Pedestrian Facilities Users Guide

Providing Safety and Mobility

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August 2000

Guide Purpose and Scope

The purpose of this "Pedestrian Facilities Guide - Providing Safety and Mobility" is to provide useful information on how to identify safety and mobility needs for pedestrians within the roadway right-of-way. The Guide first gives an overview in Chapter 1 on creating a walkable environment. Chapter 2 describes basic pedestrian crash trends and also defines 13 pedestrian crash type groupings. These crash groupings are then presented in Chapter 3 in terms of how to select pedestrian safety improvements to address specific crash problems. Chapter 3 also provides a simplified list of improvements to address certain broad objectives (e.g., reducing speeds on a street, reducing exposure for pedestrians) without the need for pedestrian crash data.

Chapter 4 of this Guide contains the details of 48 different engineering improvements for pedestrians. These improvements relate to the walking environment, roadway design, intersection treatments, traffic calming, traffic management and signals and signs.

Intended Audience

This guide is intended primarily for engineers, planners, safety professionals, and decision-makers, but may also be used by citizens for identifying pedestrian tools to improve the safety and mobility for those who walk.

Table of Contents

INTRODUCTION

Photo credit: City of Cambridge, MA

Introduction

Walking is such a basic human activity that it has frequently been overlooked in the quest to build sophisticated transportation systems. Now people are looking to change that. They want to live in places that are welcoming, safe and enjoyable. They want livable communities where they can walk, bicycle, recreate and socialize.

Creating a pedestrian environment involves more than laying down a sidewalk or installing a signal. Facilities for pedestrians should be planned, designed, operated and maintained to include the needs of all persons, including those with disabilities. A truly viable pedestrian system involves both the big picture and the smallest details-from how a city is built to what materials are under our feet.

Because most of the work that will be done involves retrofitting existing places, improving the pedestrian environment will be done on a street-by-street, neighborhood-by-neighborhood basis.

How to Use this Guide

The Pedestrian Facilities User Guide—Providing Safety and Mobility is intended primarily for engineers, planners, safety professionals and decision-makers, but may also be used by citizens for identifying pedestrian tools to improve the safety and mobility for those who walk.

The purpose of this Guide is to provide useful information on how to identify safety and mobility needs for pedestrians within the roadway right–of–way. *Chapter 1: The Big Picture* gives an overview on how to create a safe, walkable environment.

Chapter 2: Pedestrian Crash Factors describes basic pedestrian crash trends and also defines thirteen pedestrian crash type groupings and factors important in selecting the best countermeasures. These crash groupings are then presented in *Chapter 3: Selecting Pedestrian Safety Improvements* in terms of how to select pedestrian safety improvements to address specific crash problems. Chapter 3 also provides a simplified list of improvements to address certain broad objectives (e.g. reducing speeds on a street, reducing exposure for pedestrians) without the need for pedestrian crash data.

Chapter 4: The Tools contains the details of 48 different engineering improvements for pedestrians. These improvements relate to the walking environment, roadway design, intersection treatments, traffic calming, traffic management, and signals and signs.

Further resources are listed in *Chapter 5: Implementation and Resources* including a section on involving the community in developing priorities, strategies for construction, and raising funds for pedestrian improvements. A bibliography of suggested readings and useful website addresses are also provided.

The *Appendices* contain additional information regarding Pedestrian Faciltiy Case Studies (success stories, Appendix A), Recommended Guidelines/Prioirities for Sidewalks and Walkways (Appendix B), and Recommended Guidelines for Crosswalk Installation (Appendix C).

Chapter 1

The Big Picture

Photo by Dan Burden

Land Use

Assume that People Will Walk

Transit

Streets: The Arteries of Life

How Pedestrians are Affected by Traffic: Traffic Volume and Speed

Land Use

Creating a walkable place starts with the very nature of the built environment: having destinations close to each other, siting schools, parks and public spaces appropriately, allowing mixed-use developments, having sufficient densities to support transit, creating commercial districts that people can access by foot, and so on. The connection between land use planning and transportation planning is critical, but all too often ignored.

Integrating land-use and transportation planning allows new developments to implement these strategies from the onset. Communities planned to support balanced transportation make walking and public transit attractive options.

In established communities, many of these goals can be met with "in-fill development" to increase density, changes in zoning laws to allow mixed-use development, and building street or pedestrian-only connections.

Photo by Cara Seiderman

Design streets for people to use them. Assume people will walk.

Assume That People Will Walk

Whether building new infrastructure or renovating existing places, it should always be assumed that people will walk and plans should be made for them to be there. People will want to walk everywhere they can, and a comfortable, inviting and safe environment should be provided for them. There are many reasons that people walk: to run errands, to visit neighbors, to go to local stores, to take their children to the local park, for exercise, or even for the sheer enjoyment of walking. Children should be able to walk to school or to their friends' houses. All these activities constitute a significant number of trips. About four-fifths of all trips are non work-related (Source: 1995 National Personal Transportation Survey).

If people aren't walking, it is likely because they are prevented from doing so. Either the infrastructure is insufficient or has serious gaps. Are there continuous walkways? Are there physical barriers such as rivers, drainage ways, walls, or freeways that prevent convenient walking access in a community? Do bridges for cars also provide a safe walking area for pedestrians? Do the lack of curb ramps or the existence of steep grades or steps prevent the access for elderly or people in wheelchairs? Is there a major road that separates the residential neighborhood from the commercial district? Are there places for people to cross roads safely?

Walking rates in different neighborhoods within the same city are directly related to the quality of the system. In other words,

in high quality pedestrian environments, lots of people walk. Where the system fails—missing sidewalks, major barriers, no safe crossings—then people walk less, and those who do are at greater risk.

People also want to walk in an environment where they can feel safe; not only safe from vehicle traffic, but safe from crime or other concerns that can affect personal security. Areas need to be well lit to encourage walking in evening hours. The walking environment should be open and inviting, but not sterile and vacant. Pedestrians need more than sidewalks and crosswalks. In addition to protecting pedestrians from vehicle traffic, it is important to have a secure, pleasant, and interesting walking environment to encourage people to walk.

Photo by Cara Seiderman

A busy commercial street in Ann Arbor, Michigan emphasizes pedestrian use and provides attractive areas for people to sit, stroll and meet.

Transit

Walking and transit are complementary. Good walking conditions for pedestrians are important inducements to using public transportation, since most public transit trips include a walking trip at one or both ends. People should be able to walk to a bus stop or a train station from their homes and to jobs, shopping, and other activities. Conversely, good public transportation, with buses, subways and paratransit vehicles that run frequently and are reliable, is essential to achieving a walkable city. The trip should be as seamless as possible and transit stops should be friendly, comfortable places. When development occurs around a transit stop, more transit can be supported, and people will have more options for how to travel there. Special attention should be paid to how people will get from the transit stop to their destinations. No matter how convenient the trip is otherwise, if people don't feel safe walking even a short distance, they will choose not to go, or to go by another mode (usually driving – and the more people drive the less pedestrian-friendly a place becomes).

Streets: The Arteries of Life

Streets serve many functions, including:

- **Linkage**. They connect parts of cities to each other, one town to another, activities and places.
- **Transportation**. They provide the surface and structure for a variety of modes. All modes and users should be provided for: pedestrians, bicyclists, transit, motor vehicles, emergency services, maintenance services, etc.
- **Access**. They provide public access to destinations.

- **Public right-of-way**. Space for utilities and other infrastructure is an unseen function of the street.
- **Space and place**. The street is as a definable place, a place for people to interact, the heart of a community. A street in this role may serve as a place for parties, fairs, parades and community celebrations.

Streets are often designed to emphasize some functions over others. At one extreme is a limited access highway which serves as a corridor for motor vehicle travel. At the other is a private cul-de-sac, which has no linkage and limited access. Many streets are designed so that certain desirable functions are not met. Examples include commercial streets where access to destinations is difficult, and strip development along high-speed roads where no sidewalks or pedestrian crossings exist.

When streets and roads are evaluated for improvements, it is helpful to consider whether the design effectively meets all the desired functions of the roadway. If not, the street should be redesigned to adequately meet those functions.

How Pedestrians are Affected by Traffic: Traffic Volume and Speed

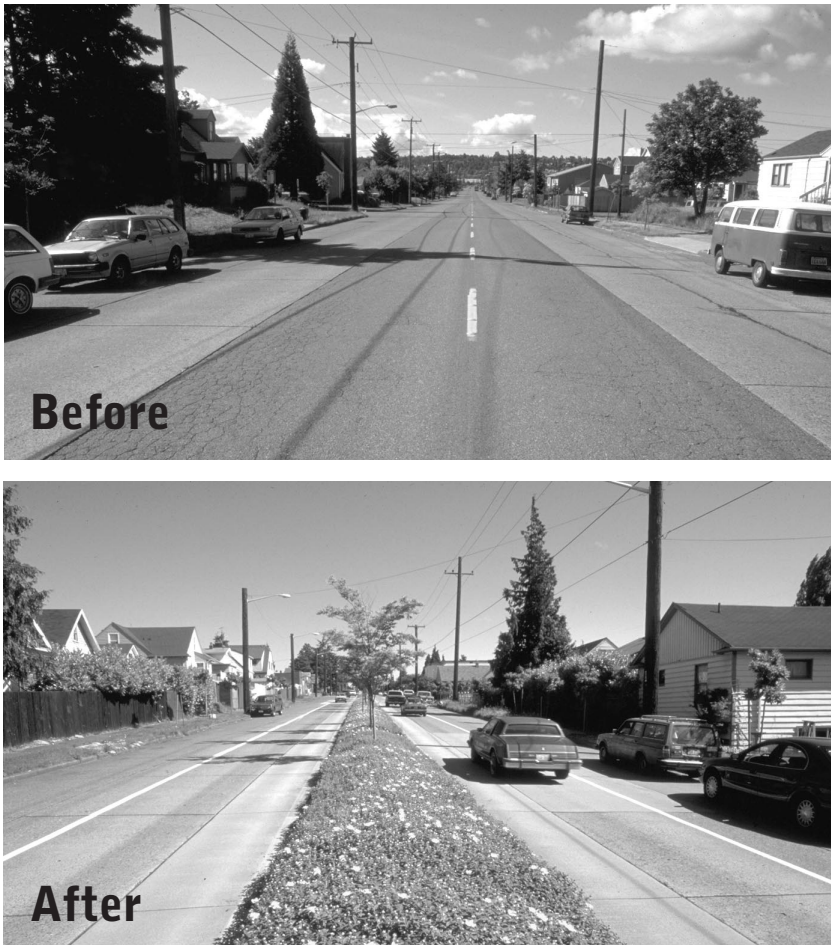
High volumes of traffic can inhibit a person's feeling of safety and comfort and create a "fence effect" where the street is almost an impenetrable barrier. The effect of traffic volumes on community life has been measured. In his seminal 1980 study, Donald Appleyard looked at how traffic volumes on comparable streets in San Francisco affected community life. People living on a street with light traffic (2,000 vehicles a day) had three times as many friends and twice as many acquaintances on the street as did people living on a street with heavy traffic (16,000 vehicles a day).

Photo by Dan Burden

This roadway may act as a barrier to pedestrians. Those who are walking along the waterfront may find it difficult to cross to the commercial establishments and those on the commercial side may be reluctant to cross to the waterfront.

Traffic speed is usually the more critical aspect to walkability and safety. Though pedestrians may feel comfortable on streets that carry a significant amount of traffic at low speeds, faster speeds increase the likelihood of pedestrians being hit. At higher speeds, motorists are less likely to see a pedestrian, and even less likely to actually stop in time to avoid a crash. At a mere 31 mph, a driver will need about 200 feet to stop; that number is halved at 19 mph (REF?).

Unfortunately, most of our streets are designed to encourage higher traffic speeds. Fortunately, we do have tools that can change this, primarily by redesigning streets through traffic calming or by designing new streets with lower design speeds. Speed reductions of 0.5-18 km/hour have been demonstrated to increase pedestrian safety by 17-92 percent (REF?). Safety benefits of reduced speeds extend to motorists and cyclists as well, although the advantage to pedestrians is the most substantial.



The street pictured at left is a heavily traveled arterial in one of Seattle, Washington's thriving residential neighborhoods. High speed and concerns about pedestrian safety resulted in the redesign shown in the "after" picture. Bike lanes and a median strip have encourage slower traffic speeds. Speeds were reduced by ____ over a _____ year period.

Chapter 2

Pedestrian Crash Factors

Photo by Dan Burden

Chapter 1 provided an overview of the need to provide a more walkable environment near streets and highways. Chapter 2 addresses the pedestrian crash problem and related factors, which must be understood to select appropriate facilities to improve pedestrian safety and mobility. A brief discussion of the pedestrian crash problem in the U.S. is given below, as also reported by Zegeer and Seiderman in a related publication(1).

Pedestrian Crash Statistics

Pedestrian-motor vehicle crashes are a serious problem throughout the world and the U.S. has a particular problem with pedestrian deaths and injuries.

Specifically, a total of 5,307 pedestrians were reported killed in motor vehicle crashes in the United States in 1997(2). These deaths accounted for 12.6 percent of the 41,967 motor vehicle deaths nationwide in that year. An estimated 77,000 pedestrians were injured or killed in motor vehicle collisions, which represents 2.3 percent of the 3.4 million total persons injured in traffic crashes(2). A drop in pedestrian fatalities in recent years may reflect that fact that people are walking less. The need to reduce pedestrian deaths and injuries continues to be an important goal for the engineering profession.

Pedestrians Most at Risk

Crash involvement rates (crashes per 100,000 people) are the highest for 5-to-9--year old males, who tend to dart out into the street. This problem may be explained by the fact that speeds are frequently a problem in areas where children are walking and playing. In general, males are more likely to be involved in a crash than females; in 1997, more than two-thirds of pedestrian fatalities were male and the male pedestrian injury rate was a third higher than for females(2). Rates for older persons (age 65 and over) are lower than for most age groups, which may reflect greater caution by older pedestrians (e.g., less walking at night, fewer dart-outs) and reduced amount of walking near traffic. However, older adult pedestrians are much more vulnerable to serious injury or death when struck by a motor vehicle than younger pedestrians. For example, the percentage of pedestrian crashes resulting in death exceeds 20 percent for pedestrians over age 75 compared to less than 8 percent for pedestrians under age 14(3,4).

Alcohol Impairment

Alcohol impairment is a serious problem for pedestrians as well as drivers of motor vehicles, although there is evidence that the picture is

improving. From 1980 through 1989, 37 percent to 44 percent of fatally injured pedestrians had blood alcohol concentrations (BAC's) of .10 or greater. In 1997, that figure was 29.5 percent and the intoxication rate for drivers was 12.5 percent. In 1989, of all adult pedestrians killed in night-time collisions with motor vehicles, 59 percent had BAC's of .10 or greater, while only 31 percent had no alcohol in their blood(4,5). From 1987 to 1997, the intoxication rates for pedestrian fatalities in all age groups decreased, with the highest decrease, 19 percent, for those 55 to 64 years old and the least decrease, 3 percent, for those 35 to 44 years (2,6).

Speeding

Speeding is a major contributing factor in crashes of all types. In 1997, speeding was a contributing factor in 30 percent of all fatal crashes (2). Speeding has serious consequences when a pedestrian is involved. A pedestrian hit at 40 mph has an 85 percent chance of being killed; at 30 mph, the likelihood goes down to 45 percent, while at 20 mph, the fatality rate is only 5 percent (7). In addition, faster speeds increase the likelihood of a pedestrian being hit in the first place. At higher speeds, motorists are less likely to see a pedestrian, and are even less likely to be able to stop in time to avoid hitting one.

Times of Occurrence

Pedestrian crashes are most prevalent during morning and afternoon peak periods, when the traffic levels are highest. Fatal pedestrian crashes typically peak later in the day between 5 and 11 p.m., where darkness and alcohol use are factors (6). In 1997, nearly one-half of all pedestrian fatalities occurred on Friday, Saturday or Sunday (17 percent, 18 percent and 13 percent respectively)(2,9). Crashes where older pedestrians are hit are more evenly distributed throughout the days of week than younger pedestrians. Older pedestrians are more likely to be struck during day-light hours, when they are most likely to be exposed to traffic (3). The months of September through January have the highest number of nationwide pedestrian fatalities, with typically fewer daylight hours and more inclement weather (4,8). Child pedestrian fatalities are greatest in May, June and July, perhaps due to an increase in outside activity (8).

Area Type

Pedestrian crashes occur most frequently in urban areas where pedestrian activity and traffic volumes are greater compared to rural areas. The National Safety Council estimates that 85.7 percent of all non-fatal pedestrian crashes in the U.S. occur in urban areas and 14.3 percent in

rural areas. However, 25 percent of pedestrian fatalities occur in rural areas, where vehicle speeds are higher than on city streets (8,10). In addition, many rural areas have no sidewalks, paths or shoulders to serve as separated pedestrian facilities.

Location Type

In terms of crash location, 65 percent of crashes involving pedestrians occur at non-intersections. This is particularly true for pedestrians under age 9, primarily because of dart-outs into the street. For ages 45 to 65, pedestrian crashes are approximately equal for intersections and non-intersections. Pedestrians aged 65 and older are more likely to be struck at intersections (60 percent) compared to non-intersections (40 percent), since older pedestrians tend to cross at intersections more often than younger ones (9). Moreover, some older pedestrians have physical disabilities that increase problems when crossing busy intersections (8,9). Studies have shown that older pedestrians are particularly overrepresented in crashes at intersections involving left-turn and right-turn vehicles (3).

Crash Types and Countermeasures

Close examination of pedestrian crashes can help determine which corrective measures can lessen the likelihood of some of these crashes. In the 1970's, methods for typing pedestrian and bicycle crashes were developed by NHTSA to better define the sequence of events and precipitating actions leading to pedestrian-motor vehicle crashes (11,12,13). In the 1990's, the methodologies were applied by Hunter in a 1996 study to over 8,000 pedestrian and bicycle crashes from six States (14). The results provided a representative summary of the distribution of crash types experienced by pedestrians and bicyclists. Some of the most frequently occurring types, for example, include: dart-out first half (i.e., the pedestrian is struck in the first half of the street being crossed) (24 percent); intersection dash (13 percent); dart-out second half (10 percent); mid-block dart (8 percent); and turning vehicle crashes (5 percent) (11,12,13).

Pedestrian Crashes by Type

The development of effective countermeasures to help prevent pedestrian crashes is hindered by insufficient detail in computerized state and local crash files. Analysis of these data can provide information on where pedestrian crashes occur (city, street, intersection, two-lane road, etc.), when they occur (time of day, day of week, etc.), and characteristics of the victims involved (age, gender, injury severity, etc.). Current crash files cannot provide a sufficient level of detail regarding the sequence of events leading to the crash.

The crash typing methodology described above has evolved over time and has been refined as part of a software package known as Pedestrian and Bicycle Crash Analysis Tool (PBCAT). The development of PBCAT was sponsored by the Federal Highway Administration (FHWA) and National Highway Traffic Safety Administration (NHTSA) through the University of North Carolina Highway Safety Research Center.

PBCAT is a software product intended to assist state and local pedestrian and bicycle coordinators, planners, and engineers with the problem of lack of data regarding the sequence of events leading to a crash. PBCAT accomplishes this goal through the development and analysis of a data base containing details associated with crashes between motor vehicles and pedestrians or bicyclists. One of these details is the crash type, which describes the pre-crash actions of the parties involved. With the data base developed, the software can then be used to produce reports and select countermeasures to address the problems identified. The PBCAT software and User's Manual may be downloaded from the Pedestrian and Bicycle Information Center web site at: *www.walkinginfo.org/pbcat*

Of the more than 60 specific pedestrian crash types, there are 13 crash groupings that are most useful for identifying safety problems and corresponding countermeasures.They are defined below:

Definitions of Pedestrian Crash Types

1. Midblock: Dart/Dash

The pedestrian walked or ran into the roadway and was struck by a vehicle. The motorist's view of the pedestrian may have been blocked until an instant before the impact

2. Multiple Threat

The pe.destrian entered the traffic lane in front of stopped traffic and was struck by a vehicle traveling in the same direction as the stopped vehicle. The stopped vehicle may have blocked the sight distance between the pedestrian and the striking vehicle.

