L E S S O N 1 5

# Pedestrian Accommodations at Intersections

## 15.1 Purpose

Walkways provide mobility along a linear path. But eventually, people need to cross roads and streets at intersections. These intersections, where the paths of people and vehicles come together, can be the most challenging part of negotiating a pedestrian network. If pedestrians cannot cross the street safely, then mobility is severely limited, access is denied, and walking as a mode of travel is discouraged.

This lesson provides an overview of several design features that are critical in order to provide for pedestrian access at intersections. Much research has been done on this topic in the past, and several design manuals provide more detail, including the *Manual on Uniform Traffic Control Devices*, AASHTO's *Policy on the Geometric Design of Highways and Streets*, and ITE's *Design and Safety of Pedestrian Facilities among others*.

Text for this lesson was taken from the Institute of Transportation Engineers' 1998 publication, entitled *Design and Safety of Pedestrian Facilities–A Recommended Practice*. Reprinted with permission.

## 15.2 Introduction

In urban areas, two-thirds of the pedestrian injuries occur at central business district (CBD) intersections. Overall, the "intersection dash," where a pedestrian enters the street at an intersection and is seen too late by a driver of a motor vehicle is the third most prevalent pedestrian accident type, accounting for 7.2 percent of all pedestrian crashes.

The solution is to design and build intersections that:

- Encourage pedestrian use in lieu of mid-block crossing locations.
- Make pedestrians as visible as possible.
- Make pedestrian actions as predictable as possible.
- Slow vehicular traffic.

***Reduced sight distances can present a serious problem for pedestrians who wish to cross the street.***

A good place to start is to develop design guidelines for intersections that are responsive to the needs of pedestrians, which can be followed whenever new intersections are built or when existing intersections are being improved or reconstructed.

Important intersection issues include consideration of the following:

1. **Improved pedestrian conspicuity.** Ways to alert motorists to the possible presence of pedestrian activity at intersections include providing painted crosswalks in the roadway, moving pedestrians out from behind parked cars through the use of bulb-outs, and improving both horizontal and vertical sight distances through the removal of extraneous curbside clutter such as newspaper boxes, redundant utility poles, or overgrown vegetation. The use of traffic-calming devices such as raised intersections tells drivers that the area is not designed for rapid through movement, but rather it is an area where pedestrians can be expected. Drivers must exercise caution when approaching raised intersections and be ready to yield right-of-way to pedestrians. Another way to slow drivers is to design right-turn slip lanes with exit angles between 50 and 60 degrees.

2. **Predictability of pedestrian actions and movement.** Pedestrian movement can be controlled and made more routine and visible through the use of crosswalks and signalization.

3. **Distance and time that pedestrians have to cross a roadway.** Both the distance and time it takes pedestrians to cross a street can be shortened through the use of curb bulbs, medians, and refuges.

*Use of colored crosswalks and median refuges makes this intersection more pedestrian-friendly.*

*Bulb-outs reduce crossing distances for pedestrians.*

4. **Ease of movement from walkway to street level and vice versa.** Curb ramps facilitate the transition from walkways to streets. Raised intersections can make it easier to meet the Americans With Disabilities Act (ADA) requirements as a crosswalk becomes a natural extension of a walkway and the need for curb ramps is eliminated.

Improving intersections for pedestrians involves the coordination and integration of a number of design elements, including crosswalks, curb ramps, curb bulbs, turning radii, signalization.

When designing intersections:

- Take vertical as well as horizontal sight distances into account.

- Refer to AASHTO's *1994 Policy on Geometric Design of Highways and Streets* (also known as the "Green Book") for formulas relating to storage space needed for pedestrians.

- Prohibit parking near intersections.
- Use curb bulbs, curb ramps, and signalization.
- Limit right-turn-on-red movements in areas of high pedestrian volumes.
- Keep crosswalks at right angles to turning roadway terminals and slip lanes.
- Keep right turns below 15 mph and left turns below 20 mph.
- Locate crossing close to the parallel street; 0.6-meter (2-feet) offset is standard.
- Use stop lines for motorists; keep stop lines behind crosswalks.

## 15.3 Crosswalks

**Typical Concerns**
Of the 61 different pedestrian accident types, the midblock "dart-out" type — where a pedestrian may suddenly appear between parked cars or otherwise cross a vehicular way at a random location — accounts for 13.3 percent of all pedestrian accidents. In three-quarters of these cases, the crash occurs in the curbside lane. One-third of mid-block dart-outs result in a serious injury or a fatality.

