impacts on pedestrian routes, and available right-of-way.
- Where there are higher pedestrian volumes, it may be beneficial to install signal controls and wider crosswalks.
- Increasing turn radii or adding high speed slip lanes for motor vehicles can compromise pedestrian and bicyclist safety.
- Chicanes or other traffic-calming treatments can be installed on adjacent roadways.
- Consider restricting large vehicles from mini-roundabouts.
- Large vehicles, such as emergency response vehicles or school buses, may need to make left turns at intersections preceding the mini-roundabout.
- Implement parking restrictions on the approach to the traffic circle or create mountable curbs on the outside of the mini-roundabout to allow for emergency-response vehicle access.
- Modern roundabouts need to consider the needs of oversize and overweight (OSOW) vehicles. Consult the statewide OSOW routing as well as local businesses to determine appropriateness of installation.

## Systemic Safety Potential

This is a systemic corridor recommendation that improves road conditions for all roadway users.



## Additional Information

- Manual on Uniform Traffic Control Devices
- BIKESAFE Bicycle Safety Guide and Countermeasure Selection System
- PEDSAFE Pedestrian Safety Guide and Countermeasure Selection System
- NACTO Urban Street Design Guide
- FHWA Proven Safety Countermeasures

# Rectangular Rapid Flashing Beacon (RRFB)

**Purpose:**
Used in combination with warning signage, Rectangular Rapid Flashing Beacons (RRFBs) provide a high-visibility warning to drivers when pedestrians are using a marked crosswalk.

**Description:**
Bright, irregularly flashing LEDs, mounted with pedestrian crossing signs, which increase pedestrian visibility to drivers at uncontrolled marked crossings. RRFBs consists of two rectangular-shaped yellow indicators with an LED light source that flashes with high frequency when activated, typically by pedestrian pushbuttons. RRFBs are often placed at locations with significant pedestrian safety issues but may also be located at a school or trail crossing.

**Estimated Cost:**

$$

## Applicable Locations

- RRFBs are a treatment option at many types of unsignalized pedestrian crossings, including at standard pedestrian, school, or trail crossings.

## Applicable Street Types

- Neighborhood Residential Street
- Main Street
- General Urban Street
- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Increase driver yielding.
- May increase effectiveness of other safety treatments, such as advance yield markings with YIELD HERE FOR PEDESTRIAN (R1-5) signs.
- More effective than traditional overhead or post-mounted circular beacons.

## Expected Crash Reduction

- 47% reduction for all pedestrian-motor vehicle crashes. (NCHRP Report 841, 2017).

## Design Guidance

- Place on both sides of an uncontrolled crosswalk.
- If pole-mounted, place below a pedestrian, school, or trail crossing warning sign and above a diagonal downward arrow plaque.
- May also be used with an overhead-mounted crossing warning sign, located at or immediately adjacent to an uncontrolled marked crosswalk.
- If sight distance approaching the crosswalk is limited, an additional RRFB may be installed on the approach with a post-mounted W11-2, S1-1, or W11-15 sign with an AHEAD or distance plaque. Consider other treatments in these locations.
- Pedestrian detection, typically pushbuttons, must meet the requirements for PROWAG. Flashing time should conform to MUTCD, part 4L.


## Considerations

- RRFBs should not be used in conjunction with "Yield," "Stop," or traffic signal control (except at roundabouts).
- An RRFB should not be used without a pedestrian crossing sign.
- RRFBs should only be used at locations with significant pedestrian safety issues. The overuse of RRFBs can diminish their effectiveness.
- Other treatments may be more appropriate in locations with sight distance constraints.
- Solar-power panels may eliminate the need for a power source.
- On high speed or multi-lane roadways, a Pedestrian Hybrid Beacon may be more appropriate (see Section 4U of the MUTCD).

## Systemic Safety Potential

Spot treatment or targeted systemic locations, such as trail or school crossings are appropriate. Broad application suggests other treatments such as speed reduction or roadway redesign may be necessary.