3. Mailbox or Other Midblock

The pedestrian was struck while getting into or out of a stopped vehicle or while crossing the road to/from a mailbox, newspaper box, ice-cream truck, etc.

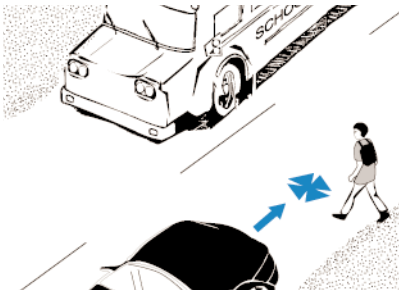
Mailbox or Other Midblock

4. Failure to Yield at Unsignalized Location

At an unsignalized intersection or midblock location, a pedestrian stepped into the roadway and was struck by a vehicle. The motorist failed to yield to the pedestrian and/or the pedestrian stepped directly into the path of the oncoming vehicle.

5. Bus-Related

The pedestrian was struck by a vehicle either: (1) by crossing in front of a commercial bus stopped at a bus stop, (2) going to or from a school bus stop, or (3) going to or from or waiting near a commercial bus stop.



Bus-Related

6. Turning Vehicle at Intersection

The pedestrian was attempting to cross at an intersection and was struck by a vehicle that was turning right or left.

7. Through Vehicle at Intersection

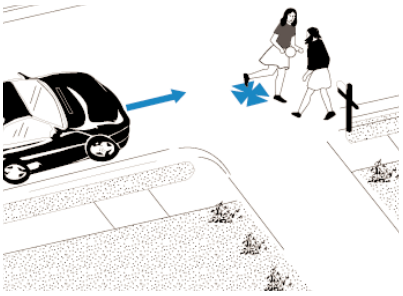
A pedestrian was struck at a signalized or unsignalized intersection by a vehicle that was traveling straight ahead.

8. Walking Along Roadway

The pedestrian was walking or running along the roadway and was struck from the front or from behind by a vehicle.

9. Working/Playing in Road

A vehicle struck a pedestrian who was (1) standing or walking near a disabled vehicle, (2) riding a play vehicle that was not a bicycle (e.g., wagon, sled, tricycle, skates), (3) playing in the road, or (4) working in the road.



Working/Playing in Road

10. Not in Road (Sidewalk, Driveway, Parking Lot, or Other)

The pedestrian was standing or walking near the roadway edge, on the sidewalk, in a driveway or alley, or in a parking lot, when struck by a vehicle.

11. Backing Vehicle

The pedestrian was struck by a backing vehicle on a street, in a driveway, on a sidewalk, in a parking lot, or at another location.

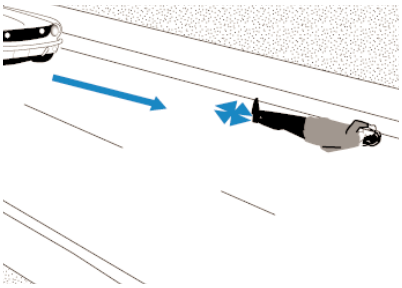
12. Crossing on Expressway

The pedestrian was crossing a limited access expressway or expressway ramp.

13. Miscellaneous

This category includes all other pedestrian crash types, such as: intentional crashes, driverless vehicle, a secondary crash after a vehicle- vehicle-collision, a pedestrian struck by falling cargo, emergency vehicle striking a pedestrian, a pedestrian standing or lying in the road, or other/unknown circumstances.

The information described above on pedestrian cash groups is needed in the next chapter for selecting corresponding pedestrian safety improvements



Miscellaneous: Pedestrian Lying in Roadway

Chapter 3

Selecting Pedestrian Safety Improvements

Photo by

Problem Solving Methods

Identify High Crash / High Risk Locations

Methods to Improve Pedestrian Safety

Crash Related Countermeasures

This chapter is divided into four sections. The first section on "problem solving" provides a list of countermeasure alternatives to address various objectives; e.g., reducing vehicle speeds, reducing volumes of motor vehicles, and others. Pedestrian crash information is not required to utilize the countermeasure list.

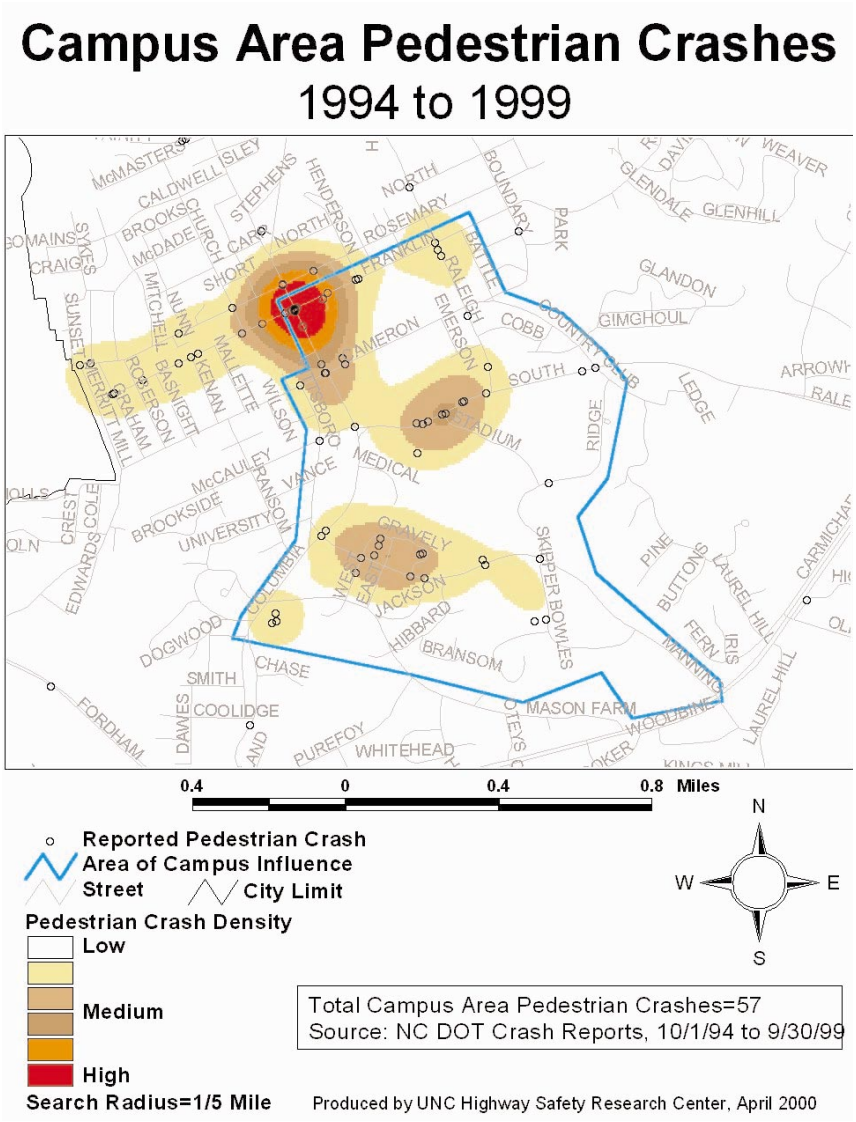
The second section discusses the process of identifying locations where pedestrian crashes have occurred in the past and may occur in the future for safety treatments. The third section of this chapter is a general discussion of methods to improve pedestrian safety. The chapter concludes by providing a matrix of pedestrian engineering improvements which might be used to address the thirteen pedestrian crash groups that were defined in Chapter 2.

Photo by Barbara Gray

Identify High Crash / High Risk Locations

A first step in the process of improving pedestrian safety is to identify locations or areas where pedestrian crash problems exist and where engineering, education, and enforcement measures will be most beneficial. Mapping the locations of reported pedestrian crashes in a neighborhood, campus, or city is a simple method of identifying sites for improving walking safety. One method of analyzing crash locations includes using computerized Geographic Information Systems (GIS) software, as shown by the density map of reported pedestrian crashes in a college campus area pictured on the next page.

The map of recent pedestrian crash concentrations in one area of a college town can help transportation engineers and planners focus safety improvements on intersections, street sections, or neighborhoods where pedestrian crashes have occurred.



Several issues should be considered when creating GIS maps of reported crash locations. First, the total number of pedestrians and vehicles that use each location will affect reported crash density. Second, pedestrian crashes may not be reported frequently enough to establish a pattern of unsafe walking locations. In either case, noting pedestrian and driver behavior or examining roadway and walkway characteristics at specific sites, or mapping locations known to have a high potential for pedestrian crashes in an area may improve the identification of unsafe locations for walking.

Methods to Improve Pedestrian Safety

Some pedestrian crashes are associated with deficient roadway designs, where pedestrians and motor vehicles are present. Pedestrians and

motorists often contribute to pedestrian crashes through a disregard or lack of understanding for laws and safe driving or walking behavior(1).

To be fully successful, pedestrian safety improvements require several important ingredients, including (1,2):

- Roadway and engineering measures, such as traffic-control devices and roadway design strategies implemented on streets and highways for both pedestrian and vehicular movements,
- Programs to enforce existing traffic laws and ordinances for motorists (e.g., obeying speed limits, yielding to pedestrians when turning, traffic signal compliance, obeying drunk-driving laws) and pedestrians (e.g., crossing the street at legal crossings, obeying traffic and pedestrian signals),
- Forgiving vehicle designs that minimize pedestrian injury from vehicle impact,
- Wearing reflective clothing, and materials by pedestrians and/or using a flashlight when walking at night, and
- Education programs provided to motorists and pedestrians.

Roadway improvements can often reduce the likelihood of a pedestrian crash. Physical improvements are most effective when tailored to an individual location and traffic problem. Factors to consider when choosing an improvement include: location characteristics, pedestrian and vehicle volume and types, vehicle speed, design of a given location, city laws and ordinances, and financial constraints (1,3).

It is important to remember that overuse or unjustified use of any traffic control measure is not recommended, since this may breed disrespect for such devices (4). Although facilities for pedestrians can, in many cases, reduce the risk of pedestrian collisions, crash reduction is not the only reason for providing such facilities. Traffic and transportation engineers have the responsibility for providing facilities for all modes of travel, including walking (1).

Crash Related Countermeasures

A total of 50 different pedestrian measures are presented in this guide that address various types of roadway situations. However, engineers and planners may want further guidance on which pedestrian measures are appropriate to address certain types of pedestrian crashes.

Pages 26-29 contain a matrix of 12 pedestrian crash groupings, with a list of 50 possible countermeasures. The dots in the matrix suggest the countermeasures that may be candidates to address a given crash type.

To illustrate how to use the table, consider the second crash type on the table termed "Multiple Threat". This is a crash involving an

unsignalized crossing on a multi-lane road, where one vehicle stops to let a pedestrian cross the street. The pedestrian steps into the street in front of the stopped vehicle and then continues into the adjacent lane in front of an oncoming vehicle and is struck. The driver of the second vehicle may not see the pedestrian, since the sight distance is typically blocked by the first (stopped) vehicle.

The chart shows that there are 21 potential countermeasures that may reduce the probability of this type of crash, depending on the site conditions. These countermeasures include curb extensions (which improve sight distance between pedestrians and motorists), pedestrian crossing islands (which provide a place of refuge in the middel of the street), crosswalk enhancements, and other possible countermeasures.

After the four–page countermeasure matrix, a more detailed chart is given for each crash type which shows potential countermeasures for various possible causes or problems. For example, for Crash Group 2 (Multiple Threat), two possible causes or problems contributing to this crash type include:

- Motorist sight distance of pedestrian is blocked, or
- Vehicle speeds are excessive

A different list of countermeasures is given for each of these two possible causes/problems.

These charts are intended to give general guidance on candidate measures that should be considered when trying to reduce a pattern of pedestrian crashes at a location or roadway section. Many pedestrian crashes are the direct result of careless or illegal driver behavior and/or unsafe pedestrian behavior. Many of these crashes cannot necessarily be prevented by roadway improvements alone. In such cases, pedestrian and/or motorist education and enforcement activities may be helpful.

The next chapter provides details on the 48 engineering improvements to enhance pedestrian safety and/or mobility.

Countermeasures	Midblock Dart/Dash	Multiple Threat	Midblock Mailbox Etc.	Fail to Yield (Unsignalized)	Bus Related
1. Diverter	•				
2. Full Street Closure	•				
3. Partial Street Closure	•				
4. Pedestrian Street	•			•	
5. Curb Extension	•	•		•	•
6. Choker	•				
7. Pedestrian Island	•	•		•	•
8. Chicane	•	•	•	•	
9. Mini-Circle				•	
10. Speed Humps	•		•	•	
11. Speed Table	•	•	•	•	
12. Raised Ped. Crossing	•	•		•	
13. Raised Intersection				•	
14. Gateway	•			•	
15. Landscape Options				•	
16. Paving Treatments				•	
17. Driveway Link/Serpentine				•	
18. Woonerf	•				
19. Sidewalk/Walkway					•
20. Street Furniture	•				•
21. Curb Ramp				•	
22. Crosswalk Enhancements	•	•		•	
23. Transit Stop Treatments	•	•		•	•
24. Overpass/Underpass	•	•		•	
25. Roadway Lighting	•	•	•	•	•
26. Smaller Curb Radius					

Turning Vehicle At Intersection	Through Vehicle At Intersection	Walking Along Roadway	Working/ Playing in Road	Not in Road	Backing Vehicle	Crossing Expressway
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Countermeasures	Midblock Dart/Dash	Multiple Threat	Midblock Mailbox Etc.	Fail to Yield (Unsignalized)	Bus Related
27. Bike Lane/Shoulder	•	•		•	•
28. Road/Lane Narrowing	•	•	•	•	
29. Fewer Lanes		•		•	•
30. One Way Street					
31. Driveway Improvement					
32. Right Turn Slip Lane					
33. Raised Median	•	•	•	•	
34. Modern Roundabout					
35. Modified T-Intersection					
36. Median Barrier		•		•	
37. Traffic Signal	•	•		•	•
38. Signal Enhancement	•				
39. Pedestrian Signal	•	•		•	•
40. Pedestrian Signal Timing					
41. RTOR Restriction					
42. Advanced Stop Lines		•			•
43. School Zone Improvement	•	•		•	•
44. Identify Neighborhood	•		•	•	
45. Speed Trailer	•		•	•	
46. ADA Improvement					•
47. Parking Enhancement	•		•	•	•
48. Sign Improvement	•	•	•	•	•
49. Ped/Driver Education	•	•	•	•	•
50. Police Enforcement	•	•	•	•	•

Turning Vehicle At Intersection	Through Vehicle At Intersection	Walking Along Roadway	Working/ Playing in Road	Not in Road	Backing Vehicle	Crossing Expressway
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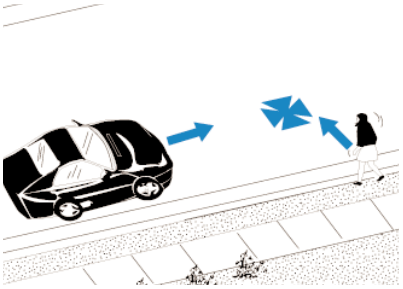
1. Midblock: Dart/Dash



Possible Cause/Problem #1

Child runs into neighborhood/collector street.

General Countermeasures

a. Implement traffic calming measures such as speed humps, speed tables or chicanes.
b. Remove or restrict on-street parking.
c. Provide adequate nighttime lighting.
d. Provide curb extensions.
e. Install spot street narrowing at high crossing midblock locations.
f. Narrow travel lanes.
g. Install street closure/diagonal diverter at selected intersection(s).
h. Provide adult crossing guard (in school zone).
i. Educate children about safe crossing behavior.
j. Add on-street bike lanes.
k. Convert street to woonerf or pedestrian street.

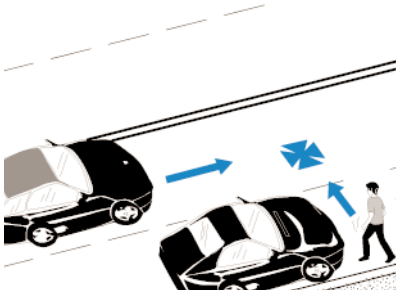
Possible Cause/Problem #2

High-speed and/or high-volume arterial street

General Countermeasures

a. Install medians or pedestrian crossing islands.
b. Provide staggered crosswalk through the median (forcing pedestrians to walk and look to the right for oncoming traffic in the second half of street).
c. Provide curb extensions at intersections or midblock to improve direct line of sight between vehicle and pedestrian.
d. Improve/add nighttime lighting.
e. Install midblock traffic signal with pedestrian signals.
f. Install overpass or underpass.
g. Remove or restrict on-street parking.
h. Enforce speed limits, pedestrian ordinances.
i. Add traffic calming measures.
j. Bus young children across busy streets or adjust school district boundaries.
k. Relocate bus stop.
l. Use speed trailer.

2. Multiple Threat



Possible Cause/Problem #1

Motorist sight distance of pedestrian is blocked.

General Countermeasures

a. Recess stop lines 30 ft. in advance of crosswalk.
b. Install traffic signals with pedestrian WALK/DON'T WALK signals.
c. Provide midblock or intersection curb extensions.
d. Install barriers or signs to prohibit crossings and direct pedestrians to safer crossing locations.
e. Provide raised crosswalks to improve pedestrian visibility.
f. Install advance warning signs or flashers.
g. Relocate bus stop.

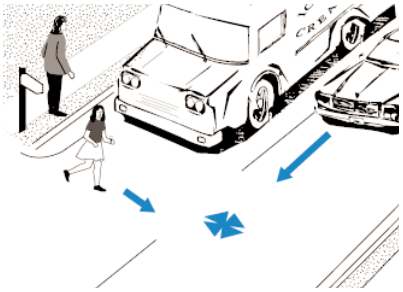
Possible Cause/Problem #2

High-speed and/or high-volume arterial street.

General Countermeasures

a. Narrow travel lanes (e.g. add bike lanes) to slow vehicle speeds and reduce crossing distance.
b. Reduce roadway width. For example, modify four-lane undivided roadways to two through lanes plus a center two-way left turn lane (with sidewalks).
c. Install traffic calming devices such as chicanes or speed tables on local or other neighborhood streets.
d. Increase police enforcement of speed limit.

3. Mailbox or Other Midblock



Possible Cause/Problem #1

Pedestrian is struck while going to/from an ice-cream vendor.

General Countermeasures

a. Adopt an Ice Cream Truck Ordinance.
b. Reduce lane or roadway width.
c. Add pedestrian crossing islands to roadway.
d. Provide traffic calming measures on local streets.
e. Create PSA's to educate parents, children, and drivers.

Possible Cause/Problem #2

Pedestrian struck while going to/from a private residence mailbox/newspaper box.

General Countermeasures

a. Relocate mailboxes to eliminate or provide safer crossings.
b. Improve nighttime lighting.
c. Provide traffic calming measures (e.g., chicanes or raised devices on residential streets).
d. Install pedestrian warning signs (see MUTCD).
e. Implement driver education program.
f. Implement pedestrian education program.