**Possible Solutions**
One solution is to create an ongoing retrofit program to establish crosswalks in locations that encourage pedestrians to cross in certain locations, and that also provide motorists with ra easonable expectation of where pedestrians might cross a roadway. Crosswalks are one tool that municipalities can use to accomplish both goals. Other tools include curb bulbs and medians (as discussed in this lesson).

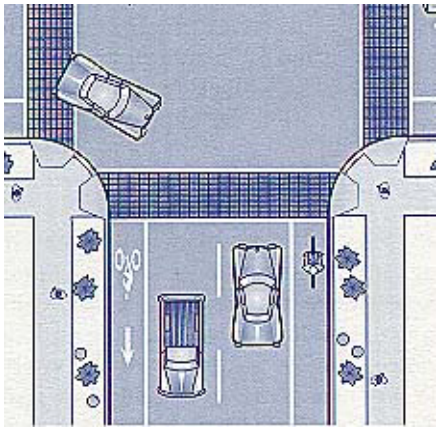
**Important crosswalk concepts and issues include:**

1. Creating reasonable expectations where pedestrians may cross a roadway. A crosswalk creates a visible indication for both motorists and pedestrians as to where pedestrians may be expected to cross a roadway.
2. Predictability of pedestrian actions and movement. When combined with signalization (as well as curb bulbs and refuge islands, where appropriate), crosswalks can help to control pedestrian movement and make them more routine.
3. Knowing when and where crosswalks are appropriate. As noted in the Oregon *Bicycle and Pedestrian Plan*, some studies have found that pedestrians may develop a false sense of security when crossing a road in marked crosswalks. Other studies have found that motorists are more likely to stop for pedestrians in marked crosswalks, especially where pedestrian right-of-way laws are enforced.

   It is important that the proper use of crosswalks is backed up by State law. Vermont is one State where State law gives pedestrians conditional right-of-way when using marked crosswalks. As long as "traffic control signals are not in operation, the driver of a vehicle shall yield the right of way, slowing down or stopping, if necessary, to a pedestrian crossing the roadway within a crosswalk" *(Vermont Statutes Annotated, 1; 23, §1051(a)).* Where this law is reinforced by signage in the crosswalk itself, reminding drivers of the State law and their responsibility to stop, some town select board officials have said that drivers' habits markedly favor pedestrians. The onus is on the pedestrian to safely enter a crosswalk. Vermont law continues, "No pedestrian may suddenly leave a curb or other place of safety and walk or run into the path of a vehicle which is so close that it is impossible for a driver to yield" *(Vermont Statutes Annotated, 1; 23, §1051 (b)).*
4. Where crosswalks might be located. Generally, marked crosswalks are located at all open legs of signalized intersections. They may also be provided at other locations. When used with curb bulbs, signage, and illumination, the visibility of pedestrian crossings can be enhanced.

Although expected at intersections, the installation of crosswalks at mid-block locations may also be desirable under some conditions, such as when medians or refuge islands are used.

The Institute of Transportation Engineers recommends that certain conditions may not warrant the installation of marked crosswalks, such as when the hourly peak pedestrian volume is very low (<25 pedestrians per peak 4 hours) or when traffic volume is very low (<2,000 Annual Average Daily Traffic [AADT]). At all other locations, or where predominately young, elderly, or handicapped pedestrians may be found, crosswalks are recommended.



*Textured crossings, using non-slip bricks or pavers, can raise a driver's awareness through increased noise and vibration.*

**Implementation Strategies**

1. Develop and adopt a crosswalk policy and design guidelines. Decide where crosswalks shall be used, and when policies and ordinances are changed or updated, make sure a crosswalk policy is implemented. Likewise, develop "standard" crosswalk designs for the public works department to follow.

2. Piggy-back on capital and/or maintenance projects. Look for opportunities to install crosswalks whenever intersections are changed or upgraded, or when roadways are resurfaced.

3. Use crosswalks to connect sidewalks and curb ramps at intersections. Coordinate crosswalk painting with new or existing curb ramp locations.

4. Establish an annual crosswalk improvement program. Schedule crosswalk replacement or repainting so that crosswalk markings never become deteriorated or less visible to motorists. The duty of a driver to yield right of way to a pedestrian in a crosswalk may be compromised if the driver could not see the crosswalk or one did not exist. Furthermore, the municipality may be liable for failing to exercise due care toward maintaining the crosswalk for pedestrians, especially if the municipality knew or should have known of a crosswalk deficiency.