**Additional Information**

- Manual on Uniform Traffic Control Devices
- FHWA Proven Safety Countermeasures
- PEDSAFE Pedestrian Safety Guide and Countermeasure Selection System


# Multiuse Paths and Trails

**Purpose:**
Separates bicycle and pedestrian traffic from motor vehicles in a dedicated space outside the curb of the street.

**Description:**
Paths that accommodate two-way traffic for bicyclists and pedestrians. While separated from traffic, multiuse paths are located inside and parallel to the road right-of-way. Trails can be located along railway or utility corridors, land dedicated for planned but unbuilt streets, and through public land.

**Estimated Cost:**

$$$$

## Applicable Locations

- Multiuse paths may be preferable to separated bike lanes if low pedestrian volumes are anticipated in order to minimize right-of-way impacts.
- Most useful on wide, multi-lane streets with speeds above 30 mph, or significant motor vehicle volume.
- Applicable on streets with three or more lanes, speeds of 30 mph or greater, or 6,000 vehicles or more.
- Suited for truck or bus routes, or streets where on street bike lane obstruction is likely to be frequent.
- Locations with limited right-of-way where combining walking and bicycling facilities to save space may be the only feasible option.

## Applicable Street Types

- Neighborhood Connector Street
- Suburban Connector Street

## Safety Benefits

- Fewer conflicts with motor vehicles than on-road bike lanes.
- Accommodate two-way pedestrian and bicyclist flow.

## Expected Crash Reduction

- 25% reduction for all bicyclist-motor vehicle crashes. (Alluri et al, 2017)

## Design Guidance

- Minimum 2-foot graded area with clearance from lateral obstructions, such as bushes, large rocks, bridge piers, abutments, and poles.
- A minimum 1-foot clearance from "smooth" features, such as bicycle railings or fences with appropriate flaring and treatments.
- Ideally, a graded shoulder area of 3 to 5 feet, with a 5-foot minimum buffer from traffic for user comfort and snow storage.
- Separation of modes in areas with existing or anticipated higher levels of activity, including a 10-foot (minimum width) bikeway and a 5-foot (minimum width) walkway.
- Adequate widths to enable side-by-side travel and passing and occasional maintenance vehicles typically at least 11 feet wide.
- Wider multiuse paths may be needed when adjacent to retail or commercial development to accommodate street furniture, swinging doors, etc, on steep up grade segments, or tight corners.
- PROWAG requirements for slopes must be followed.
- Lighting should be provided at path/roadway intersections at a minimum and at other locations where personal security may be an issue or where nighttime use is likely to be high.

## Considerations

- To maintain year-round use, multiuse paths should be swept and plowed of snow, which may require additional maintenance equipment.
- High-quality construction and maintenance that avoids pavement cracking and buckling.
- Asphalt preferably as the surface material. If concrete is used, use longer sections with small joints for a smoother riding experience.
- Intuitive and safe intersection crossings.
- Straight alignments to allow direct and higher speed travel.
- Removal or relocation of poles, traffic signs, trees, or other obstructions that are present in many existing sidepath locations.
- Adequate lighting for nighttime use.

## Systemic Safety Potential

This is a systemic corridor recommendation that improves road conditions for all roadway users.

**Additional Information**

- ODOT Multimodal Design Guide
- FHWA Bikeway Selection Guide
- BIKESAFE Bicycle Safety Guide and Countermeasure Selection System
- FHWA Shared Use Path Level of Service Calculator

# Sidewalks

**Purpose:**
Sidewalks provide space along a street for pedestrian travel.

**Description:**
For sidewalks to function, they must be kept clear of any obstacles and be wide enough to comfortably accommodate expected pedestrian volumes (as anticipated by density and adjacent land use), and different types of pedestrians, including those using mobility assistance devices, pushing strollers, or pulling carts.

**Estimated Cost:**
$$-$$$$ (depending on design and length)

## Applicable Locations

- Sidewalks should be installed on both sides of the street unless otherwise inconsistent with the City's Transportation Plan.