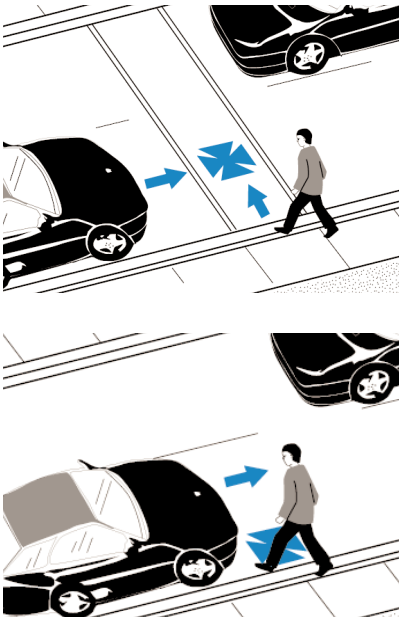
Possible Cause/Problem #3

Pedestrian struck while getting into/from parked vehicle or by emergency/speeding vehicle. Increase police enforcement of speed limit.

General Countermeasures

a. Implement speed reduction measures such as chicanes or speed tables.
b. Implement traffic calming measures on local/collector streets.
c. Restrict on-street parking.
d. Increase police enforcement of speed limit.

4. Failure to Yield at Unsignalized Location



Possible Cause/Problem #1

Motorists fail to yield to pedestrians on two-lane, low speed road crosswalks (or unmarked crossings).

General Countermeasures

a. Install raised intersection, raised crosswalk, speed table or speed humps.
b. Install overhead CROSSWALK or pedestrian warning signs.
c. Install curb extensions or street neckdowns.
d. Construct raised pedestrian crossing island.
e. Install traffic signal with pedestrian signals, if warranted.
f. Add chicane along street to slow traffic.

Possible Cause/Problem #2

Pedestrians having difficulty crossing multi-lane road.

General Countermeasures

a. Install raised medians or pedestrian crossing islands.
b. Install traffic signal with pedestrian accommodations if warranted.
c. Modify four lane undivided street to two lanes plus a two-way left turn lane (TWLTL) or median with turning pockets and bike lanes.
d. Install nighttime lighting.
e. Use police speed enforcement.
f. Use far-side bus stops.
g. Narrow lanes, reduce number of lanes and/or install bike lanes.
h. Relocate bus stops.

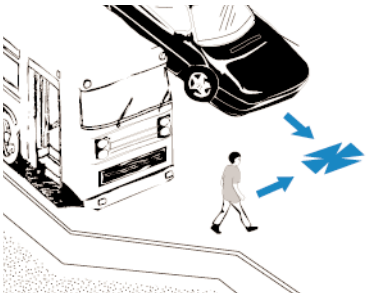
Possible Cause/Problem #3

High motorist speeds or high traffic volumes.

General Countermeasures

a. Implement traffic calming measures.
b. Narrow roadway by reducing number of lanes, reducing lane widths, and/or adding bicycle lanes.
c. Provide gateway.
d. Increase police enforcement of speed limit.
e. Construct pedestrian crossing islands.
f. Install traffic signal if warranted.
g. Install signs or sidewalk barriers to guide pedestrians to safer crossing locations.

5. Bus-Related



Possible Cause/Problem #1

Limited sight distance at intersection.

General Countermeasures

a. Move bus stop to far side of intersection.
b. Install curb extension.
c. Consider an alternative bus stop location.
d. Install pedestrian crossing islands.
e. Install or improve roadway lighting.

Possible Cause/Problem #2

Midblock location with high vehicle speeds and/or volumes.

General Countermeasures

a. Provide bus pull-off area.
b. Consider an alternative bus stop location.
c. Install midblock curb extensions.
d. Provide a sidewalk.
e. Install sidewalk barriers to direct pedestrians to a nearby crossing location.
f. Provide pedestrian education/training.
g. Add bike lanes or painted shoulder.
h. Add recessed stop lines.
i. Increase police speed enforcement.
j. Install or improve roadway lighting.

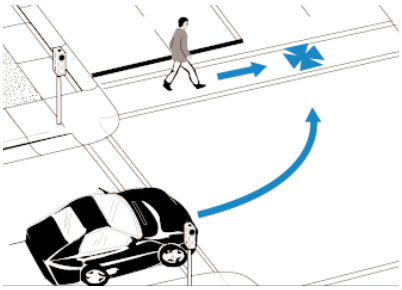
Possible Cause/Problem #3

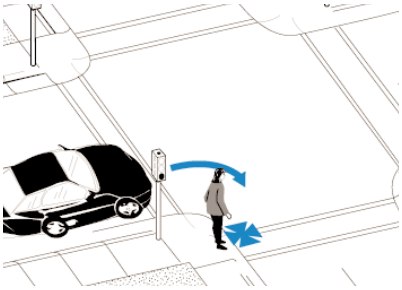
School bus stop.

General Countermeasures

a. Select safer location for school bus stop.
b. Implement pedestrian/driver education programs.
c. Involve school, neighborhood groups, and PTA in promoting enforcement and education.
d. Provide sidewalks.
e. Install or improve roadway lighting.

6. Turning Vehicle at Intersection





Possible Cause/Problem #1

Large number of pedestrians and/or left-turn vehicles.

General Countermeasures

a. Prohibit left turns.
b. Provide separate left-turn and WALK/DON'T WALK signals.
c. Add special pedestrian signal phasing (e.g., exclusive protected pedestrian signal or leading pedestrian interval).
d. Convert to one-way street network (if justified by surrounding area-wide pedestrian and traffic volume study).
e. Install warning signs for pedestrians and/or motorists (see MUTCD).
f. Develop/provide Public Safety Announcement (PSA) safety messages.
g. Add curb extensions.
h. Convert intersection to modern roundabout where all motorists turn right.

Possible Cause/Problem #2

Pedestrian crossing activity conflicting with right-turn motorists.

General Countermeasures

a. Prohibit right-turn-on-red.
b. Reduce right-turn radii.
c. Add curb extensions.
d. Improve right-turn slip lane design.
d. Install warning signs for pedestrians and/or motorists.
e. Provide leading pedestrian interval.
f. Remove intersection snow/clutter at the corner.
g. Improve intersection lighting.

Possible Cause/Problem #3

Substantial number of school children crossing and large left-turn vehicle movement.

General Countermeasures

a. Provide adult crossing guards during school crossing periods.
b. Provide police enforcement at the intersection.
c. Educate children about safe crossing behavior (e.g., using such films as "Willie Whistle" and "Keep on Looking").
d. Install pedestrian crossing islands for wide two-way streets.
e. Prohibit left turns.
f. Add exclusive pedestrian phase or leading pedestrian interval.
g. Improve intersection lighting.

Possible Cause/Problem #4

Inadequate sight distance and/or intersection geometrics.

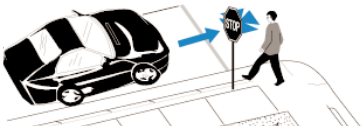
General Countermeasures

a. Remove sight obstructions and/or roadside obstacles (e.g., trees/shrubs, mailboxes, poles, newsstands, trash cans).
b. Provide special pedestrian signal phasing (e.g., exclusive protected pedestrian signal interval).
c. Install pedestrian warning signs and/or motorist regulatory signs (see MUTCD).
d. Prohibit left turns.
e. Reduce turn radius.
f. Install right turn slip lane with pedestrian safety islands.
g. Improve intersection lighting.

7. Through Vehicle at Intersection

Possible Cause/Problem #1

Pedestrians cannot see traffic signal.

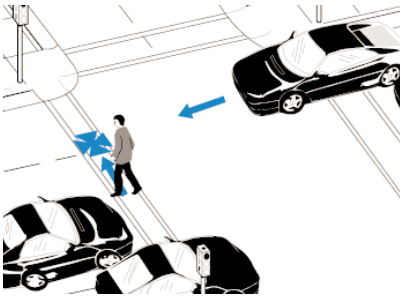


General Countermeasures

a. Install new or larger pedestrian WALK/DON'T WALK signals.
b. Move bus stop to far side of intersection.

Possible Cause/Problem #2

Children crossing in school zones.



General Countermeasures

a. Provide adult crossing guards.
b. Install pedestrian overpass or underpass.
c. Install pedestrian signals.
d. Install school regulatory flashers (e.g. SPEED LIMIT 25 MPH WHEN FLASHING).
e. Provide school zone signs and pavement markings.
f. Provide pedestrian education to students.
g. Increase police enforcement.

Possible Cause/Problem #3

Excessive delay to pedestrians prior to getting the WALK interval.

General Countermeasures

a. Retime signal to be more responsive to pedestrian needs (e.g., shorter cycle lengths or convert to fixed time operation).
b. Provide quick-response pedestrian push-buttons or automatic (e.g., microwave or infrared) detectors.
c. Install pedestrian overpass or underpass (if justified based on high pedestrian volumes with high traffic speeds or volumes).
d. Provide pedestrian crossing islands.
e. Create pedestrian street.

Possible Cause/Problem #4

Lack of pedestrian compliance with WALK phase due to other causes.

General Countermeasures

a. Retime signal to be more responsive to pedestrian needs (e.g., shorter cycle length).
b. Provide adequate WALK and clearance intervals.
c. Provide leading pedestrian interval.
d. Provide pedestrian education to students.
e. Provide adult crossing guard.

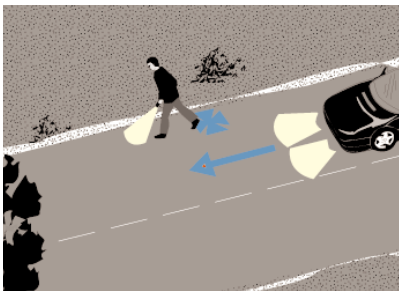
Possible Cause/Problem #5

Motorist does not see pedestrian in time to stop.

General Countermeasures

a. Remove sight obstructions.
b. Add pedestrian crossing islands or raised crosswalk.
c. Remove on-street parking near intersection (e.g. up to100').
d. Traffic calm streets if speeds are an issue.
e. Add curb extensions.
f. Construct raised intersection.
g. Improve nighttime lighting.
h. Move bus stop to far side of intersection

8. Walking Along Roadway



Possible Cause/Problem #1

Inadequate walking area.

General Countermeasures

a. Provide a sidewalk on both sides of road.
b. Provide an asphalt path.
c. Reduce number of lanes (e.g., 4 lanes to 3 lanes) and add sidewalk, planting strip, or painted shoulder.

Possible Cause/Problem #2

High vehicle speeds and/or volume.

General Countermeasures

a. Add sidewalk or walkway.
b. Provide nighttime lighting.
c. Install "Walk on Left Facing Traffic" signs.
d. Increase lateral separation between pedestrians and motor vehicles.
e. Increase police enforcement of speed limit.

Possible Cause/Problem #3

Route to school.

General Countermeasures

a. Provide sidewalks.
b. Involve school groups, and PTA in promoting enforcement and education.
c. Provide adult crossing guards.
d. Implement traffic calming at selected sites.

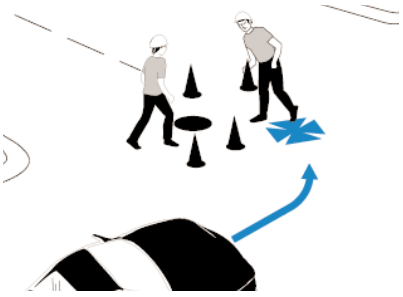
Possible Cause/Problem #4

Inaccessible sidewalk.

General Countermeasures

a. Construct wheelchair ramps.
b. Remove obstacles in sidewalk.
c. Build missing sidewalk segments.
d. Provide well–placed street furniture.

9. Working/Playing in Road



Possible Cause/Problem #1

Worker, policeman, etc. struck in roadway (arterial street).

General Countermeasures

a. Increase worker safety training.
b. Improve traffic control measures (e.g., signs and markings) warning motorists of workers' presence.
c. Provide better physical separation/protection from motor vehicles.
d. Improve nighttime lighting and retroflective materials on workers.
e. Increase police enforcement of speed limits in work zones.

Possible Cause/Problem #2

Pedestrian was struck playing on foot or on play vehicle (e.g., skateboard, wagon, sled, in-line skates)(local/collector street).

General Countermeasures

a. Provide sidewalks or walkways on both sides of street.
b. Provide community park/playground.
c. Consider street closures (full or partial).
d. Convert streets to a woonerf.
e. Implement pedestrian education program.
f. Introduce traffic calming measures (e.g., speed humps, street narrowing).
g. Improve nighttime lighting.

Possible Cause/Problem #3

Vehicle speeds are excessive on local street.

General Countermeasures

a. Narrow streets and/or travel lanes.
b. Install traffic calming such as speed humps, speed tables, mini–circles and/or chicanes.
c. Convert to driveway link/serpentine street.
d. Use speed trailers in conjunction with police enforcement.

Possible Cause/Problem #4

Disabled vehicle related (walking to/from disabled vehicle).

General Countermeasures

a. Provide sidewalks, walkways or paved shoulders.
b. Implement pedestrian/driver education program.
c. Provide adequate nighttime lighting.
d. Provide emergency phones.
e. Provide motorist assistance program.

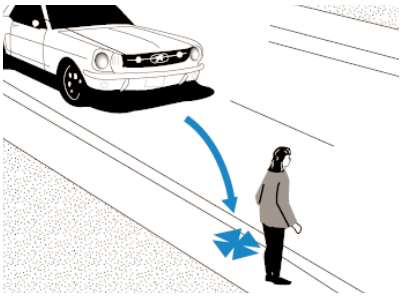
Possible Cause/Problem #5

Working on or standing by a disabled vehicle.

General Countermeasures

a. Provide paved shoulders.
b. Provide adequate nighttime lighting.
c. Teach drivers what to do if their vehicle becomes disabled

10. Not in Road (Sidewalk, Driveway, Parking Lot, or Other)



Possible Cause/Problem #1

Pedestrian was struck while waiting to cross roadway, standing at or near curb.

General Countermeasures

a. Provide sidewalks/walkways.
b. Install curb extensions for better line of sight distance between pedestrians and motor vehicles.
c. Reduce curb radii to slow turning cars and install bollards at corners.
d. Implement driver education program.
e. Install sidewalk barriers.
f. Improve nighttime lighting.
g. Provide well-designed right-turn slip lanes.
h. Increase speed enforcement.

Possible Cause/Problem #2

Pedestrian was struck in parking lot, driveway, private road, gas station, alley, etc.

General Countermeasures

a. Re-design or re-stripe parking lot to provide pedestrian access.
b. Maintain level sidewalk across driveway area.
c. Implement pedestrian education program.
d. Implement driver education program.
e. Move sidewalk farther back so that driver will have more time to stop for a pedestrian crossing a driveway.
f. Improve nighttime lighting.
g. Build/improve local parks for child activities.
h. Provide clear pedestrian path across parking lot.

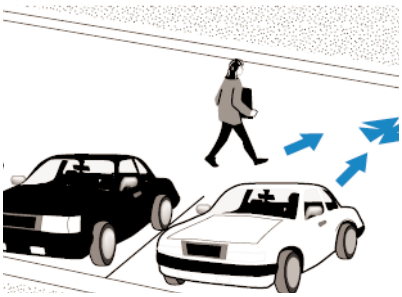
Possible Cause/Problem #3

Vehicle enters or exits a driveway or alley and strikes pedestrian.

General Countermeasures

a. Provide sidewalk or walkway.
b. Add adequate planting strip or sidewalk separation.
c. Remove sight obstructions (e.g., trim hedges or lower fencing).
d. Maintain level sidewalks across driveways or alleys.
e. Narrow driveways.
f. Provide clear walking path across driveway.
g. Remove unneeded driveways and alleys.

11. Backing Vehicle



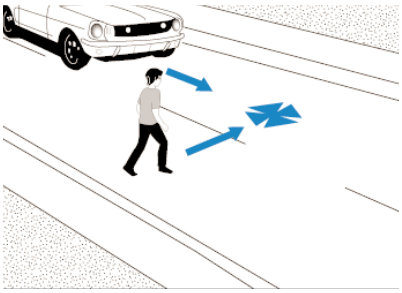
Possible Cause/Problem #1

Pedestrian struck by backing vehicle.

General Countermeasures

a. Enhance pedestrian education.
b. Enhance motorist education.
c. Provide auditory backing alert on vehicle.
d. Eliminate, modify, or relocate parking if feasible.
e. Remove unneeded driveways and alleys.
f. Remove landscaping or other sight obstruction near driveways.

12. Crossing on Expressway



Possible Cause/Problem #1

Disabled vehicle (pedestrian crosses expressway to seek help).

General Countermeasures

a. Install emergency telephones.
b. Install/upgrade roadway lighting.
c. Increase police surveillance.
d. Provide motorist assistance program.
e. Educate drivers on what to do if their vehicle is disabled.

Possible Cause/Problem #2

Pedestrians routinely cross section of expressway.

General Countermeasures

a. Install large, visible pedestrian warning signs.
b. Install/upgrade nighttime lighting.
d. Provide pedestrian overpass/underpass.
e. Install pedestrian fencing or barriers along roadway right-of-way.

13. Miscellaneous

Possible Cause/Problem #1

Pedestrian lying in road.

General Countermeasures

a. Install or upgrade nighttime lighting.
b. Increase police enforcement and surveillance.
c. Provide taxi rides home from bars.

Possible Cause/Problem #2

Emergency vehicle related.

General Countermeasures

a. Provide emergency phones.
b. Increase police surveillance.
c. Install/upgrade lighting.

Possible Cause/Problem #3

Pedestrian falls from vehicle.

General Countermeasures

a. Increase police enforcement of teens "vehicle surfing."
b. Pass/enforce laws and provide education programs against riding in back of pickup truck.

Possible Cause/Problem #4

Pedestrian standing in road prior to crash—action unknown.

General Countermeasures

a. Install/upgrade roadway lighting.
b. Provide raised median (multi-lane roads).
c. Add pedestrian crossing islands.
d. Enforce speed limit.
e. Provide safe pedestrian crossing (e.g., traffic signal).

Possible Cause/Problem #5

Pedestrian struck by driverless vehicle.

General Countermeasures

a. Require mandatory statewide vehicle inspection.
b. Address through state driver education program.

Possible Cause/Problem #6

Unknown or unusual circumstances.

General Countermeasures

a. Consider the need for basic 3E (education, enforcement and engineering) program in the area if problems persist.

Chapter 4

The Tools

Photo by

A total of 48 roadway and engineering improvements are discussed in this chapter. The categories of improvements include:

A. The Walking Environment

B. Road Design

C. Intersection Treatments

D. Traffic Calming

E. Traffic Management

F. Signs and Signals

G. Other Measures

Photo by Dan Burden

Problem Solving Methods

Pedestrians face a variety of challenges when they walk along and across streets with motor vehicles. Communities are asking for help to "slow traffic down", "make it safer to cross the street" and "make the street more inviting to pedestrians".

The following is a list of requests (objectives) that transportation professionals are likely to face when they become involved in pedestrian issues:

- Reduce Speed of Motor Vehicles
- Improve Sight Distance & Visibility for Motor Vehicles and Pedestrians
- Reduce Volumes of Motor Vehicles
- Reduce Exposure Time for Pedestrians
- Improve Pedestrian Access and mobility
- Encourage Walking by Improving Aesthetics
- Improve Compliance with Traffic Laws (motorists & pedsestrians)
- Eliminate Behaviors that Lead to Crashes (motorists & pedestrians)

Each of these objectives can be accomplished through a variety of treatments, though typically most treatments will work best when used at multiple locations or in combination with other treatments.

Additionally, many of the treatments will accomplish two or more objectives. The key is to make sure that the right treatments are chosen to accomplish the desired effect.

The chart located on the following two pages is intended to assist in the decision-making process. In using the chart, it is important to remember that it is simply a guide. In all cases, good engineering judgement should be applied when making decisions about what treatment will be best for a specific location.