5. Implement a vigorous enforcement program. Convince law enforcement authorities to actively monitor crosswalk behavior, enforce crosswalk laws, and prosecute crosswalk scofflaws. Create and implement a public relations program to increase public awareness about the rights and responsibilities of crosswalk use. Emphasize crosswalk laws through the use of informational signage at crosswalk locations.

**Resources and Scheduling**

Crosswalks are relatively inexpensive to install. Obtaining authorization to install them, on the other hand, could take months or longer.

**Evaluation**

An informal traffic study can determine if the crosswalk program is enhancing pedestrian safety. Especially monitor locations of high pedestrian use. Review crash statistics on a regular basis.

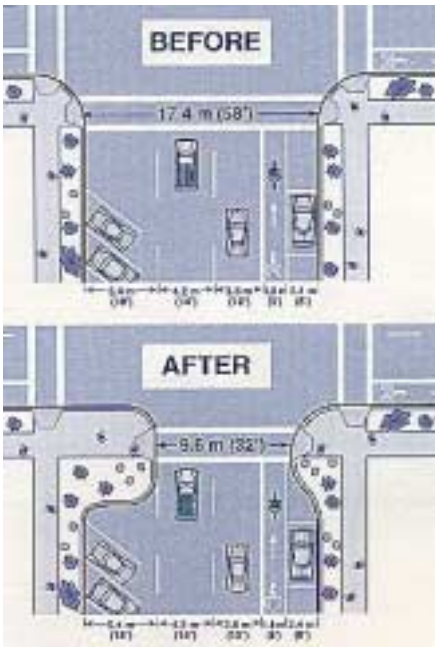
**Planning and Design Considerations**

When planning and designing crosswalks, consider these recommendations:

- Place crosswalks across the full width of the pavement.
- Use crosswalks at all signalized intersections.
- Use crosswalks at non-signalized intersections with discretion.
- Place crosswalks in locations where they are visible and where they are not obscured by parked cars or signs.
- Illuminate mid-block crosswalks that are not expected by motorists.
- Use two white parallel lines 0.2 meters to 0.6 meters (0.5 feet to 2 feet) wide, spaced at a 1.8-meter (6-feet) minimum, or the width of the approaching sidewalk if it is greater, to define a crosswalk area.

- Use special markings such as striped ("zebra") longitudinal lines or diagonal cross-hatching for added visibility and to emphasize a crossing.
- Consider textured crossings, using non-slip bricks or colored pavers, to increase a driver's awareness through increased noise and vibration.
- Use crosswalks at the corners of skewed intersections.

Where warranted, the lighting levels in pedestrian areas should meet those recommended by the Illuminating Engineering Society (IES).




*Also known as bulbs, neck-downs, flares, or chokers, curb extensions reduce the pedestrian crossing distance and improve the visibility of pedestrians by motorists.*

## 15.4 Curb Bulbs and Curb Radii

**Typical Concerns**

Walking across a wide street takes longer than crossing a narrow street. As a result, pedestrians are exposed for a longer length of time to the threat of being hit by a vehicle when crossing a wide street. Another problem pedestrians face when trying to cross a street is visibility. Parked cars may make it difficult for them to see oncoming vehicles and vice versa.

Also, when streets intersect at an acute or obtuse angle, or have a large curb radius, motorists can make turns at relatively high speeds. By contrast, 90-degree intersections and corners with tight curb radii tend to slow motorists down. The problem with obtuse angles is particularly bad when a vehicle on an arterial street turns onto a residential street. Pedestrians crossing the residential street adjacent to the arterial may not expect high-speed turning traffic or they may have their backs turned toward the turning cars.

**Possible Solutions**

The solution is to shorten the crossing distance for pedestrians. One way to effectively shorten the pedestrian crossing distance on streets where parking is permitted is to install curb bulbs, also known as curb extensions and chokers. Curb bulbs project into the street, usually for a distance equal to the depth of a typical parallel parking space, making it easier for pedestrians to see approaching traffic and giving motorists a better view of pedestrians. When motorists are better able to see pedestrians, they have a greater opportunity to stop before a crash can occur.