## Applicable Street Types

- All street types

## Benefits

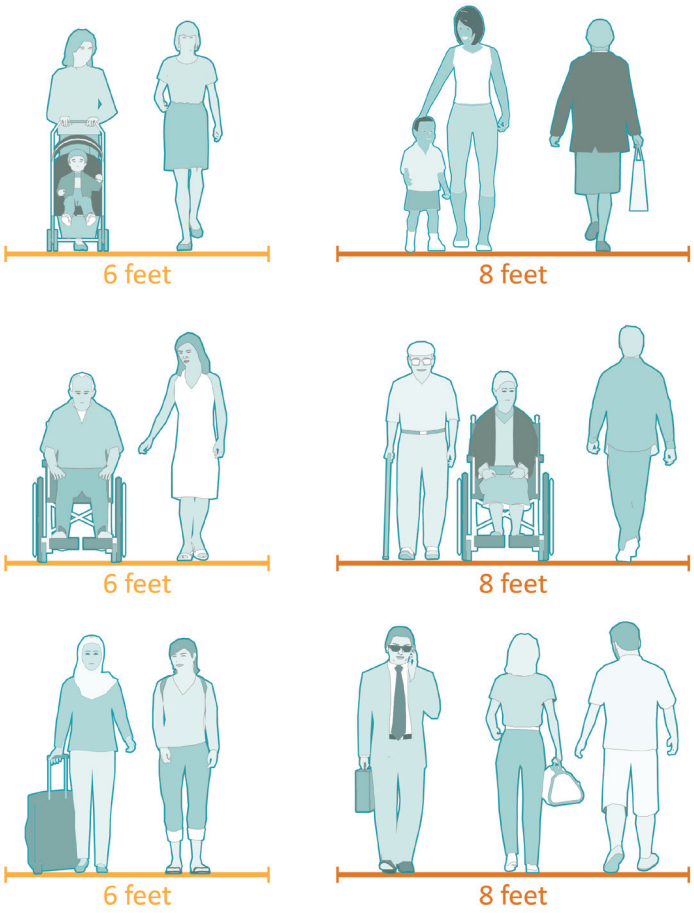
- Sidewalks make walking an easy choice between destinations since they create a network for pedestrian travel throughout the city.
- Sidewalks and their buffers provide space for utilities, signs, and amenities such as bus shelters or waiting areas, bicycle parking, public seating, public art, newspaper stands, trash and recycling receptacles, and greenscape elements.
- Sidewalks are not only used for transportation, but for social walking, exercise, lingering, commerce, recreation, and as public social space—all activities that contribute to a vibrant and lively street.
- Sidewalks make access to transit possible since the majority of transit users walk between their destination and transit stops.

## Expected Crash Reduction

- 65-89% reduction for pedestrian-motor vehicle crashes (Gan et al, 2005).

## Design Guidance

- The widths of sidewalks will vary based on context and expected pedestrian volumes. Widths may range from 5 feet along residential and industrial streets to 12 feet or wider downtown and in areas of high use. Width can be lost due to grass on both sides and occasional large trees of up to 1 foot.
- Sidewalks must include an accessible pathway that is free of obstructions, such as light poles, traffic signals, trees, utilities, and furniture. ADA guidelines allow a minimum accessible pathway of 4 feet where there are major constraints. Bloomington uses a minimum width of 5 feet for the accessible pathway.