Objective	A. The Walking Environment	B. Road Design	C. Intersection Treatments
1. Reduce Speed of Motor Vehicles		•Curb Radius Reduction •Add Bike Lanes •Road Narrowing •Reduce Number of Lanes •Driveway Improvements •Right Turn Slip Lanes	•Modern Roundabouts
Use in Conjunction with Other Treatments	•Street Furniture		
2. Improve Sight Distance and Visibility for Motor Vehicles and Pedestrians	•Crosswalk •Roadway Lighting	•Add Bike Lanes	
3. Reduce Volumes of Motor Vehicles		•Reduce Number of Lanes	
4. Reduce Exposure for Pedestrians	•Overpasses/Underpasses	•Road Narrowing •Reduce Number of Lanes	
5. Improve Pedestrian Access and Mobility	•Sidewalk/Walkway •Curb Ramps •Crosswalks/Enhancements •Transit Stop Treatments •Overpasses/Underpasses		
6. Encourage Walking by Improving Aesthetics	•Street Furniture •Roadway Lighting	•Medians	
7. Improve Compliance with Traffic Laws			
8. Eliminate Behaviors that Lead to Crashes			

D. Traffic Calming	E. Traffic Management	F. Signs and Signals	G. Other Measures
•Curb Extension •Choker •Chicane •Mini-circles •Speed Humps •Speed Table •Raised Pedestrian Crossing •Raised Intersection •Driveway Link/Serpentine •Woonerf •Street Trees •Paving		•Sign Improve-ments	•Speed Trailer •School Zone Improvement
•Curb Extension •Speed Table •Raised Pedestrian Crossing •Raised Intersection •Paving •Recessed Stop Lines			
•Woonerf	•Diverters •Full Street Closure •Partial Street Closure •Pedestrian Street		
•Curb Extension •Choker •Pedestrian Crossing Island		•Pedestrian Signal Timing	
		•Traffic Signals •Signal Enhancements •Pedestrian Signals •Pedestrian Signal Timing	•ADA Improvement
•Gateway •Landscaping •Paving			•Identify Neighborhoods
•Traffic Calming in general improves compliancewith speed limits			•Speed Trailer •Pedestrian/Driver Education •Police Enforcement
			•Pedestrian/Driver Education •Police Enforcement

A. The Walking Environment

Photo by Dan Burden

Walkways are the portion of the public right–of–way that provide a separated area for people traveling on foot. Walkways that are safe, accessible and aesthetically pleasing attract pedestrians. People walk for many reasons: to go to a neighbor's house, to run errands, to school, or to a business meeting. People also walk for recreation and health benefits or for the enjoyment of being outside. It is a public responsibility to provide a safe and comfortable system for all people who walk.

1. Provide Sidewalks or Walkways

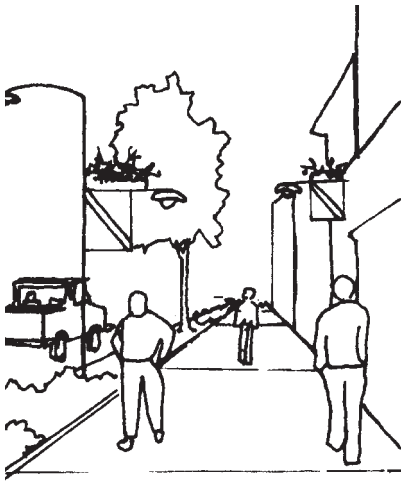
Sidewalks and walkways separate pedestrians from the roadway and provide places for children to walk, run, skate, ride bikes, and play. Sidewalks are associated with significant reductions in pedestrian collisions with motor vehicles.[1] Such facilities also improve mobility for pedestrians and should be provided for all types of pedestrian travel: to and from home, work, parks, schools, shopping areas, transit stops, etc. Walkways should be part of every new and renovated facility and every effort should be made to retrofit streets that currently do not have sidewalks.

While sidewalks are typically made of concrete, less expensive walkways may be constructed of asphalt, crushed stone, or other materials if they are properly maintained. In more rural areas in particular, a "side path" made of one of these materials may be suitable. A minimum width of 5 feet for a sidewalk or walkway allows two people to pass comfortably or to walk side by side. Wider sidewalks should be installed along schools, transit stops, in downtown areas or anywhere high concentrations of pedestrians exist.

A buffer zone of 4 to 6 feet is desirable and should be provided to separate pedestrians from the street. The buffer zone will vary according to the street type. In downtown or commercial districts a street furniture zone is usually appropriate. Parked cars and/or bicycle lanes can provide an additional buffer zone. In more suburban or rural areas, a grass strip, with or without trees, is generally most suitable. Careful planning of sidewalks and walkways is important for a neighborhood or area to provide adequate safety and mobility. Sidewalks should be continuous along both sides of a street and sidewalks should be fully accessible to pedestrians in wheelchairs. ITE guidelines recommend a minimum sidewalk width of 5 feet. Recommended guidelines and priorities for walkways are given in Appendix B.

Photo by Cara Seiderman

This sidewalk and buffer zone provides a safe place for pedestrians to walk outside the paths of vehicles in the street.



Making Streets That Work, Seattle 1996

Purpose:

- Creating the appropriate facility for the walking area of the public right-of-way.
- Improving pedestrian safety dramatically.

Considerations:

- While continuous walkways are the goal, retrofitting areas without them will usually occur in phases. Lack of a seamless system is no excuse not to provide parts of the system.
- In retrofitting places that do not have a continuous system, transit, schools, parks and public buildings should be the highest priority.
- Street furniture placement should not restrict pedestrian flow.

Estimated cost

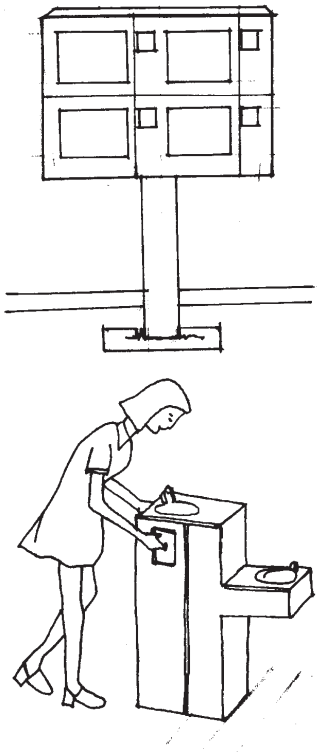
The cost for concrete curb and sidewalk is approximately $15/linear foot for curbing and $11/square foot for walkways. Asphalt curbs and walkways are less costly but require more maintenance.

2. Street Furniture/Walking Environment

Sidewalks should be continuous and be part of a system that provides access to goods, services, transit, and homes. Well designed walking environments are enhanced by urban design elements and street furniture such as benches, bus shelters, trash receptacles and water fountains.

Sidewalks and walkways should be kept clear of poles, sign posts, newspaper racks, and other obstacles that could block their paths or become a tripping hazard. Benches, water fountains, bicycle parking racks and other street furniture should be carefully placed to create an unobstructed path for pedestrians. Such areas must also be properly maintained and kept clear of debris, overgrown landscaping, tripping hazards, or areas in which water accumulates and causes problems for pedestrians.

Walking areas should also be interesting for pedestrians and provide a secure environment. Storefronts should exist at street levels and walking areas should be well lit and have good sight lines.



Making Streets That Work, Seattle 1996

Purpose:

- Enhance the pedestrian environment.
- Enliven commercial districts by fostering community life.

Considerations:

- Good-quality street furniture will show that the community values its public spaces and is more cost effective in the long run.
- Include plans for landscape irrigation and maintenance at the outset.
- Ensure proper placement of furniture; do not block pedestrian walkway or curb ramps.

Estimated cost

Varies depending on the type of furniture, the material out of which it is constructed, and the amount of plant material used.

Photo by Cara Seiderman

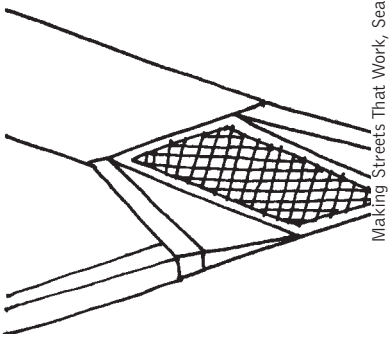
This is a good example of a street furniture zone along the sidewalk on Portland, Oregon's light rail transit line.

3. Curb Ramps

Curb ramps (wheelchair ramps) provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, hand carts, bicycles, and also for pedestrians with mobility problems who have trouble stepping up and down high curbs. Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by Federal legislation. Wheelchair ramps must have a slope of at least 12:1 (1 inch per foot or 8.33 percent) and a maximum side slope of 20:1, and must be designed in accordance with the ADA guidelines.

It is required, where feasible, to build curb ramps for each crosswalk at an intersection rather than having a single ramp at a corner for both crosswalks. This provides improved directional guidance to visually impaired pedestrians. Similarly tactile warning devices can be used to alert the visually impaired of the ramp and crosswalk. All new construction or major maintenance projects are required to include curb ramps. In addition, all agencies should upgrade existing facilities. They can begin by conducting audits of their pedestrian facilities to make sure transit services, schools, public buildings and parks, etc. are accessible to pedestrians in wheelchairs.

While curb ramps are needed for use on all types of streets, priority locations are in downtown areas and on streets near transit stops, schools, residences, medical facilities, and shopping areas.



Making Streets That Work, Seattle 1996

Purpose:

- Creates accessible sidewalks and walkways.

Considerations:

- Follow American with Disabilities Act (ADA) guidelines.

Estimated cost

The cost is approximately $800 to $1,500 per curb ramp (new or retrofitted).

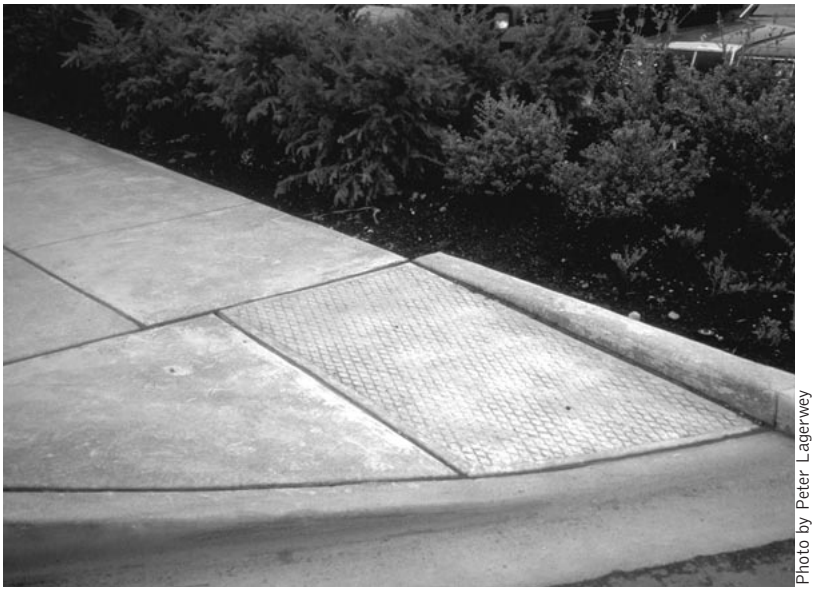


Photo by Peter Lagerwey

A curb ramp with a single apron that incorporates landscaping.

4. Marked Crosswalks and Enhancements

Marked crosswalks indicate locations for pedestrians to cross and signify to motorists to yield to them. Crosswalks are often installed at signalized intersections and other selecdted locations. Various crosswalk marking patterns are given in the MUTCD.[2] Marked crosswalks are desirable at high pedestrian volume locations to guide pedestrians along a preferred walking path. They can be raised or installed in conjunction with other enhancements that physically reinforce crosswalks and reduce vehicle speeds. It is also useful to supplement crosswalk markings with warning signs. In some locations, signs can get "lost" in visual clutter so care must be taken in placement. The most effective approach combines engineering treatments with enforcement and education.

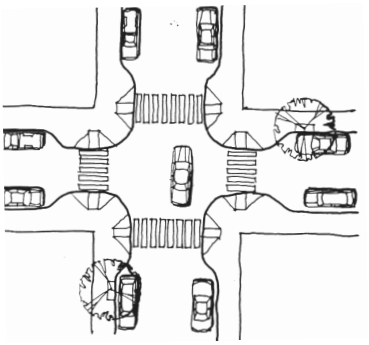
Pedestrians are sensitive to out-of-the-way travel, and reasonable accommodation should be made to make crossings both convenient and at safe locations with adequate visibility. Recommended guidelines for crosswalk installation at controlled locations are given in Appendix C. These guidelines are based on a major study of 1000 marked crosswalks and 1000 unmarked crossings in 30 US cities.[3]

Crosswalk materials

It is important to ensure that crosswalks are visible to motorists, particularly at night. Crosswalks should not be slippery or create trip hazards. Even though brick, granite, or cobblestones are aesthetically appealing materials, they are generally not appropriate for crosswalks. The best material today for marking crosswalks is inlay tape which is installed with new or repaved streets. It is highly reflective, long lasting, slip-resistant and does not require maintenance. Although initially more costly, inlay tape is more cost-effective than paint or thermoplastic in the long run.

Photo by Peter Lagerwey

The "ladder" pattern shown above is more visible to motorists and requires less maintenance if painted to allow the tires of motor vehicles to track between the paint lines.



City of Cambridge

Thermoplastic is also superior to paint, being longer lasting and more visible.

Purpose:

- Warn motorists to expect pedestrians crossing.
- Indicate preferred crossing locations.

Considerations:

- Crosswalk locations should be convenient for pedestrian access.
- Crosswalk markings alone are unlikely to significantly affect pedestrian safety. Ideally, crosswalks should be done in conjunction with other measures such as curb extensions to improve the safety of a pedestrian crossing.

Estimated cost

$100 for a regular striped crosswalk, $300 for a ladder crosswalk and $3,000 for patterned concrete crosswalk.

5. Transit Stop Treatments

Good public transportation is as important to the quality of a community as good roads. Well–designed transit routes and stops are essential to a usable system.

Bus stops should be located at intervals that are convenient for passengers. The stops should be designed to provide safe and convenient access and should be comfortable places for people to wait. Adequate bus stop signing, lighting, and a bus shelter with seating and trash receptacles are also desirable features. Bus stops should be highly visible locations where people can reach them easily on foot. Convenient crossings are also important.

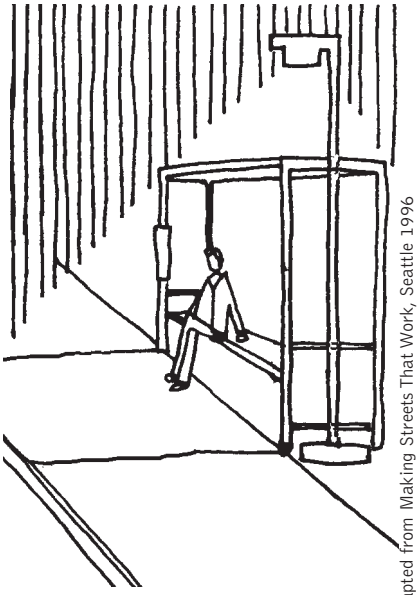
Proper placement of bus stops is a key to user safety. For example, placing the bus stops on the near side of intersections or crosswalks may block pedestrians' views of approaching traffic, and the approaching drivers' view of pedestrians. Approaching motorists may be unable to stop in time when a pedestrian steps out into traffic from behind the front of the bus.

Relocating the bus stop to the far side of the intersection can improve pedestrian safety since it eliminates the sight distance restriction caused by the bus.[4] Placing bus stops at the far side of intersections can improve motor vehicle operation but should always be placed where pedestrians can cross the roadway safely.

The bus stop location should be fully accessible to pedestrians in wheelchairs, and should have paved connections to sidewalks where landscape buffers exist. Adequate room should exist to operate wheelchair lifts.

Photo by Barbara Gray

The transit shelter above is in a lively commercial district. The shelter design reflects the surrounding architecture. Pedestrian scale lighting and landscaping add visual interest and security.



Adapted from Making Streets That Work, Seattle 1996

Purpose:

- Provide safe, convenient and inviting access for transit users.

Considerations:

- Ensure that access to and from stops is provided for when transit stops are created.
- Ensure adequate room to load wheelchairs.
- Ensure a clear and comfortable walking path for passing pedestrians when placing transit shelters.
- Locate transit stops on the far side of marked crosswalks.

Estimated cost

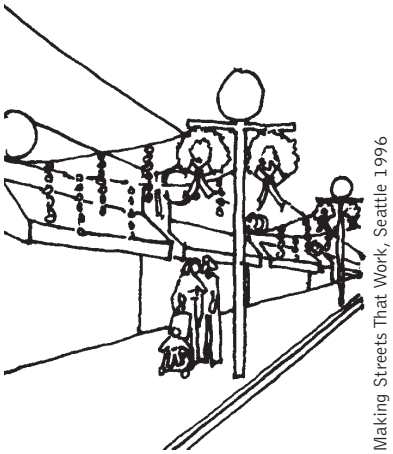
$1,000–$10,000. Cost varies widely depending on type of improvements.

6. Roadway Lighting Improvements

Good quality and placement of lighting can enhance an environment as well as increase comfort and safety. Pedestrians often assume that motorists can see them at night; they are deceived by their own ability to see the oncoming headlights. Without sufficient overhead lighting motorists may not be able to see pedestrians in time to stop.

In commercial areas with night time pedestrian activity, street lights and building lights can enhance the ambiance of the area and the visibility of pedestrians by motorists. It is best to place street lighting along both sides of arterial streets and to provide a consistent level of lighting along a roadway. Nighttime pedestrian crossing areas may be supplemented with brighter or additional lighting.

In commercial areas or in downtown areas, specialty pedestrian level lighting may be placed over the sidewalks to improve pedestrian comfort, security and safety. Mercury vapor or incandescent lighting is often preferred as pedestrian level lighting. Low pressure sodium lights are low energy use but have a high level of color distortion.



Making Streets That Work, Seattle 1996

Purpose:

- Enhance safety of all roadway users, and particularly pedestrians.
- Enhance commercial districts.
- Improve nighttime security.

Considerations:

- Ensure pedestrian walkways and crosswalks are well lit.
- Install lighting on both sides of wide streets and streets in commercial districts.
- Use uniform lighting levels.

Estimated cost

Varies depending on fixture type and service agreement with local utility.

Photo by Dan Burden

This well–lit commercial district is an attractive place to shop in the evening. The combination of pedestrian scaled street lighting, holiday lights in the trees, and light from shop windows enhances visibility and creates a secure and festive atmosphere.

7. Pedestrian Overpasses/Underpasses

Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic. However, they should be a measure of last resort, and usually it is more appropriate to use traffic calming measures or install a pedestrian activated signal. Overpasses are often suggested as a way of preventing motor vehicle flow from being impeded by pedestrian traffic and give an environment a feel more akin to a highway, which is where they are most appropriate. This is also an extremely high-cost measure.

Such a facility must accommodate all persons as required by ADA. These measures include ramps or elevators. The extensive ramping required to accommodate wheelchairs will also accommodate bicyclists, but requires long crossing distances and discourages use.

Studies have shown that many pedestrians will not use an overpass or underpass if they can cross at street level in about the same amount of time.[5, 6] Overpasses work best when the topography allows for a structure without ramps (e.g. overpass over a sunken freeway). Underpasses work best when designed to feel open and accessible. Grade separation is most feasible and appropriate in extreme cases where pedestrians must cross roadways such as highways, high speed, and high volume arterials.

Purpose:

- Providing complete separation of pedestrians from motor vehicle traffic.
- Providing crossings where no other pedestrian facility is available.
- Connecting off-road trails and paths across major barriers.

Considerations:

- Use sparingly and as a measure of last resort. Most appropriate over busy, high speed highways.
- Pedestrians will not use if a more direct route is available.
- Lighting, graffiti removal and security are also major concerns with underpasses.

Estimated cost

$500,000–$4 million depending on site characteristics.

Photo by Dan Burden

A pedestrian overpass that also provides a well-marked crossing at street level.