Decreasing crossing distances for pedestrians also provides these motor vehicle capacity benefits:

- At signalized intersections, it decreases the length of the pedestrian phase.
- At unsignalized intersections, it reduces the time a right-or-left turning vehicle has to wait for a pedestrian to cross before exiting the roadway.

*Reduced sight distances can present a serious problem for pedestrians who wish to cross the street.*

When designing curb bulbs at intersections where there is low truck traffic, consider making the corner radius as small as possible. This will have the effect of slowing down right-turning motor vehicles. Where truck traffic is present, a tight corner radius may make the turn difficult to negotiate for these vehicles. Furthermore, the constant overriding of the curb and sidewalk by rear wheels of trucks may ultimately cause damage to the curb or sidewalk or cause injury to pedestrians.

Simultaneously installing curb bulbs and changing curb radii is frequently possible since both involve moving the curb and gutter into the improved portion of the street right of way.

Where acute or obtuse intersections are encountered, such as where a residential street meets an arterial, creating an intersection that is closer to 90 degrees may also provide opportunities to reduce curb radii and create curb bulbs.

**Implementation Strategies**
Typically, curb bulbs and curb radius changes are appropriate at a limited number of intersections. Consequently, over time, most intersections that need improvements may be upgraded for pedestrians in this fashion. As with other pedestrian improvements, the key is to develop a strategy and stick to it over a period of years. Here's how to get started:

1. Determine arterial and residential street specifications. Include curb bulbs and/or smaller curb radii in standard plans and specifications for public and private road projects. A change in one or more local ordinances may be required or specifications may sometimes be implemented by administrative rule.

2. Start an annual program to install curb bulbs and adjust the curbs at obtuse-angle intersections. Develop project selection criteria to select the projects that will do the most to enhance safety. Some areas to be considered include:

   a. Locations where residential streets meet arterial streets at an obtuse angle.
   b. Locations that are on routes used by school children or the elderly.
   c. Downtown or neighborhood shopping areas with high pedestrian volumes.
   d. Projects nominated by neighborhood associations.

**Resource Requirements and Scheduling**
The cost of installing curb bulbs and changing the curb radii can vary considerably, depending on whether drain grates have to be moved and/or whether there are other issues that have to be addressed. For example, it may be necessary to move the conduit for a signal or relocate utility poles and light and/or sign standards.

Decide if the work is to be done by the public works department or a private contractor. In general, if only a few bulbs are involved, it may be cheaper and faster to have town or city crews do the work. If there is a lot of work to be done, it may be cheaper to use a private contractor. The key is to let the public know how long it will take to install a bulb and then deliver promptly.

**Evaluation**
Visit project sites to determine if good locations have been selected and the best design(s) is being used. Check crash records, do speed studies of cars making turns, look at the curbs to see if trucks or buses are driving over them, and ask pedestrians if they feel safer. Be a good listener and observer, and make modifications where needed.

**Planning and Design Considerations**
Transportation agencies have increased curb radii over the years to keep trucks and buses from running over curbs and striking pedestrians standing on the corner; such changes also increase capacity. Unfortunately, curb radii have been increased at intersections that do not have large truck traffic or buses (e.g., in residential neighborhoods). The following are guidelines for curb bulbs and small curb radii:

*Pedestrian push buttons should be conveniently placed. Be sure existing site features are not obstacles to reaching the button.*

- On arterial streets, install curb bulbs only where permanent parallel parking is next to the curb. Curb bulbs should protrude a minimum of 2 meters (6 feet) into the roadway. Ideally, they should project the full depth of adjacent parking stalls, usually 5.5 meters to 6 meters (8 feet to 9 feet). Curb bulb projections prevent the parking area next to the curb from becoming a travel lane.
- A curb radius of 3 meters to 4.5 meters (10 ft to 15 ft) should be used where residential streets intersect other residential streets and arterial streets.
- A curb radius of 6 meters (20 feet) should be used at the intersections of arterial streets that are not bus or truck routes.
- A curb radius of 7.5 meters to 9 meters (25 feet to 30 feet) should be used at the intersections of arterial streets that are bus and/or truck routes.
- Curb bulbs should not extend too far into the street to present a bottleneck for bicycle travel. As a minimum, a 4.3-meter (14-foot) travel lane should be maintained.