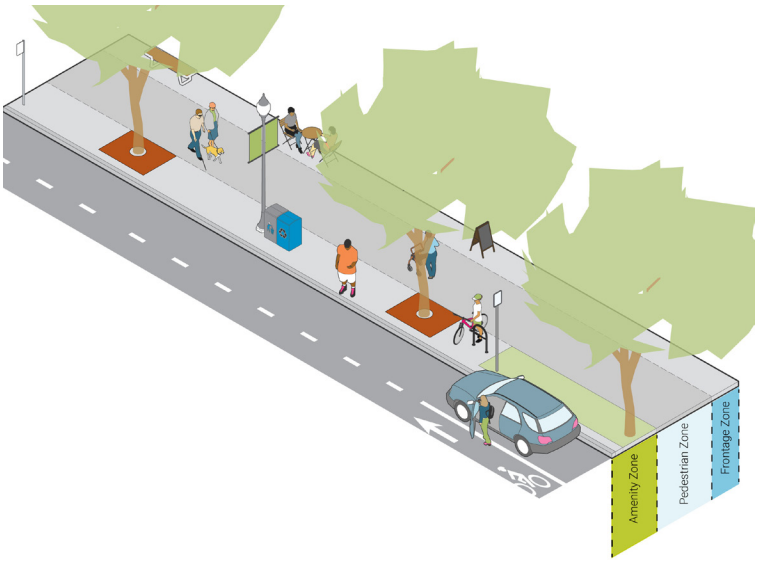



## Considerations

- Sidewalks that are replaced for maintenance reasons should not be narrower than the sidewalk being replaced (e.g. a 6-foot wide sidewalk should not be replaced with a 5-foot wide sidewalk).
- All new sidewalks and curb ramps shall comply with ADA regulations, including running slope and cross slope.
- Sidewalks should be clear of any obstructions, including utilities, traffic control devices, trees, and furniture and large surface defects or heaved sections.
- The width and design of sidewalks will vary depending on street type, demand, and available right-of-way.
- Sidewalks should, as much as possible, follow the natural path of pedestrian travel parallel to the street. Crosswalks should be aligned with sidewalks to maintain the most direct path of travel.

## Systemic Safety Potential

This is a systemic corridor recommendation that improves road conditions for all roadway users.




## Additional Information

- NACTO Urban Street Design Guide
- PROWAG
- FHWA Guide for Maintaining Pedestrain Facilities for Enhanced Safety

# Tree Lawn/ Boulevard

**Purpose:**
Separate sidewalk from the roadway, narrow motorists' field of vision. Add shade, comfort, and beauty to the street.

**Description:**
Trees or other appropriate plantings in raised medians or on the edge of streets.

**Estimated Cost:**

$$-$$$$ (depending on design and length)

## Applicable Locations

- Residential neighborhoods.
- Downtown commercial areas.
- Rural roads.
- Areas near schools.

## Applicable Street Types

- All street types

## Safety Benefits

- Large, mature trees can provide a physical barrier between the road and pedestrian pathways.
- May reduce vehicle speeds due to increased perceived friction and sense of enclosure.
- Lower vehicle speeds can result in improved safety outcomes for all road users.


## Design Guidance

- Select the right tree species for a space to provide canopy and minimize maintenance costs. Avoid tree species with shallow root systems that may heave sidewalks and pathways.
- Provide access to 800 cubic feet or more of unrestricted and unshared soil space.
- Provide soil depth of 36 inches or more.
- Street trees are healthier in areas with greater permeable surface access.
- Provide minimum 5-foot-wide tree pit or raised planter area in urban contexts, and continuous vegetation in the planting strip in non-urban contexts where possible.
- Coordinate placement of street trees with streetlights, overhead utilities, street furniture, traffic signals and signs (especially stop signs).
- Tree pits or raised planter areas may accommodate trees when additional sidewalk is needed to accommodate pedestrian volumes.
- Make sure to minimize construction impacts including trenching and soil compaction in root areas.

## Considerations

- Width of planting zone should be considered so trees do not damage the sidewalk as they grow.
- Street trees can improve vibrancy of the streetscape.
- Street trees help to create a sense of enclosure.
- Consider allocation of space to optimize tree health and maintenance.
- Sight distance (and the maintenance needed to maintain a safe sight distance) must be considered for street trees near intersections or on roadway curves.
- Mature trees and other plantings by the City require ongoing maintenance, including regular trimming, pruning, and street sweeping.

## Systemic Safety Potential

Street trees can be included for traffic calming on all street types. Sight lines should be maintained on all street types and clear zones as applicable.

**Additional Information**

- Bloomington Urban Forestry Plan
- Bloomington Tree Care Manual