B. Roadway Design

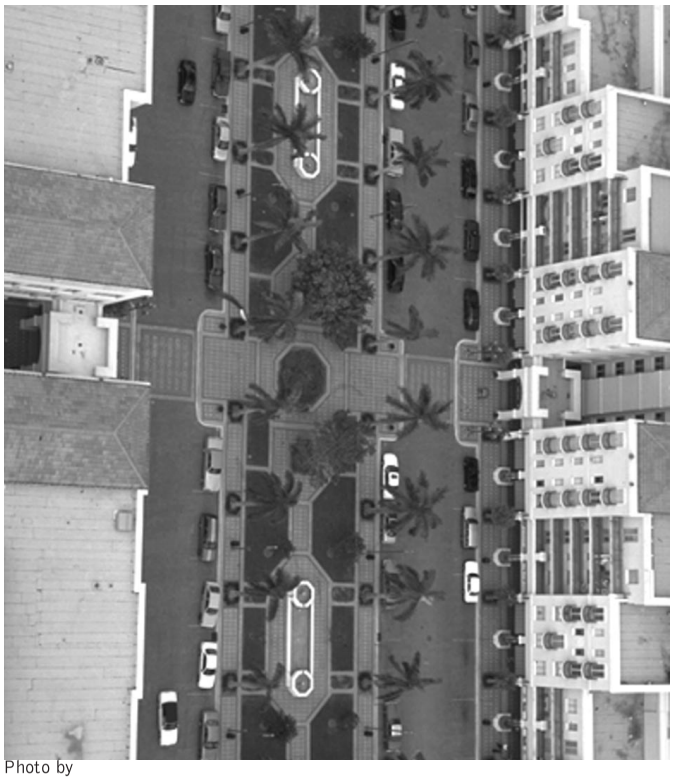


Photo by

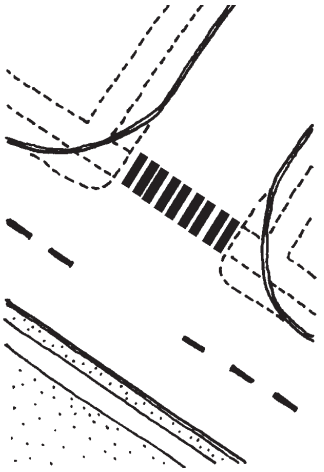
8. Curb Radius Reduction

One of the common pedestrian crash types involves a pedestrian who is struck by a right-turning vehicle at an intersection. A wide curb radius typically results in high-speed turning movements by motorists. Reconstructing the turning radius to a tighter turn will reduce turning speeds, shorten the crossing distance for pedestrians, and also improve sight distance between pedestrians and motorists.

If a curb radius is made too small, large trucks or buses may ride over the curb placing pedestrians in danger. Development type and types of road users should be considered when designing an intersection so that curb radii are sized appropriately.

Where there are no curb extensions and there is a parking and/or bicycle lane, curb radii can be even tighter, because the vehicles will have more room to negotiate the turn. Curb radii can in fact be tighter than any modern guide would allow: older cities in the Northeast frequently have radii of 2'-5' without suffering any detrimental effects.

More typically, in new construction, the appropriate turning radius is about 15' and about 25' for arterial streets with a substantial volume of turning buses and/or trucks. Tighter turning radii are particularly important where streets intersect at a skew. While the corner characterized by an acute angle may require a slightly larger radius to accommodate the turn moves, the corner with an obtuse angle should be kept very tight, to prevent high speed turns.



Making Streets That Work, Seattle 1996

Purpose:

- Safer intersection design.
- Slow right-turning vehicles.
- Improve pedestrian crossings by reducing crossing distances and improving visibility between drivers and pedestrians.
- Shorter crossing distances can lead to improved signal timing.

Considerations:

- Consider effective radius by taking into account parking and bicycle lanes.
- Make sure that public maintenance vehicles, school buses and emergency vehicles are accommodated.

Estimated cost

Construction costs for reconstructing a tighter turning radii are approximately $2,000 to $20,000 per corner, depending on site conditions.

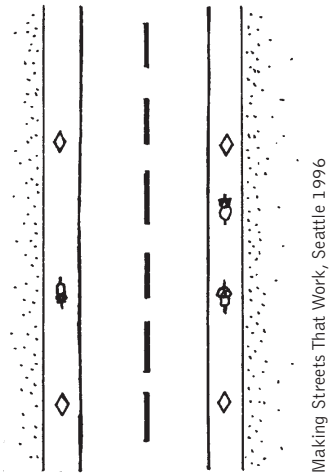
Photo by Peter Lagerwey

Tight corner radii keep turning vehicle speeds down and minimize crossing distances for pedestrians. This demonstration project uses inexpensive curbing to reduce the curb radius.

9. Adding Bicycle Lanes

Bike lanes indicate a preferential or exclusive space for bicycle travel along an arterial street. Bike lanes have been found to cause more consistent separation between bicyclists and passing motorists and have been shown to increase safety for cyclists. Marking bicycle lanes can also benefit pedestrians - as turning motorists slow and yield more to cyclists, they will by default also be doing so for pedestrians.

Bike lanes are typically designated by striping and/or signing, although colored pavement (e.g., blue or red bike lanes) has also been used in certain situations. As striping bike lanes reduces the space dedicated to motor vehicles, safety may be enhanced for pedestrians who wish to cross the street. Bicycle lanes also provide a buffer between motor vehicle traffic and pedestrians when sidewalks are immediately adjacent to the curb.



Making Streets That Work, Seattle 1996

Purpose:

- Create on-street travel facilities for cyclists.
- Narrowing the roadway may reduce motor vehicle speeds.
- Provide additional separation between pedestrians and motor vehicles.
- Adding on-street lanes reduces the effective crossing distance for pedestrians.

Considerations:

- All roads should be evaluated for adequate bicycle facilities.

Estimated cost

The cost of installing a bike lane is approximately $5,000 to $50,000 per mile, depending on the condition of the pavement, the extent of removing and repainting of lane lines, the need to adjust signalization, and other factors. The best time to create bicycle lanes is during regular street reconstruction, street resurfacing or at the time of original construction.

Photo by Cara Seiderman

A well-marked bicycle lane and bicycle parking in Cambridge, Massachusetts.

10. Roadway Narrowing

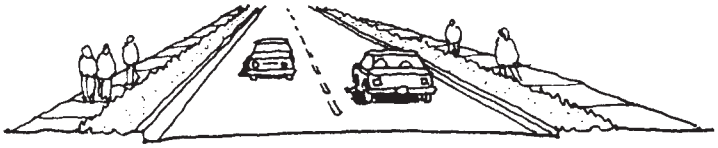
Roadway narrowing can be achieved in several different ways:

1) Lane widths can be reduced (to 9, 10, or 11 feet) and excess asphalt striped with a bicycle lane or paved shoulders;

2) Travel lanes can be removed (see #11); or,

3) the street can be physically narrowed by extending sidewalks, landscaped areas, or by adding on-street parking within the former curb lines.

This can reduce vehicle speeds along a roadway section and enhance movement and safety for pedestrians. Bicycle travel will also be enhanced and bicyclist safety improved when bicycle lanes are added.



Before

After

Sketches by Michael Kimelberg

Photo by Dan Burden

Colored asphalt has been used to identify bike lanes on this street in Holland. The bike lanes visually narrow the street and help reduce speeds. Although the curb to curb width is more than thirty feet, the motorist only sees 11 feet of driving space.

Purpose:

- Multiple benefits in terms of reducing speeds, increasing safety, and redistributing space to other users.

Considerations:

- Bicyclists must be safely accommodated. Bike lanes or wide curb lanes are needed if motor vehicle volumes and/or speeds are high.
- Road narrowing must consider school bus and emergency service access, and truck volumes.
- Evaluate if narrowing may encourage traffic to divert to other local streets in the neighborhood.

Estimated cost

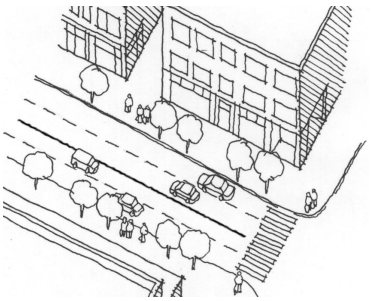
Adding striped shoulders or on-street bike lanes can cost as little as $1000 per mile if the old paint does not need to be changed. The cost for restriping a mile of street to bike lanes or reducing the number of lanes to add on-street parking is $5,000–$10,000 depending on the number of old lane lines to be removed. Constructing a raised median or widening a sidewalk can cost $100,000 or more per mile.

11. Reducing Number of Lanes

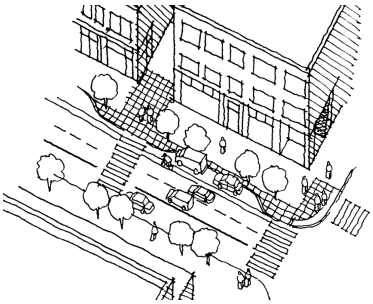
Many roads have more travel lanes than necessary. Reducing the number of lanes on a multi-lane roadway can reduce crossing distances for pedestrians and slow vehicle speeds. A traffic analysis should be done to determine if the number of lanes of roadways - many of which were built without such an analysis - is appropriate. Level of service analysis for intersections should not dictate the design for the entire length of a roadway. For example, a four lane undivided road can be converted to one through lane in each direction with a center left turn lane or with a raised median and turn pockets and bicycle lanes on both sides of the roadway. Turning pockets may be needed only in specific locations.

Depending on conditions, it may also be possible to add on-street parking while allowing for bicycle lanes on both sides of the street - instead of a center turn lane. If no sidewalks exist on the roadway, these should be added. If sidewalks exist, and there is adequate room, a landscaped buffer is desirable to separate pedestrians from the travel lane.

A typical three-lane configuration (two travel lanes and a center turn lane) has advantages for motorists also: through traffic can maintain a fairly constant speed, while left-turning drivers can enter the center turn lane to wait, out of moving traffic.



Before



After

Photo by Cara Seiderman

This street in Cambridge, MA was reduced from four lanes to three. The conversion introduced wider sidewalks, additional space for landscaping, street furniture and cafes, and bicycle lanes.

Purpose:

- Remedy a situation where there is excess capacity.
- Provide space for pedestrians, cyclists and parkers.
- Reduce crossing width and help optimize signal timing.

Considerations:

- A traffic analysis should segregate intersection capacity needs from through capacity needs to determine overall design.
- Select routes with minimal out-of-direction travel, and less need to walk along a busy street.
- Ensure street connections so major arterials can be crossed at controlled intersections.
- Cluster development in nodes that are accessible to transit.

Estimated cost

The cost for restriping a mile of four-lane street to one lane in each direction plus a two-way left-turn lane and bike lanes is about $5,000–$20,000 per mile, depending on the amount of removing and repainting lane lines required. The estimated cost of extending sidewalks or building a raised median is much higher and can cost $100,000 per mile or more.

If a reconfiguration is done after repaving or overlay for maintenance, and no curbs are changed, there is no cost for the change.

12. One–Way/Two–Way Street Conversions

One–way streets can simplify crossings for pedestrians, who must look for traffic in only one direction. While studies have shown that conversion of two–way streets to one-way generally reduces pedestrian crashes, one–way streets tend to have higher speeds which creates new problems. If a street is converted to one–way, it should be evaluated to see if additional changes should be made, especially if the street or lanes are overly wide. Also, traffic circulation in the broader area must be carefully considered before conversion to one-way streets.

As a system, one–way streets can increase travel distances of motorists and create some confusion, especially for non-local residents. One-way streets operate best in "pairs," separated by a block to no more than one-quarter mile. Conversion costs can be quite high to build "crossovers" where the one-way streets convert back to two-way streets, and to rebuild traffic signals and revise striping, signing and parking meters.

One-way streets work best in downtown or very heavily congested areas. One-way streets can offer improved signal timing and accommodate odd-spaced signals, but signal timing for arterials that cross a one-way street pair is difficult.

Conversions can go the other way as well: some places are returning one–way streets back to two–way to allow better local access and to slow traffic. Two–way streets tend to be slower due to "friction," especially on residential streets without a marked center line.

Purpose:

- Managing traffic patterns.
- Reducing conflicts.
- A one–way to two–way conversion will generally reduce speeds.

Considerations:

- Consider impacts on other streets.
- Be careful not to create speeding problems where a two–way is changed to a one–way. Redesign or traffic calming measures may be required to address this.

Estimated Cost:

$20,000–$200,000 depending on length of treatment and if the conversion requires modification to signals.

Photo by Cara Seiderman

Cars are forced to drive slowly on this two-way street with parking.

13. Driveway Improvements

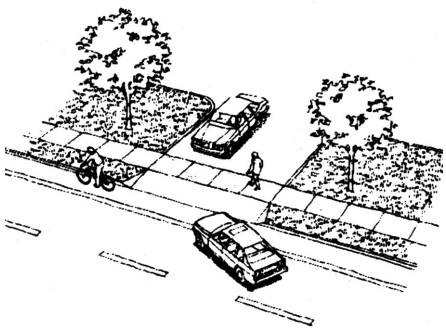
Several driveway designs may cause safety problems for pedestrians, including excessively wide and/or sloped driveways, driveways with wide turning radii, multiple adjacent driveways, driveways that are not well defined, and driveways where motorist attention is focused on finding a gap in congested traffic.

Examples of driveway improvements include narrowing or closing driveways, tightening turning radii, converting driveways to right-in/out only movements, and providing median dividers on wide driveways.

When driveways cross sidewalks, it is preferable to maintain the sidewalk level across the driveway (see sketch). This is more comfortable for pedestrians and makes it clear to motorists that they must watch for pedestrians. It is important to minimize large signs and bushes at driveways to improve the visibility between motorists and pedestrians. The sidewalk material (usually concrete) should be maintained across the driveway as well.

Photos by Peter Lagerwey

The driveways pictured above demonstrate how to provide driveway access across a sidewalk while maintaining a continuous, level walkway for pedestrians. The top example shows a driveway with a wide apron to accommodate a landscaped planting strip.



Pedestrian Facilities Guidebook, Washington State, 1998

Purpose:

- Reduce pedestrian/ motor vehicle conflicts.
- Improve access for people with disabilities.
- Improve visibility of cars and pedestrians at driveways.

Considerations:

- It is best to design driveways well at the outset. Local regulations can require appropriate design when driveways are created.

Estimated cost

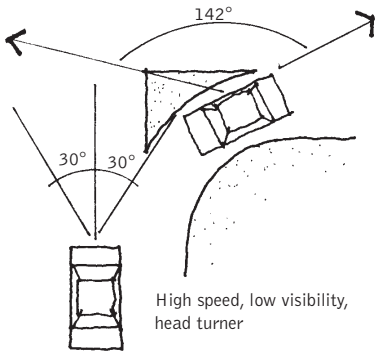
No additional cost if part of original construction.

14. Well Designed Right–Turn Slip Lanes

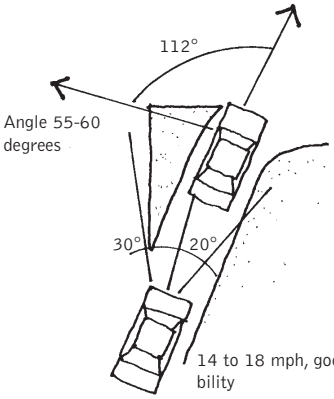
Intersections should be designed to accommodate safe pedestrian crossings using tight curb radii, shorter crossing distances, and other tools as described in this document. While right-turn slip lanes are generally a negative facility from the pedestrian perspective due to the emphasis on easy and fast vehicle travel, they can be designed to be less problematic. At many arterial street intersections, pedestrians have difficulty crossing due to right turn movements and wide crossing distances. Well designed right-turn slip lanes provide pedestrian crossing islands within the intersection and a right-turn lane that is designed to optimize the right turning motorist's view of the pedestrian and of vehicles to their left. Pedestrians are able to cross the right-turn lane and wait on the refuge island for their walk signal.

The problem for pedestrians is that many slip lanes are designed for unimpeded vehicular movement. Islands for the right-turn slip lanes should be designed instead to discourage high-speed turns, while accommodating large trucks and buses. The triangular "porkchop" island that results should have the "tail" pointing to approaching traffic. Since the traffic signal is timed based on a shorter crossing, the pedestrian crossing time has much smaller influence on the timing of the signal. This design has an additional advantage for the pedestrian; the crosswalk is located in an area where the driver is still looking ahead. Older designs place the crosswalk too far down, where the driver is already looking left for a break in the traffic.

Current AASHTO Standard



Recommended Design



Sketches by Michael Kimelberg

Photo by

Well designed slip lanes at a busy, wide intersection. The crosswalks are located to allow the greatest visibility between the drivers and pedestrians.

Purpose:

- Separate right–turning traffic.
- Recommended design can slow turning vehicle speeds and improve safety.
- Recommended design allows drivers to see approaching cross street traffic more clearly.

Considerations:

- Evaluate first whether a slip lane is really necessary.

Estimated Cost:

Approximately $50,000–$200,000 to reconfigure roadway, add striping and construct an island.

15. Raised Medians

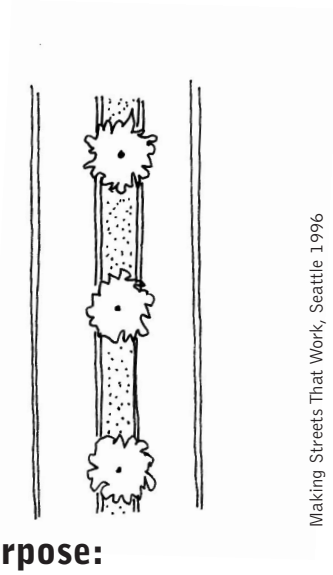
Medians – raised barriers in the center portion of the street or roadway - are appropriate in some locations and not appropriate in others. They are a pedestrian benefit, because they can serve as a place of refuge for pedestrians who cross a street midblock or at intersections. They provide space for street trees and other landscaping which, in turn, can help reduce speeds by changing the character of a street. They also have benefits for motorist safety when they replace center turn lanes. Desired turning movements need to be carefully provided so that motorists are not forced to travel on inappropriate routes such as residential streets or an unsafe U-turn condition is not created.

Continuous medians may not be the most appropriate treatment in every situation. In some cases, they can increase traffic speeds by decreasing the perceived friction through separating traffic flow directions. They may also take up space that can be better used for wider sidewalks, bicycle lanes, landscaping buffer strips, or on-street parking. In some environments, medians can be constructed in sections creating an intermittent rather than continuous median. Another good alternative device for two, three or four lane roads is the crossing island, which provides the crossing refuge for pedestrians, and in some designs, aids in decreasing vehicle speeds.

Raised medians are most useful on high volume, high speed roads.

Photo by Dan Burden

Used in combination with bike lanes, this landscaped median in Seattle, Washington converted this 4 lane street to one lane in each direction that is pleasant for walking, bicycling and driving.



Making Streets That Work, Seattle 1996

Purpose:

- Manage motor vehicle traffic and provide comfortable left-hand turning pockets with fewer or narrower lanes.
- Provide a refuge for pedestrians crossing the street.
- Provide space for street trees and other landscaping.

Considerations:

- Consider crossing islands if cost is an issue or space is limited.
- Ensure there is enough room for wider sidewalks, bike lanes and planting strips before proceeding with construction.
- Landscaping in medians should not obstruct the visibility between pedestrians and approaching motorists.
- Midblock crossings must be fully wheelchair accessible.

Estimated Cost:

The cost for adding a raised median is approximately $15,000 to $30,000 per 100 feet, depending on the design, site conditions, and whether the median can be added as part of a utility improvement or other street construction project.