## 15.5 Signal Timing and Push Buttons

**Problem Statement**
The public is often baffled by pedestrian signal timing and push buttons; such pedestrian features seem to vary not only from jurisdiction to jurisdiction, but also from intersection to intersection. Walk/Don't Walk timing lengths often appear arbitrary–especially the Walk and flashing Don't Walk phases. Part of the problem stems from the fact that many walkers do not know that the flashing Don't Walk is intentionally displayed before an average person can completely cross the street. Another part of the problem may result from timing cycles that are simply too fast for slow walkers such as older pedestrians or people who are handicapped.

Another aspect of the problem may be due to the absence of pedestrian push buttons or because a call button is obscured or difficult to reach. At many intersections that do have push buttons, the Don't Walk phase is so long that pedestrians feel their push-button request has not been recognized by the signal system. All of these problems encourage disrespect for pedestrian signals, promote increased jaywalking, and create conflicts with motorists.

**Solution Statement**
Develop policies governing pedestrian signal timing and push-button actuation to ensure fair treatment for pedestrians. Make signal timing as consistent as possible, and adopt a clear pedestrian push-button warrant. Develop a desired level of service for pedestrian waiting and push-button response times and evaluate signalized intersections to see if the pedestrian level of service at signalized intersection falls within an acceptable range.

Major issues related to pedestrians and signalized intersections include:

- Seemingly arbitrary length of Walk and flashing Don't Walk cycles.
- Pros and cons of lengthening flashing Don't Walk to accommodate slower pedestrians.
- Safety trade-off of shortened pedestrian phase implemented to enhance vehicular right turns


- Fairness of laws that allow motorists to enter an intersection on the yellow while prohibiting pedestrians from doing so during flashing Don't Walk.
- Trade-off between motor traffic delays and pedestrian delays at actuated pedestrian crossings.
- Integrating pedestrian recall and pedestrian actuation in a way pedestrians will understand.

**Implementation Strategies**
Making signalized intersections consistent with stated policies won't happen overnight; consider it as part of a long-term commitment to pedestrian safety. Whatever strategy is employed, use field observations to see how pedestrians react to signal timing and push buttons. Comparing a variety of configurations will help. It is possible for workable and consistent policies to be developed.

Annual Program: A comprehensive program should be established to evaluate and prioritize improvements. It should not be hard to locate those areas needing attention. In all likelihood, the public works department probably maintains a file filled with complaints from citizens.

New Signal or Signal Timing Projects: Review the pedestrian signal timing plan for any intersections undergoing signal modification or adjustments. Keep aware of signal work, providing appropriate suggestions. This will help signal engineers become more sensitive to pedestrian needs.

**Resource Requirements**
The peculiarities of many intersections means that a strictly policy-driven approach may not be possible. As a result, trained personnel will be needed to evaluate signal timing and actuation at many specific locations. Most of the work will be done by agency crews unless there is a large enough backlog to justify going out to bid.

**Evaluation**
Monitor intersections with modified signal timing and push buttons, and compare them with unaltered intersections. Crash reductions and/or fewer pedestrian complaints will be good indicators of whether the new policies are working. Develop a level of service for pedestrian push buttons and apply accordingly

**Planning and Design Considerations**
Consider these features when providing signals that are responsive to pedestrians:

- Signals must fulfill a need, gain attention, convey a clear and simple meaning, and command the respect of road users, as well as provide adequate time for response.
- Average walking speed should be calculated at 1.2 meters (4 feet) per second; 1.1 meters (3.5 feet) per second is becoming more common; 0.9 meters (3 feet) per second should be used where there is a high frequency of older pedestrians; and people with mobility impairments move as slow as 0.8 meters (2.5 feet) per second.
- Many pedestrians stop watching for lights and, instead, look for gaps to cross streets when their delay exceeds 30 seconds.
- Place pedestrian signal heads at each end of the crosswalk.

- Place the push button at the top of and as near as possible to the curb ramp and clearly in line with the direction of travel. This will improve operations as many pedestrians push all buttons to ensure that they hit the correct one.

- Use a push-button box that gives pedestrians a visible acknowledgment (indicator light comes on at push-button box) that their crossing request has been received. Where medians exist, place additional push buttons in medians. If signal head on opposite side of the street is more than 18.3 meters (60 feet) away, place additional pedestrian signal heads in medians.


***Pedestrian push buttons are often provided at locations with intermittent pedestrian volumes to call for the WALK message and/or extend the crossing interval.***

- Place pedestrian signals in channelized islands.

- Visually impaired people need audio support at key signalized intersections.