C. Intersection Treatments

Photo by

16. Roundabouts

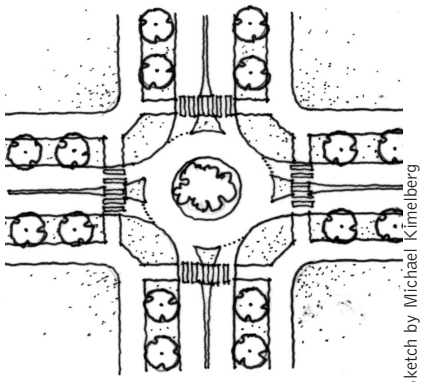
A modern roundabout is built with a large, circular, raised island located at the intersection of an arterial street with one or more crossing roadways and may take the place of a traffic signal. As with a traffic mini-circle, traffic maneuvers around the circle in a counter clockwise direction, and then turns right onto the desired street. All traffic yields to motorists in the circle and left-turning movements are eliminated. Unlike a signalized intersection, vehicles generally flow and merge through the roundabout from each approaching street without having to stop. Splitter islands at the approaches slow vehicles and allow pedestrians to cross one lane at a time.

The roundabout needs to be constructed to accommodate the needs of pedestrians and bicyclists. Pedestrians may need to travel out of their way to cross the intersection, but generally have a shorter wait than with a signal and have only one direction of approaching traffic to watch for. Unfortunately, visually impaired people have difficulty crossing at roundabouts. This issue needs to be adequately addressed in the design of roundabouts.

Bicyclists usually suffer the most from roundabout design. Unless the road is very narrow (one lane in each direction), speeds very slow, and traffic very light, bicyclists may not be able to share the road comfortably. Marking bicycle lanes through the roundabout has not always been shown to be safer. In larger roundabouts, an off-road bicycle path should be created to direct cyclists to follow the pedestrian route; while this is usually inconvenient and takes longer, it is generally safer.

Photo by Dan Burden

This Fort Pierce, Florida roundabout was constructed to reduce speeding, improve safety, and enhance the aesthetics of the community.



Sketch by Michael Kimelberg

Purpose:

- Provides good traffic management where the existing intersection is large, complex, and/or has more than 4 approach legs.
- Replaces a signalized intersection that is experiencing heavy traffic backup and congestion.
- Slows speeds at an intersection.
- Creates a gateway into an area.

Considerations:

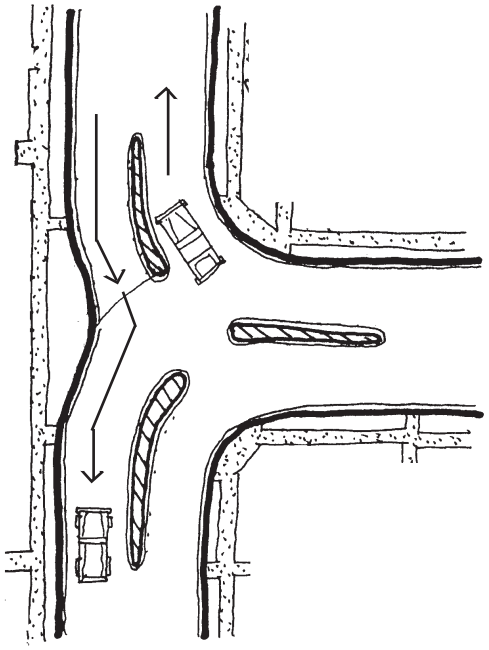
- Street widths and/or available right-of-way need to be sufficient to accommodate a properly designed roundabout.
- Roundabouts have a mixed record regarding bicyclist safety – low design speed required.
- Roundabouts are generally not appropriate if traffic volumes are extremely high.
- Roundabouts often work best where there is a high percentage of left-turning traffic.
- Deflection on each leg of the intersection must be set to control speeds to 15-18 mph.

Estimated cost

The cost for a landscaped roundabout varies widely and can range from $45,000-$150,000.

17. Modified T–Intersection

This design treatment is intended for certain T-intersections in residential areas where there is a need to reduce speeds of through traffic. It involves a gradual curb extension or bulb at the top of the T such that vehicles are deflected slightly as they pass straight through the intersection (see diagram). This type of design can help to discourage cut through traffic in a neighborhood and reduce speeds at the intersections. If not properly designed, it can create confusion regarding priority of movement. Consider a mini–circle before installing this treatment.



A modified T-intersection in Portland, Oregon.

Purpose:

- Reduce vehicle speeds through a T–intersection on a residential street.
- Used when vehicle volumes are low to moderate.

Considerations:

- Don't use this treatment if the main movement at the intersection is intended to connect local streets.
- A mini–traffic circle may accomplish the same objective and will be much less costly.
- If designed to eliminate some turning movements, the affected neighborhood residents should be consulted for input and an analysis of traffic patterns done to ensure that through traffic would not be diverted inappropriately.
- Pedestrian access must be accommodated through the islands.

Estimated cost

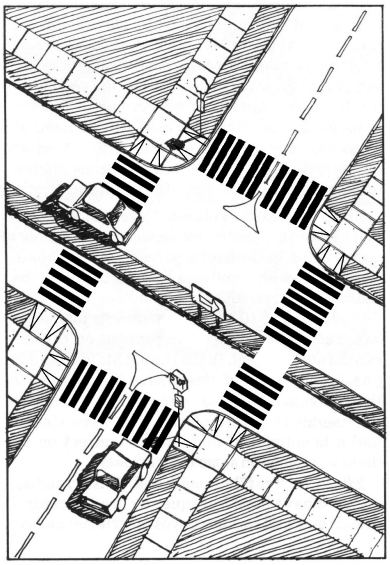
$30,000- $60,000 depending on the design.

18. Intersection Median Barriers

This shortened version of a raised curb median extends through the intersection a distance adequate to prevent cross street through movements and left turning movements to cross streets from the main street.

This treatment can benefit pedestrians who need to cross any leg of the intersection and restricts vehicle entry into and out of neighborhoods and can therefore greatly reduce cut through traffic. This is also a traffic management technique.

Cut–through for cyclists should also be incorporated into the design.



Purpose:

- To reduce cut through traffic on a neighborhood street.

Considerations:

- Local residents need to be provided access so they do not have to drive excessive distances to access their homes.
- An analysis of traffic patterns should be done to ensure that cut through traffic would not be diverted to a nearby street.
- Design should ensure safe and convenient bicycle and pedestrian access.
- Ensure that emergency access is not negatively impacted. Some designs (e.g. high mountable curbs) may allow fire truck access while inhibiting cars.

Estimated cost

$10,000 - $20,000

Photo by Dan Burden

Intersection median barriers need to keep a free-flow of walking and bicycling through the neighborhood.

D. Traffic Calming

Traffic calming is a way to design streets, using engineering principles, to encourage people to drive more slowly. It creates physical and visual cues that induce drivers to travel at appropriate speeds. Traffic calming is self-enforcing. The design of the roadway results in the desired effect, without reliance on enforcement or voluntary compliance. Traffic control devices such as signals and signs rely on compliance. While elements such as landscaping and lighting do not force a change in driver behavior, they do provide the visual cues that encourage people to drive more slowly.

The reason traffic calming is such a powerful and compelling tool is that it has proven to be so effective. Some of the goals of traffic calming are clearly measurable such as increasing safety through fewer and less severe crashes. Others such as supporting community and livability - are less tangible but equally important.

Numerous studies throughout Europe, Australia and North America have shown that traffic calming reduces traffic speeds, the number and severity of crashes, and noise levels. In the Netherlands, an evaluation of 44 redesigned roads found a 72 percent reduction in the frequency of crashes. Extensive studies in Germany, France and Britain show speed and/or crash reductions of 30 percent-53 percent.[7] In Vancouver, BC, an analysis of traffic calming in four neighborhoods quantified the substantial economic benefits arising from fewer crashes. These included reductions in police, fire, hospital, and insurance costs. Conversely, higher speeds have a negative effect: an increase in the average speed of motor vehicle traffic by 1 km/hour increases the number of injury crashes by approximately 3 percent and increases crash related costs by approximately 6 percent.[8]

There are certain overall considerations that are applicable to both traffic management and traffic calming:

- In terms of safety, speed is more critical than volume and should be addressed first where there are monetary constraints.
- Neighborhood involvement is important to successful implementation. Please see Chapter 5: Implementation and Resources for a discussion of public process.
- Traffic calming and management measures should fit into and preferably enhance, the street environment.
- Traffic calming and management measures should make sense.
- Traffic calming designs should be predictable rather than random, and easy to understand by drivers and other users.
- Devices that meet multiple goals are usually more acceptable. For example, a raised crosswalk is more understandable to motorists than a speed hump. The former has a clear goal whereas the latter may be perceived as a nuisance.

Photo by Peter Lagerwey

This midblock crossing is in Kalamazoo, Michigan. The landscaping and textured crosswalk are visually appealing and provide a clear message about where pedestrians can be expected to cross the street.

The Institute of Transportation Engineers has arrived at the following definition of traffic calming, which is often used in the United States:

Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users

- Devices need to be well designed and be based on current available information on their applications and effects. Information of U.S. experiences with various traffic calming measures are found in ITE's "Traffic Calming: State of the Practice."[9]
- Traffic calming areas or devices should be adequately signed, marked and lit to be visible to motorists.
- Devices need to be spaced appropriately to have the desired effect on speed - too far apart and they will have limited effect, too close and they will be an unnecessary cost and annoyance. Devices usually need to be spaced about 300-500 feet apart. If they are spaced too far apart, motorists may speed up between them. This is particularly the case where the devices are added onto the street, e.g., speed humps. Whole street designs are usually able to create an environment that supports slower speeds for the entire length.
- Devices should not be under–designed, or they will not work. Keeping the slopes too gradual for a speed table or curves too gentle for a chicane will not solve the problem and will appear as a waste of money and may ruin chances for future projects.
- If a measure is likely to divert traffic, the area-wide street system should be considered so as not to shift the problem from one place to another.

Traffic calming tools may be used in combination, and are often most effective this way. The tools in this guide are organized into the following categories:

- Roadway narrowing
- Lateral or horizontal shifts in the roadway
- Raised devices (vertical devices)
- Complementary tools (landscaping and paving)
- Whole street designs

Some tools fall into multiple categories, but for simplicity are listed only once.

Trials and Temporary Installations for Traffic Calming

In communities trying traffic calming for the first time, it may be useful to lay out a new design with cones or temporary markings to test it. This provides emergency vehicle drivers, residents and others with an opportunity to test the design to assure that they are comfortable with it. Some communities have constructed elaborate temporary devices with concrete ("jersey") barriers, or plastic barriers. These can instill a negative reaction in the community due to their unaesthetic nature. They do not generally have any significant benefits over the simpler test run devices, and it is better to go straight to a final product, which is more appropriate for a neighborhood setting.

Traffic calming improvements need to include input from and coordination with neighborhoods which are impacted

Photo this page by Dan Burden

19. Curb Extensions

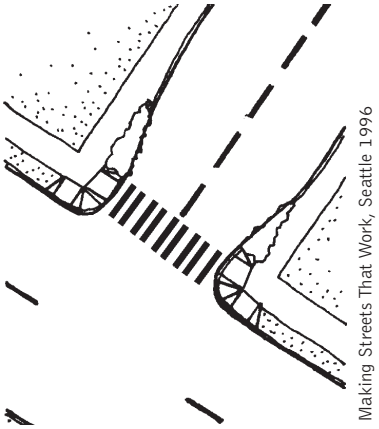
Curb extensions - also known as bulb-outs or neckdowns - extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. Curb extensions significantly improve pedestrian crossings by reducing the pedestrian crossing distance, improving the ability of pedestrians and motorists to see each other, and reducing the time that pedestrians are in the street.

Curb extensions placed at an intersection essentially prevent motorists from parking in or to close to a crosswalk or from blocking a curb ramp. Motor vehicles parked at corners present a threat to pedestrian safety, as they block sight lines, obscure visibility of pedestrians and other vehicles, and make turning particularly difficult for emergency vehicles and trucks. Motorists are encouraged to travel more slowly at intersections or midblock locations with curb extensions, as the restricted street width sends a visual cue to motorists. Turning speeds at intersections are reduced with curb extensions (curb radii should be as tight as is practicable).

Curb extensions are only appropriate where there is an on-street parking lane. Curb extensions must not extend into travel lanes, bicycle lanes or shoulders). The turning needs of larger vehicles such as school buses need to be considered in curb extension design.

Photo by Dan Burden

This curb extension in Venice, Florida reduced motorists turning speeds by 6–8 MPH. Pedestrian crossing distance and time exposed to traffic was also reduced.



Making Streets That Work, Seattle 1996

Purpose:

- Improves safety for pedestrians and motorists at intersections; increases visibility and reduces speed of turning vehicles.
- Encourages pedestrians to cross at designated locations.
- Prevents motor vehicles from parking at corners.

Considerations:

- Curb extensions should typically be used where there is a parking lane, and where transit and cyclists would be traveling outside the curb edge for the length of the street.
- Midblock extensions provide an opportunity to enhance midblock crossings. Care should be taken to insure that street furniture and landscaping do not block motorists' views of pedestrians.
- Where intersections are used by significant numbers of trucks or buses, the curb extensions need to be designed to accommodate them. However, it is important to take into consideration that those vehicles should not be going at high speeds, and most can make a tight turn at slow speeds. It is

Photo by Peter Lagerwey

A curb extension on an arterial street in Seattle, Washington. The crossing distance for pedestrians is substantially reduced by the installation of this device.

Photo by Peter Lagerwey

A curb extension on a residential street, also in Seattle, Washington. In addition to improving pedestrian safety at this intersection, the bulb provides additional sidewalk space for a bicycle rack.

also not always necessary for a roadway to be designed so that a vehicle be expected to turn from right lane to right lane - i.e., the vehicles can often encroach into adjacent lanes safely where volumes and/or speeds are slow. Keep in mind that speeds should be slower in a pedestrian environment.

- Emergency access is often improved through the use of curb extensions, as intersections are kept clear of parked cars. Fire engines and other emergency vehicles can climb a curb where they would not be able to move a parked car. In addition, at mid-block locations, curb extensions can keep fire hydrants clear of parked cars and make them more accessible.
- Curb extensions can be used to place landscaping and street furniture; this is especially beneficial where sidewalks are otherwise too narrow.

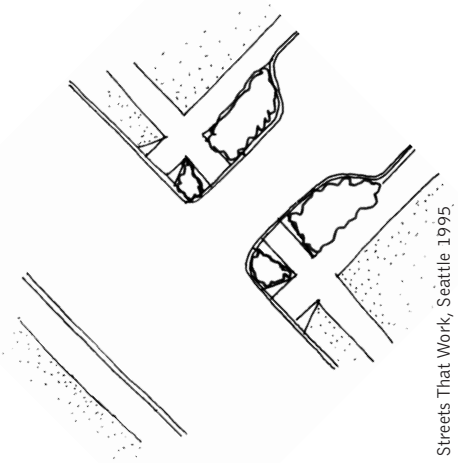
Estimated Cost

Curb extensions cost from $2,000 to $20,000 per corner, depending on design and site conditions. Drainage is usually the most significant determinant of costs. If the curb extension area is large and special pavement and street furnishings and planting are included, costs would also be higher. Costs can go up significantly if something major such as a mast arm or controller box is moved.

20. Choker

Chokers are curb extensions that narrow a street by widening the sidewalks or planting strips, effectively creating a pinch point along the street. Chokers can be created by bringing both curbs in, or they can be done by more dramatically widening one side at midblock locations. They can also be used at intersections, creating a gateway effect when entering a street.

Chokers can have a dramatic effect by reducing a two-lane street to one lane at the choker point, requiring motorists to yield to each other. In order for this to function effectively, the width of the travelway cannot be wide enough for two cars to pass: 12' is generally effective (and will allow emergency vehicles to pass unimpeded). This kind of design is usually only appropriate for low volume, low speed streets.



Making Streets That Work, Seattle 1995

Purpose:

- Slows vehicles at a mid-point along the street.
- Creates a clear transition between a commercial and a residential area.
- Narrows overly wide intersections, and midblock areas of streets.
- Adds room along the sidewalk or planting strip for landscaping or street furniture.
- Reduces cut-through traffic.

Considerations:

- If two travel lanes are maintained on a two-way street and/or the travel lane widths are unchanged (at the location of the choker), it will have a minimal effect on speed.

Estimated cost

$5,000-$20,000 depending on site conditions and landscaping. Drainage may represent a significant cost.

Photo by Dan Burden

This choker on a two-way roadway in Seattle, Washington narrows the street from two lanes to one. Traffic is forced to slow, and in some cases wait for an approaching vehicle to pass before proceeding.

21. Crossing Islands

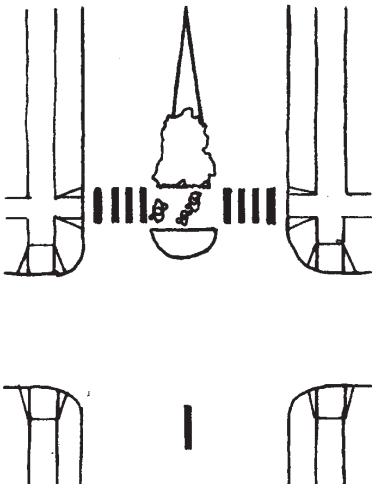
Crossing islands–also known as center islands, refuge islands, pedestrian islands or median slow points–are raised islands placed in the center of the street at intersections or midblock to help protect crossing from motor vehicles. Center crossing islands allow pedestrians to deal with only one direction of traffic at a time, and enable them to stop part–way across the street and wait for an adequate gap in traffic before crossing the second half of the street. Where midblock or intersection crosswalks are installed at uncontrolled locations (i.e.,where no traffic signals or stop signs exist), crossing islands should be considered as a supplement to the crosswalk. They are also appropriate at signalized crossings. If there is enough width, center crossing islands and curb extensions can be used together to create a highly improved pedestrian crossing.

This kind of facility has been demonstrated to decrease the percentage of pedestrian crashes and casualties by 57–82 percent.[10] The factors contributing to pedestrian safety include reduced conflicts, reduced vehicle speeds approaching the island (if designed as such the approach can be designed to force a greater or lesser slowing of cars, depending on how dramatic the curvature is), greater attention called to the existence of a pedestrian crossing, opportunities for additional signage in the middle of the road, and reduced exposure time for the pedestrians.

Curb extensions may be built in conjunction with center crossing islands where there is on–street parking, Care should be taken to maintain bicycle access. Bicycle lanes (or shoulders, or whatever space is being used for bicycle travel) must not be eliminated or squeezed in order to create the curb extensions or islands.

Photo by

Crossing islands allow pedestrians to be concerned with one direction of traffic at a time. The roadway markings and the deviation of the travel lane in the design shown here help make motorists aware that a pedestrian may be crossing.



Making Streets That Work, Seattle 1996

Purpose:

- Enhances pedestrian crossings, particularly at unsignalized crossing points.
- Reduces vehicle speeds approaching pedestrian crossings.
- Highlights pedestrian crossings.

Considerations:

- Do not squeeze bicycle access.
- Illuminate or highlight islands with signs and reflectors to ensure that motorists see them.
- Design islands to accommodate pedestrians in wheelchairs. A cut-through design such as depicted in the diagram works best.
- Crossing islands at intersections or near driveways may affect left turn access.

Estimated cost

Costs range from $6,000 - $9,000. The cost for installing a raised concrete pedestrian refuge island (with landscaping) is about $10,000 to $30,000. The cost is less for an asphalt island or one without landscaping.

22. Chicanes

Chicanes create a horizontal diversion of traffic and can be gentler or more restrictive depending on the design.

Diverting the path of travel. Shifting a travel lane has an effect on speeds as long as the taper is not so gradual that motorists can maintain speeds. For calming, the taper lengths may be as much as half what is suggested in traditional highway engineering.