- Audio signals are available using different sounds — from pleasant (cuckoo or tinkling bell sounds preferred) to obnoxious (avoid raspy-sounding buzzers).

- Walk Phase: Allow time for pedestrians to search and start walking. For coordinated signal systems, extend to full green time minus flashing.

- Don't Walk Phase (pedestrian clearance interval): Avoid shortening the Walk phase to improve the flow of right-turning vehicles.

- Flashing Don't Walk Phase (pedestrian clearance interval): Included in the full green time. Calculated as part of the crossing time. Crossing time equals distance divided by 0.8 meters to 1.2 meters (2.5 feet to 4 feet) per second, depending on customer base.

- Steady Don't Walk Phase: Equal time for yellow clearance and all-red signal. Pedestrians should be out of the street.

The MUTCD has many suggestions regarding push-button placement and pedestrian signal timing. However, in many other areas of pedestrian activity, it leaves a great deal to engineering judgment.

## 15.6 Pedestrian Refuge Islands

Pedestrian refuge islands are defined as the areas within an intersection or between lanes of traffic where pedestrians may safely wait until vehicular traffic clears, allowing them to cross a street. Refuge islands are commonly found along wide, multi-lane streets where adequate pedestrian crossing time could not be provided without adversely affecting the traffic flow. These islands provide a resting area for pedestrians, particularly those who are wheelchair-bound, elderly, or otherwise unable to completely cross an intersection within the provided signal time. These refuge islands also provide a safety area for pedestrians caught in the street when a signal changes.

***Refuge islands provide a safety area for pedestrians who cannot cross the entire street on one cycle.***

When evaluating whether a refuge island is needed, both crossing time and safety must be considered. For example, in suburban areas with long distances between intersections and traffic signals, a large proportion of pedestrian crossings occur at unsignalized intersections and at mid-block locations. However, with a median, a pedestrian would only have to look in one direction to cross to the median, and in the opposite direction to complete their crossing from the median to the far side of the street. Pedestrians crossing an undivided, multi-lane street may experience delays 10 times longer than the delay incurred crossing a street with a median as shown by the pedestrian crossing delay curves provided in NCHRP Report 294A.

The effect of refuge islands and medians on pedestrian safety is unclear. Studies have reported both increases and decreases in accidents after pedestrian islands have been installed. There is a substantial lack of definitive information on this subject. However, a 1978 study in western Australia indicated that the rate of pedestrian accidents at a four-lane unsignalized intersection was reduced to 11.5 percent of its original level when raised median islands were installed.

Refuge islands can be beneficial under certain conditions and inconsequential or even harmful under others. The typical conditions where refuge islands are most beneficial include:

- Wide, two-way streets (four lanes or more) with high traffic volumes, high travel speeds, and large pedestrian volumes.

***Streets with raised medians usually have lower pedestrian crash rates.***

- Wide streets where the elderly, people with disabilities, and children cross regularly.
- Streets with insufficient green signal phasing time for safe pedestrian crossings.
- Wide, two-way intersections with high traffic volumes and significant numbers of crossing pedestrians.
- Low-volume side-street traffic demands with insufficient green time to cross (i.e., low side-street volumes in combination with high main street volumes may warrant short green times for the side street, which, in turn, does not allow enough time for the pedestrian to cross the entire street).

The typical conditions where refuge islands are least beneficial or possibly harmful include:

- Narrow streets and/or streets where substandard-width refuge islands are used.
- Instances in which a high turning volume of large trucks exist.
- Conditions under which the roadway alignment obscures the island, thereby making it likely that vehicles will drive onto the island.
- Areas where the presence of a safety island will severely hamper snowplowing.

In areas where refuge islands are beneficial, the advantages to pedestrians are many, including:

- Reducing pedestrian crossing time by splitting crossing distances (i.e., providing staged crossing of pedestrians), thereby reducing the green time required for the pedestrian crossing phase.
- Providing pedestrians with a resting place when crossing wide roads or intersections.
- Providing a pedestrian storage area.
- Increasing the capacity of the intersection with a near-side island that provides a better location for the stop bar.

- Loading and unloading transit riders (although curbside locations provide a better alternative).

- Providing a location for traffic control (shorter mast arms) and utility pole installations.

The disadvantages of pedestrian refuge islands include:

- A false sense of security or safety to pedestrians.
- Street sweeping or snowplowing problems.
- Damage to vehicles if struck.
- Installation costs will be higher.
- Generally, more right of way is required.

***Pedestrian refuge islands can create a safer crossing for wide streets.***

**Recommended Practice**

Pedestrian refuge islands may be installed at intersections or mid-block locations as deemed appropriate by engineering studies. Refuge islands should be considered during the design of complex intersections or streets rather than after construction has been completed. They must be visible to motorists at all times and should be delineated by curbs, guideposts, signs, or other treatments. Refuge islands should be designed to minimize the potential hazard to motorists and pedestrians alike.

**Island Design Features**

Pedestrian refuge islands must be designed in accordance with the AASHTO policy and the MUTCD requirements. Design considerations should include:

- Areas at traffic signals where the total length of crosswalk cannot be readily traveled in one pedestrian phase. Special consideration should be given to intersections where a large number of elderly pedestrians and/or people with disabilities will be present. Special consideration should also be given to complex or irregularly-shaped intersections where islands could provide a pedestrian with the opportunity to rest and become oriented to the flow of oncoming traffic.

- Raised curbs with cut-through ramps at pavement level or curb ramps for wheelchair users. Cut-through ramps should be graded to drain quickly and should also have special provisions to assist the visually impaired in identifying the refuge island. Islands with ramps should have a level area at least 48 inches long at the same level as the top of the raised median to provide a level area for wheelchair users.

- Areas at least 6 feet wide from the face of the curb to the face of the curb. The minimum width should not be less than 4 feet wide from the face of the curb to the face of the curb. The island should not be less than 12 feet long or the width of the crosswalk, whichever is greater. The minimum island size should be 50 square feet.

- An approach nose, offset from the edge of the traffic lane, appropriately treated to provide motorists with sufficient warning of the island's presence. This can be achieved in various ways, such as illumination, reflectorization, marking, signage, and/or size.

- Pedestrian push buttons and signage adjacent to crosswalks.

- Guidestrips for the blind.

- Placement on wide (four lanes or more) streets with high traffic volumes.

- No obstruction to visibility by such features as foliage, barriers, or benches.
- Barriers that may be necessary to keep pedestrians from stepping into traffic at improper locations.

***Refuge islands provide pedestrians with a resting place when crossing roads or intersections.***

## 15.7 Exercise: Urban Intersections

The need to develop and detail pedestrian intersection improvements in a manner that can be constructed within the normal field of highway construction is an extremely important issue. Pedestrian accommodations at intersections include both traffic signal and pavement marking improvements. An exercise covering pavement marking issues was previously addressed in Exercise 14.8. With regard to signalization at intersections, pedestrian improvements typically include pedestrian signals, pedestrian push buttons, conduit/wiring, mounting brackets, and pedestrian poles. Traffic signal improvements are specified through a detailed system of standard drawings, specifications, and bid item numbers. An example plan view drawing demonstrating this method for specifying traffic signal improvements using Georgia Department of Transportation standards is provided for reference in Figure 15-1.

Develop a plan to install pedestrian signals and related improvements for an intersection in your community. The plan should be developed using nomenclature and reference standards from your State DOT. A list of standard drawings pertaining to pedestrian facility construction from Caltrans (California Department of Transportation) was previously provided in Exercise 14.8. If possible, you should obtain an intersection drawing from your local traffic engineering department. This drawing typically shows the location of existing roadway features, travel lanes, signal equipment, and utilities. In addition to preparing a plan of proposed improvements, develop an estimate of quantities needed for each construction item and prepare an engineer's construction cost estimate. You will need to utilize the following resources:

- Plan view drawing of local intersection.
- Standard drawings (periodically published document).
- Standard specifications (periodically published document).
- Bid item numbers (typically a published list).
- Statewide average bid summary (typically assembled several times a year).

## 15.8 References

"A Comparison of the Pedestrian Safety of Median Islands and Marked Crossings," *Western Roads*, Western Australia, August 1978.

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Federal Highway Administration, *Manual on Uniform Traffic Control Devices*, Washington, DC, 1988.

ITE, *Design and Safety of Pedestrian Facilities–A Recommended Practice of ITE*, Washington, DC, 1998.

National Cooperative Highway Research Program, Transportation Research Board, *Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas*, NCHRP Report 294A, Washington, DC, June 1987.

# Figure 15-1:

***Example Traffic Signal Plan.***
***Sugarloaf Parkway Construction Plans***
***Lawrenceville, Georgia***