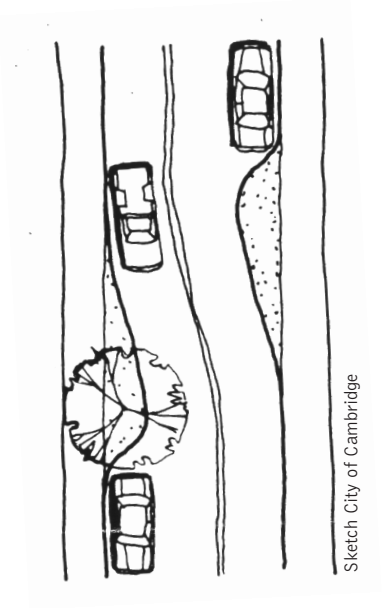
Shifts in travelways can be created by shifting parking from one side to the other (if there is only space for one side of parking), or by building landscaped islands (islands can also effectively supplement the parking shift).

Diversion plus restriction (Angled Slow Points). Diverting the path of travel plus restricting the lanes (as described under "Chokers") usually consists of a series of bulb-outs or curb extensions, narrowing the street to two narrow lanes or one lane at selected points and forcing motorists to slow down to maneuver between them. Such treatments are intended for use only on residential streets with low traffic volumes.

If there is no restriction (i.e., the number of lanes is maintained), chicanes can be created on streets with higher volumes, such as collectors or minor arterials.

Photo by Peter Lagerwey

The chicanes pictured above narrow this residential street to one lane and require traffic to move slowly.



Sketch City of Cambridge

Purpose:

- Reduces vehicle speeds.
- Adds more green to a street.

Considerations:

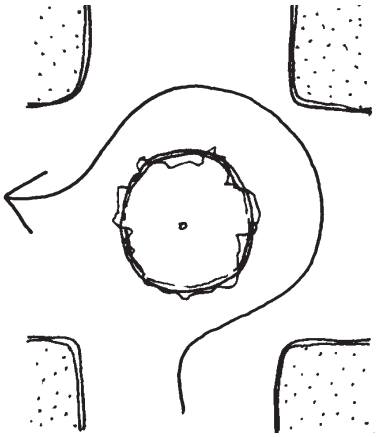
- Chicane may reduce on-street parking.
- Maintain good visibility by planting only low shrubs or trees with high canopies.

Estimated cost

Costs for landscaped chicanes are approximately $10,000 (for a set of 3 chicanes) on an asphalt street and $16,000 on a concrete street. Drainage may represent the most significant cost consideration.

23. Traffic Mini-Circles

Mini-circles are raised circular islands constructed in the center of residential street intersections. They reduce vehicle speeds by forcing motorists to maneuver around them and are sometimes used instead of stop signs. Mini–circles have been found to reduce motor vehicle crashes by an average of 90 percent in Seattle, WA.[11] Drivers making left turns are directed to go on the far side of the circle (see diagram at right) prior to making the turn. Signs may be installed within the circle to direct motorists to proceed around the right side of the circle before passing through or making a left turn. Mini-circles are commonly landscaped (bushes, flowers, or grass), most often at locations where the neighborhood has agreed to maintain the plants. In locations where landscaping is not feasible, traffic circles can be enhanced through pavement materials.



Adapted from Making Streets That Work, Seattle 1996

Mini-circles are an intersection improvement as well as a traffic calming device and can take the place of a signal or four-way stop (many unwarranted signals are installed because of the demand for action by the community).

Mini-circles must be properly designed to benefit pedestrians and cyclists. Right-turning vehicles are not controlled at an intersection with a mini-circle, potentially putting pedestrians and cyclists at risk. Curb radii should not be reduced to what would be otherwise desirable. Traffic circles with splitter islands make crossing easier for pedestrians (especially for persons with disabilities) and control vehicle movements entering the intersection, but require more space.

The occasional larger vehicle going through an intersection with a traffic circle (e.g., a fire truck or moving van) can be accommodated by created a mountable curb in the outer portion of the circle.

Photo by Dan Burden

A traffic mini-circle helps reduce vehicle speeds, but still allows cars, buses and other large vehicles to pass through the intersection with little difficulty.

Purpose:

- Manage traffic at intersections where volumes do not warrant a signal.
- Reduce crash problems at the intersection of two local streets.
- Reduce vehicle speeds at the intersection.
- Treat a series of intersections along a local street as part of a neighborhood traffic improvement program.

Considerations:

- Do not make generous allowances for motor vehicles by increasing the turning radii —this compromises pedestrian and cyclist safety.
- Larger vehicles that need access to streets (e.g. school buses and fire engines) may need to make left hand turns in front of the circle.
- Use yield, not stop controls.

Estimated cost

The cost is approximately $6,000 for a landscaped traffic mini-circle on an asphalt street and about $8,000-$15,000 for a landscaped mini-circle on a concrete street.

24. Speed Hump; 25. Speed Table

Speed humps are paved (usually asphalt) and approximately 3-4 inches high at their center, and extend the full width of the street. Speed humps should not be confused with a speed "bump" that is often found in mall parking lots. There are several designs for speed humps. The traditional 12-foot hump has a design speed of 15 to 20 mph, a 14-foot one a few mph higher, and a 22-foot table, of 25 to 30 mph. The longer humps are much gentler for larger vehicles.

A speed table is a term used to describe a very long and broad speed hump, or for a flat-topped speed hump, where sometimes a pedestrian crossing is provided in the flat portion of the speed table. The speed table can either be parabolic, making it more like a speed hump, or trapezoidal, which is used more frequently in Europe. Speed tables can be used in combination with curb extensions where parking exists.

Photo by Peter Lagerwey

Speed humps are frequently used on residential streets to reduce speeds. However, they can create unwanted noise if they are too severe, or cause motorists to slow down more than is necessary.

Purpose:

- Reduces vehicle speeds. Raised measures tend to have the most predictable speed reduction impacts.
- Enhances the pedestrian environment and pedestrian crossings.

Considerations:

- Do not use if sight distance is limited and/or if the street is on a steep grade.
- If the street is a bus route or primary emergency route, design must be coordinated with operators. Usually some devices are acceptable if used prudently - one device may be appropriate and may serve the primary need, e.g. if there is a particular location along a street that is most in need of slowing traffic and improving pedestrian conditions.
- The aesthetics of speed humps and speed tables can be improved through the use of color and specialized paving materials.
- Noise may increase particularly if trucks use the route regularly.
- May create drainage problems on some streets.

Estimated cost

The cost for each speed hump is approximately $2,000. Speed tables are $5,000–$15,000, again depending on drainage conditions and materials used.

26. Raised Intersection; 27. Raised Pedestrian Crossing

A raised intersection is essentially a speed table (see photo below) for an entire intersection. Construction involves providing ramps on each intersection approach and elevating the entire intersection to the level of the sidewalk. They can be built with a variety of materials, including asphalt, concrete, or pavers. The crosswalks on each approach are also elevated as a part of the treatment, to enable pedestrians to cross the road at the same level as the sidewalk. This is good for mobility impaired pedestrians but may cause problems for the sight impaired if they cannot detect the curb edge.

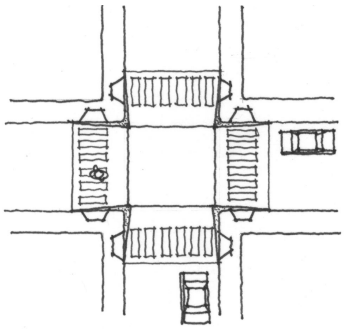
A raised pedestrian crossing is also essentially a speed table, with a flat portion the width of a crosswalk, usually 10–15 feet. Raised intersections and crosswalks encourage motorists to yield. On one street in Cambridge, Massachusetts, motorists yielding to pedestrians crossing at the raised devices went from approximately 10 percent before installation of the project to 55 percent after installation.

Photo by Cara Seiderman

A raised intersection slows all vehicular movements through the intersection and improves pedestrian crossings in all directions.

Photo by Cara Seiderman

A raised pedestrian crossing provides a continuous route for the pedestrian at the same level as the sidewalk. Pavement markings on the slope (inlay type) make the crossing visible to motorists.



Sketch by Michael Kimelberg

Purpose:

- Tend to be the most predictable in reducing vehicle speeds.
- Enhances the pedestrian environment and pedestrian crossings.

Considerations

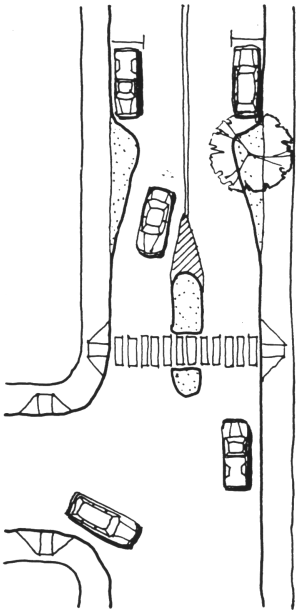
- Don't use if sight distance is limited and/or the street is steep.
- If the street is a bus or emergency route, design must be coordinated. One device may be appropriate and may serve the primary need. Several raised devices may be disruptive, so other measures should be considered.
- Speed tables and raised crosswalks and intersections can be an urban design element through the use of special paving materials.
- Add tactile warning strips at edges to enable site impaired people to detect the crossing.
- Care must be taken in adding drainage.

Estimated cost

Raised crosswalks are approximately $5,000 - $7,000, depending on drainage conditions and materials used. The cost of a raised intersection is highly dependent on the size of the roads. They can cost from $25,000 to $70,000.

28. Gateways

A gateway is a physical or geometric landmark that indicates a change in environment from a higher speed arterial or collector road to a lower speed residential or commercial district. Gateways may be a combination of street narrowing, medians, signing, archways, roundabouts, or other identifiable feature. Gateways send a clear message to motorists that they have reached a specific place and must reduce speeds. This can help achieve the goal of meeting expectations and preparing motorists for a different driving environment. Gateways are only an introduction and slower speeds are not likely to be maintained unless the entire area has been redesigned or other traffic calming features are used.



City of Cambridge

Photo by

The combination of landscaping and a short median create a gateway to this neighborhood.

Purpose:

- Creates an expectation for motorists to drive more slowly and watch for pedestrians where traffic enters a commercial business or residential district from a higher speed roadway.
- Creates a unique image for an area.

Considerations:

- Traffic slowing effects will depend upon device chosen and overall traffic calming plan for the area.

Estimated cost

Varies widely depending on measures chosen.

29. Landscaping

The careful use of landscaping along a street can provide separation between motorists and pedestrians, reduce the visual width of the roadway (which can help to reduce vehicle speeds), and provide a more pleasant street environment for all. This can include a variety of trees, bushes, and/or flower pots, which can be planted in the buffer area between the sidewalk or walkway and the street.

The most significant issue with any landscaping scheme is ongoing maintenance. Some communities have managed effectively through the volunteer efforts of neighbors, while others have found them to be unreliable and budget for public maintenance instead. Consider adding irrigation systems in areas with extensive planting.

Choosing appropriate plants and preparing the ground can help ensure that they survive with minimal maintenance, and don't buckle the sidewalks as they mature. The following guidelines should be considered: plants should be adapted to the local climate and fit the character of the surrounding area - they should survive without protection or intensive irrigation; and plant's growth patterns should not obscure signs or pedestrians' and motorists' views of each other.

Photo by Dan Burden

Landscaping with low shrubs, ground cover and mature trees that are properly limbed can add shade, color and visual interest to a street.

Purpose:

- Enhance the street environment.
- Traffic calm by creating a visual narrowing of the roadway and presenting an image of the street that is one of a place rather than a through route.

Considerations:

- Maintenance must be considered and agreed to up front, whether it is a municipality or neighborhood residents who will take responsibility for the maintenance.
- Shrubs should be low growing and trees should be trimmed up at least eight to ten feet to ensure sight distances are maintained and personal security is not compromised.
- Plants and trees should be chosen with care to match the character of the area, be easily maintained, and not create other problems such as buckling sidewalks.

Estimated cost

Opportunities for funding landscaping are often more flexible than with major street changes. For example, the cost of the actual landscaping may be paid for by the corresponding neighborhood or business groups. Often, municipalities will pay for the initial installation and neighborhood residents or businesses agree to maintain anything more elaborate than basic street trees.

30. Specific Paving Treatments

Paving materials are important to the function and look of a street, both in the road and on the sidewalk. Occasionally paving materials in and of themselves act as a traffic calming device, e.g. when the street is paved in brick or cobblestone. However, some of these materials may be noisy, not friendly to cyclists, pedestrians, wheelchairs or snow plow blades. In particular, cobblestones should not be used in the expected pedestrian or cycle path although they can be used as aesthetic elements in a streetscape design.

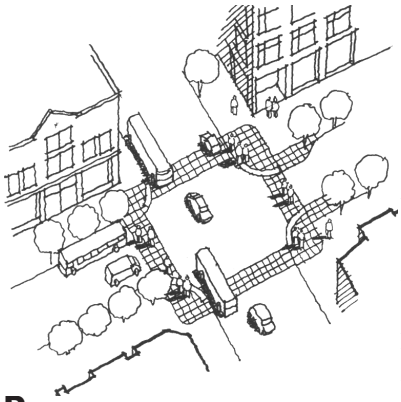
The pedestrian walkway material should be even and not slippery. Concrete is usually the preferred walking surface. A different look can be achieved by using stamped concrete or concrete pavers, which are available in a variety of colors and shapes. They can also be used on the top of raised devices.

It is important to ensure crosswalk visibility. Textured crosswalks should be marked with reflective lines since they are not as visible, especially at night or on rainy days. In general, brick, granite and cobblestones should not be used in crosswalks.

Colored paving can often enhance the function of portions of the roadway, such as a colored bicycle lane. This can create the perception of street narrowing in addition to enhancing the travel facility for cyclists.

Photo by Dan Burden

Brick or cobblestone streets help slow traffic and create a feeling that the street is not a highway or fast-moving arterial.



Sketch by Michael Kimelberg

Purpose:

- Sends a visual cue about the function of a street. An asphalt surface "reads" as motor vehicle space; brick or pavers imply at least a shared space.
- Aesthetic enhancement of a street.
- Can delineate separate space for pedestrians or cyclists.

Considerations:

- Slippery surfaces such as smooth granite and uneven surfaces such as cobblestones should not be used in the primary pedestrian or bicycle travel path. Bumpy surfaces may be especially uncomfortable for wheelchair users.
- Coordinate choice and placement of materials with maintenance agencies.
- Design and maintenance must ensure crosswalk visibility over time.
- Using materials such as bricks and cobblestones may increase the cost of construction and maintentance.

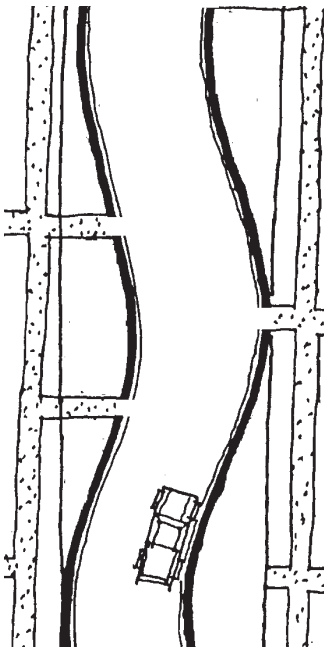
Estimated cost

Variable; materials requiring hand labor (cobblestones or pavers) have a higher cost.

31. Serpentine Design

Serpentine design refers to the use of a winding street pattern with built–in visual enhancements through a neighborhood, which allow for through movements while forcing vehicles to slow. The opportunities for significant landscaping can be used to create a park like atmosphere.

Such designs are usually implemented with construction of a new neighborhood street or during reconstruction of an existing street corridor. This type of design can be more expensive than other traffic calming options and needs to be coordinated with driveway access.



Making Streets That Work, Seattle 1995

Purpose:

- Changes the entire look of a street. Sends a significant message to drivers that the nature of the road is not for fast driving.
- Often created where slow streets are being designed into new neighborhood construction.

Photo by Peter Lagerwey

The serpentine street pictured above is a curving roadway that helps slow traffic through the use of curbs and landscaping.

Considerations:

- Where costs are a concern, lower cost, equally effective traffic calming strategies may be preferable.
- Most cost-effective to build as a new street or where a street will soon undergo major reconstruction for utility or other purposes.

Estimated cost

The cost can be high ($60-90,000) to retrofit a street, but may be no extra to build a new street with this design.

32. Woonerf

Woonerf ("Street for living") is a Dutch term for common space created to be shared by pedestrians, bicyclists, and low speed motor vehicles. They are typically streets without curbs and sidewalks, and vehicles are slowed by placing trees, planters, parking areas, and other obstacles in the street. Motorists become the intruders and must travel at very low speeds below 10 mph. This makes a street available for public use that is essentially only intended for local residents. A woonerf identification sign is placed at each street entrance.

Purpose:

- Designed for residential streets that are very low volume, limited use, and primarily local access streets.
- Streets where there is a neighborhood desire to create a public space for social activities and play by local residents.

Considerations:

- A woonerf is generally not appropriate where there is a need to provide for nonresident motorists to access services or through streets.
- The design needs to keep vehicle speeds very low in order to make the streets safe for children.

Estimated cost

The cost to retrofit a woonerf may be quite high, but there would no extra cost if designed into original construction.

Photo by

Motorists, cyclists and pedestrians share the space on this woonerf or "living street" in Asheville, North Carolina.

E. Traffic Management

Photo by Michael Cynecki

Although they are sometimes lumped together, traffic management and traffic calming are different tools and address different problems. Traffic management includes the use of traditional traffic control devices to manage volumes and routes of traffic. Traffic calming deals with what happens to traffic once it is on a street. For example, limiting access to a street (e.g., diverting traffic from entering a street on one end) may reduce the amount of traffic on that street, but will do nothing to affect the speed of the traffic that travels on that street or others. Traffic management and traffic calming are often complementary, and a plan to retrofit an area often includes a variety of tools.

Communities should think about the broader context of traffic. If there is too much traffic on any one street, it may be that there is too much traffic altogether. A more significant plan to reduce overall traffic volumes would be appropriate: encouraging and providing for alternate modes of travel, implementing Transportation Demand Management, enhancing transit systems, improving land use planning, etc. Comprehensive traffic reduction or mitigation strategies are important but beyond the scope of this guide. Resources that provide guidance on these issues are included in the reference section.

Traffic calming and traffic management should also be evaluated from an area wide perspective. The problem should not just be shifted from one street to another. Although implementation usually occurs in stages, an overall plan can be developed up front, involving a larger neighborhood or area of the city.

Traffic calming has also helped reduce motor vehicle traffic volumes and increase walking and bicycling. For example, on one traffic-calmed street, in Berkeley, California the number of cyclists and pedestrians more than doubled after the street was reconstructed with traffic calming tools, and motor vehicle volumes decreased by about 20 percent.[12] Traffic volume reduction raises the question: where does the traffic go? In the Berkeley case traffic volumes on parallel streets did not account for all the traffic that "disappeared" on the traffic calmed street. Ideally, the reduction in traffic means that some people choose a different mode of travel, such as transit, walking or bicycling. This is only feasible if a system is in place to support those modes. What is often the case in selective street redesign is that traffic is routed onto other streets. Sometimes it is desirable to keep traffic on an arterial and off residential streets. However, in many communities, arterials are already over capacity, and alternate routes may also involve other residential streets.

Traffic management and traffic calming should involve the community. Neighborhood participation and the community involvement process are discussed in Chapter 5.

Photo by Cara Seiderman

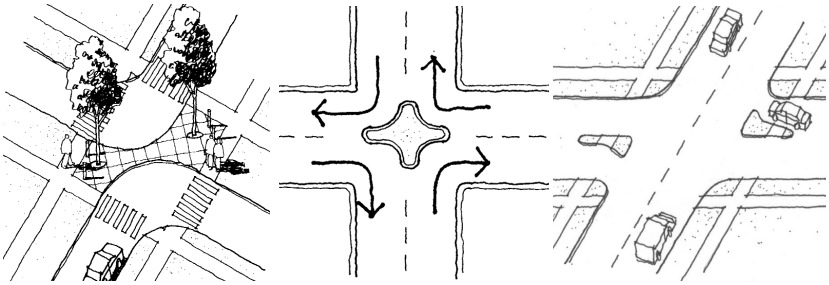
This partial street closure is found in Berkeley, California.

33. Diverters (Diagonal, Star, Forced Turn and Truncated)

A diverter is an island built diagonally across a residential street intersection which prevents certain through and/or turning movements. Diverters affect people living in the neighborhood more than anyone else. Therefore, diverters should be considered when less restrictive measures are not appropriate.

A diagonal diverter breaks up cut through movements and forces right or left turns in certain directions. A star diverter consists of a star-shaped island placed at the intersection which forces right turns from each approach. A truncated diagonal diverter is a diverter with one end open to allow additional turning movements. Other types of island diverters can be placed on one or more approach legs to prevent through and left turn movements and force vehicles to turn right.

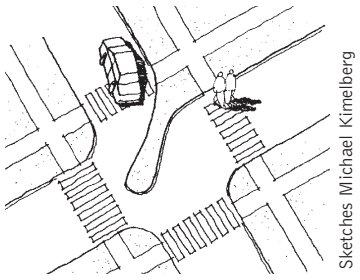
As with other traffic management tools, diagonal diverters must be used in conjunction with other traffic management tools within the neighborhood street network. Any of these diverters can be designed for bicycle and pedestrian access.



Diagonal Diverter **Star Diverter** **Forced Turn Diverter**

Photo by Dan Burden

By eliminating direct passages through a neighborhood, communities can ensure that through traffic remains on the appropriate roadways. This treatment is best used as part of an overall neighborhood traffic management plan.



Sketches Michael Kimelberg

Truncated Diverter

Purpose:

- Discourage traffic from cutting through a neighborhood.

Considerations:

- Impacts residents more than through traffic.
- Consider less restrictive measures first.
- Evaluate traffic patterns to determine whether other streets would be adversely affected.
- Design diverters to allow bicycle and emergency vehicle access. If this cannot be done and the street is a major bicycle corridor, a diverter should not be used.
- Diverters generally do not effectively address midblock speeding problems.
- Diagonal diverters may be used in conjunction with other traffic management tools and are most effective when applied to the entire neighborhood street network.
- Diverters should have strong neighborhood support.
- Consideration should be made of diverters effect on service vehicles.

Estimated costs

$15,00-$45,000 each, depending on the type of diverter.

34. Full Street Closure

A full street closure is accomplished by installing a physical barrier that blocks a street to motor vehicle traffic either in initial design (e.g., new cul-de-sac) or by closure of an existing street. Full street closures should be used only in the rarest of circumstances. Neighborhoods with cul-de-sac streets require extensive out-of-the-way travel, which is not a mere convenience issue, but has serious implications for impacts to other streets. All traffic is forced to travel on feeder streets, which has negative consequences for the people who live on those streets and forces higher levels of controls at critical intersections.

If a street closure is done, it should always allow for the free through movement of pedestrians (including wheelchair users) and bicyclists. Emergency vehicles should also be able to access the street; this can be done with a type of barrier or gate that permits large vehicles to traverse it but not automobiles. Examples are mountable curbs or an access way with a raised element in the center that a low vehicle would hit. This second is usually only appropriate for places with no snow (otherwise the device would be covered with snow and the access way could not be cleared).

Photo by Michael Cynecki

Access is closed on this residential street in Phoenix, AZ.

Purpose:

- Ultimate limitation of motor vehicle traffic to certain streets.
- Part of an overall traffic management strategy.

Considerations:

- Does not adversely affect access by service vehicles.
- Analyze whether other streets would receive diverted traffic as a result of the street closure, and whether alternative streets exist for through traffic.
- Provide a turn-around area for motor vehicles including service vehicles and provide for surface drainage.
- This device will not address speeding problems.
- Full street closures may be considered for local streets but are not appropriate for collector streets.
- Does not adversely affect access by children to community areas.
- Not an appropriate measure for addressing crime or other social problems.

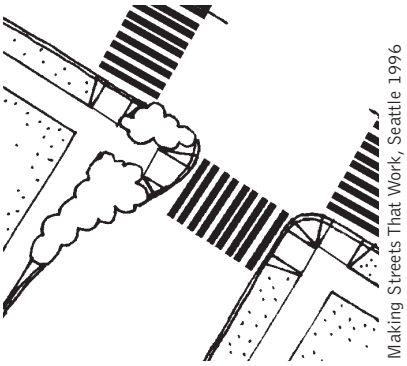
Estimated costs

The cost for a full, landscaped street closure varies from approximately $30,000 to $100,000, depending on conditions.

35. Partial Street Closure

A partial street closure involves physically closing or blocking one direction of motor vehicle travel into or out of an intersection; it could also involve blocking one direction of a two-way street. Partial street closures at the entrance to a neighborhood or area should consider the traffic flow pattern of the surrounding streets as well. The design of this measure should allow for easy access by bicyclists and pedestrians.

A partial closure provides better emergency access than a full closure. Since this design also allows motorists to easily violate the prohibitions, police enforcement may be required. If the partial closure only eliminates an entrance to a street, a turnaround is not needed; closing an exit will generally require a turnaround.



Making Streets That Work, Seattle 1996

Purpose:

- Prevent turns from an arterial street onto a residential street
- Reduces the use of the street as a cut-through route.
- Restricts access to a street without creating one-way streets.

Considerations:

- Analyze whether less restrictive measures would work.
- Analyze whether other local streets will be adversely affected and/or access into or out of the neighborhood would not be adequate.
- Will create out-of-the-way travel for residents and put additional traffic on other streets.
- Do not use if the street is an emergency or school bus route.
- Will not solve speeding issues; speeds may increase on the new one-way street.

Estimated cost

A well designed, landscaped partial street closure at an intersection typically costs approximately $10,000 - $25,000. They can be installed for less if there are no major drainage issues and landscaping is minimal.

Photo by Cara Seiderman

This partial street closure is found in Phoenix, AZ.

36. Pedestrian Streets/Malls

There are two types of pedestrian streets/malls: 1) those that eliminate motor vehicle traffic (deliveries permitted during off peak hours); and 2) those that allow some motor vehicle traffic at very low speeds. The second type can be thought of as a pedestrian street that allows some motor vehicles as opposed to a motor vehicle street that allows some pedestrians.

Pedestrian streets have been successful in places that are thriving and have high volumes of pedestrians. They are not likely to improve the economy in an area that is not doing well. Examples include Church Street in Burlington, Vermont; Downtown Crossing in Boston, Massachusetts; Maiden Lane in San Francisco, California; and Occidental Street in Seattle, Washington; Third Street Promenade in Santa Monica, California; and, Fremont Street in Las Vegas, Nevada.

Photo by Cara Seiderman

Church Street in Burlington, Vermont is a successful pedestrian street with market stalls, public art, landscaping and cafes.

Purpose:

- Enhances the experience for people in a commercial district.
- Creates a significant public space in a downtown district, a tourist district, or a special events or marketplace area.

Considerations:

- Pedestrian streets (those that eliminate motor vehicles) created with the notion of attracting people in areas that are on the decline have usually been unsuccessful.
- The pedestrian environment can often be enhanced through other measures, including street narrowing/sidewalk widening and the addition of landscaping.

Estimated cost

A pedestrian street can be created simply by blocking either end of an existing street with nothing more than a few signs. Temporary pedestrian streets can be created for weekends or holidays. If the street is going to be a permanent public space, care should be taken in the design. Depending on the extent of the treatment (one block or several blocks) and quality of materials used, a true pedestrian street can cost from $100,000 to several million dollars.

F. Signals and Signs

Photo by Cara Seiderman

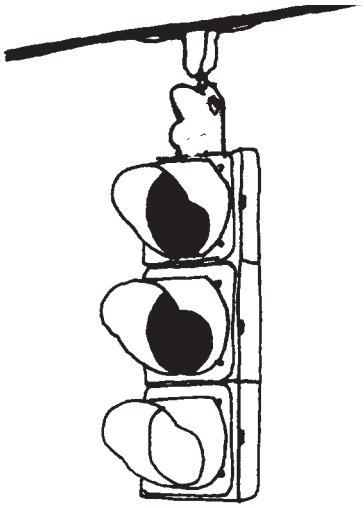
37. Traffic Signals

Traffic signals create gaps in traffic flow allowing pedestrians to cross the street. They should allow adequate crossing time for pedestrians and an adequate clearance interval based upon a maximum walking speed of 4 feet per second. A lower speed of less than 4 ft/sec should be used in determining pedestrian clearance time for areas where there is a heavy concentration of elderly or children. Signals are particularly important at high use, mid-block crossings on higher speed roads, multi-lane roads or at highly congested intersections. National warrants from the "Manual on Uniform Traffic Control Devices" based on the numbers of pedestrians and vehicles crossing and intersection are usually used in the selection of traffic signal sites.[1] However, judgment must also be used on a case-by-case basis. For example, a requirement for installing a traffic signal is that there are a certain number of pedestrians present. If a new facility is being built - a park or recreational path, for example - there will be a new demand, and the signal should be installed in conjunction with the new facility based on projected crossing demand. There may also be latent demand if a destination is not currently accessible but could become so with new facilities or redesign.

In downtown areas signals are often closely spaced, sometimes every block. They are usually spaced further apart in suburban or outlying areas. When high pedestrian traffic exists during a majority of the day, fixed-time signals should be used to consistently allow crossing opportunities. Pedestrian actuation should only be used when pedestrian crossings are intermittent.

Photo by Barbara Gray

A traffic signal at a busy intersection with high volumes of pedestrians, bicyclists and cars.



Making Streets That Work, Seattle 1996

Purpose:

- Provides intervals in a traffic system where pedestrians can cross streets safely.

Considerations:

- Where pedestrian traffic is regular and frequent, pedestrian phases should come up automatically. Pedestrian actuation should only be used when pedestrian crossings are intermittent.
- Signal cycles should be kept short (ideally 90 seconds maximum) to reduce pedestrian delay. Pedestrians are very sensitive to delays and a 30 second maximum wait time is ideal.
- Marked crosswalks at signals can encourage pedestrians to cross at the signal and help dissuade motorists from encroaching into the crossing area.

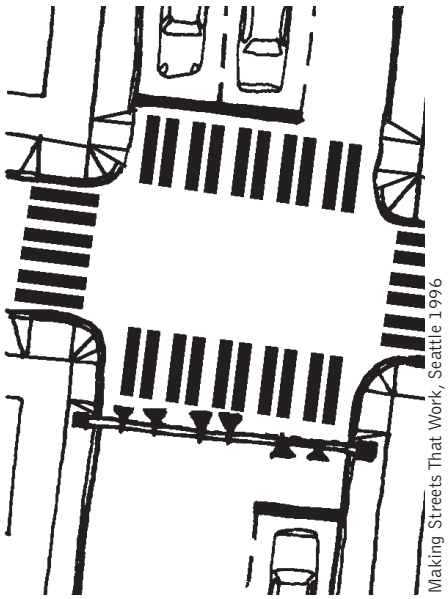
Estimated cost

$30,000–$140,000.

38. Upgrade/Modify Pedestrian Signal Timing

Shorter cycle lengths and longer WALK intervals generally provide better service to pedestrians and encourage better signal compliance. For optimal pedestrian service, fixed-time signal operation usually works best. Pedestrian push buttons may be installed at locations where pedestrians are expected intermittently. Quick response to the button or feedback to the pedestrian should be programmed into the system. When used, push buttons should be well signed and fully accessible to pedestrians in wheelchairs. They should be conveniently placed in the area where pedestrians wait to cross. Since pedestrian push-button devices are not activated by about one-half of pedestrians (even fewer activate them where there are sufficient motor vehicle gaps), new "intelligent" microwave or infrared pedestrian detectors are now being installed and tested in some U.S. cities. These automatically activate the red traffic and WALK signal when pedestrians are detected. Other detectors can be used to extend the crossing time for slower moving pedestrians in the crosswalk.

In addition to concurrent pedestrian signal timing (where motorists may turn left or right across pedestrians' paths), exclusive pedestrian intervals stop traffic in all directions. This timing has been shown to reduce pedestrian crashes by 50% in downtown locations with heavy pedestrian volumes and low vehicle speeds and volumes.[2] With concurrent signals, pedestrians usually have more crossing opportunities and have to wait less. Unless a system is willing to take more time from vehicular phases, pedestrians will often have to wait a long time for an exclusive signal. This is not very pedestrian friendly, and many pedestrians will simply choose to ignore the signal and cross if and when there is a gap in traffic.[3]



Making Streets That Work, Seattle 1996

Purpose:

- Improves pedestrian accommodation at signalized crossings.

Consideration:

- Wider intersections may require longer cycle lengths.
- Longer walk intervals may also lead to longer cycle lengths.

Estimated Costs:

Adjusting signal timing is very low cost, and requires a few hours of staff time to accomplish. New signal equipment is approximately $20,000.

Photo by Barbara Gray

With a leading pedestrian interval, pedestrians get an advance walk signal before motorists get a green. This gives the pedestrians several seconds to get well ahead in the crosswalk before motorists start to turn.

38. Upgrade/Modify Pedestrian Signal Timing, Continued

Leading Pedestrian Interval

A simple, useful change is the "leading pedestrian interval" (LPI). An LPI gives pedestrians an advance walk signal before the motorists get a green light, giving the pedestrian several seconds to start in the crosswalk where there is a concurrent signal. This makes pedestrians more visible to motorists and motorists more likely to yield to them. This advance phase approach has been used successfully in several places, such as New York City, for two decades and studies have demonstrated reduced conflicts for pedestrians.[4] The advance phase approach is particularly effective where there is a two lane turning movement.

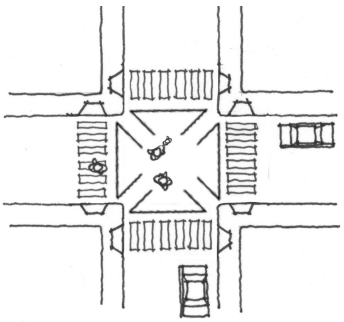
There are some situations where an exclusive pedestrian phase will still be preferable. They are desirable where there are high volume turning movements that conflict with the pedestrians crossing.

Photo by Cara Seiderman

LPI's (Leading Pedestrian Intervals) are in use at this intersection in Cambridge, Massachusetts.

39. Traffic Signal Enhancements

A variety of traffic signal enhancements that can benefit pedestrians and bicyclists are available. These include providing left turn phasing separate from pedestrian walk intervals, timing signals in sequence to encourage desired vehicle speeds, providing "leading pedestrian interval" timing to give enhanced pedestrian service, a brief all-red interval, providing larger traffic signals heads to ensure visibility, and placing signal heads so that motorists waiting at a red light can't see the other signals and anticipate the green. Specific signal enhancements are described in detail on the following two pages.



Pedestrian Scramble

Sketch by Michael Kimelberg

The pedestrian has a dedicated walk phase at this intersection of a busy street and a trail crossing.

Photo by Herman Huang

The pedestrian has a dedicated walk phase and is allowed to cross diagonally at this intersection.

40. Pedestrian Signals

Pedestrian signal heads should be used at all signals where pedestrians are permitted to cross unless pedestrian volumes are extremely low. The use of WALK/DON'T WALK pedestrian signal indicators at signal locations are important in many cases including: when vehicle signals are not visible to pedestrians; when signal timing is complex, e.g., there is a dedicated left turn signal for motorists; at established school zone crossings; when an exclusive pedestrian interval is provided; and, for wide streets where pedestrian clearance information is considered helpful.

The international symbol pedestrian signal head is preferable and is recommended in the MUTCD; the "WALK" and "DONT WALK" word message is an allowable alternate.[1] Pedestrian signal heads should be clearly visible to the pedestrian at all times when in the crosswalk or waiting on the far side of the street. Larger pedestrian signal heads can be beneficial in some circumstances. Signals may be supplemented with audible messages to assist trained visually impaired pedestrians. These should be used judiciously, because they can become a noise problem.

Pedestrian Facilities Guidebook, Washington State, 1998

Pedestrian signals (from MUTCD)

Purpose:

- Indicates appropriate phase for pedestrians to cross.
- Provides pedestrian–only phases in a cycle.

Considerations:

- Ensure signal heads are visible to pedestrians.

Estimated Costs:

$30,000–$140,000.

Photo by Cara Seiderman

This countdown signal in Cambridge, MA indicates to pedestrians the amount of time they have available to cross.

41. Right Turn on Red Restrictions

A permissible "Right Turn on Red" (RTOR) was introduced in the 1970s as a fuel savings measure and has sometimes had detrimental effects on pedestrians. While the law requires motorists to come to a full stop and yield to cross street traffic and pedestrians prior to turning right on red, many motorists do not fully comply with the regulations. Motorists are so intent on looking for traffic approaching on their left that they may not be alert to pedestrians on their right. In addition motorists usually pull up into the crosswalk to wait for a gap in traffic, blocking pedestrian crossing movements. In some instances, motorists simply do not come to a full stop.

One significant concern that comes up when RTOR is prohibited is that this may lead to higher RTOG (right turn on green) conflicts when there are concurrent signals. The use of the leading pedestrian interval (LPI) can usually best address this issue (see Tool #38). Where pedestrian volumes are very high, exclusive pedestrian signals should be considered.

RTOR should be prohibited where and/or when there are high pedestrian volumes. This can be done with a simple sign posting, although there are some options that are more effective than a standard size sign. For example, one option is a NO TURN ON RED sign with a red ball in the center. This sign may be noticed more easily by an approaching potential RTOR motorist. Another option is a larger 30" by 36" NO TURN ON RED sign which is more conspicuous. For areas where a right turn would be acceptable during certain times, a variable message NO TURN ON RED/blankout sign is an option.

Photo by Cara Seiderman

Prohibiting right turns on red will significantly improve pedestrian safety.

Purpose:

- Increasing pedestrian safety and decreasing crashes at intersections.

Considerations:

- Prohibiting right turns on red is a simple, low cost measure. Together with a leading pedestrian interval, the signal changes can benefit pedestrians with minimal impacts on traffic. They should be done in locations with substantial pedestrian volume and places where children cross.
- Part-time ROTR prohibitions during the busiest times of the day may be sufficient to address the problem.
- Signs should be clearly visible to right-turning motorists stoped in the curb lane at the crosswalk.

Estimated Costs:

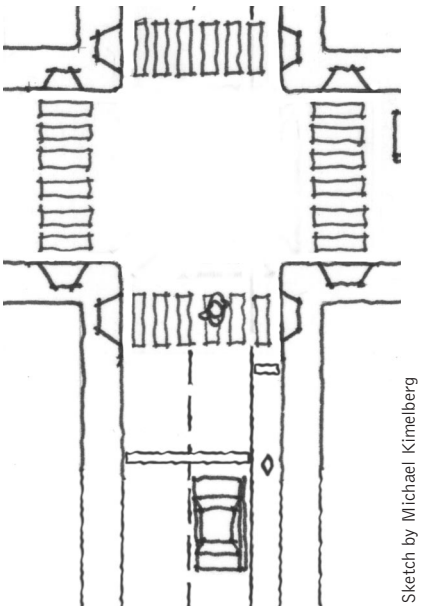
$30–$150 per NO TURN ON RED sign. Electronic signs have higher costs.

42. Recessed Stop Lines

At signalized intersections, the vehicle stop line can be moved further back from the pedestrian crosswalk for an improved factor of safety and for improved visibility of pedestrians. In some places the stop line has been moved back by 5 to 10 m (15 to 30 feet) relative to the marked crosswalk with considerable safety benefits for pedestrians.

The recessed stop lines allow pedestrians and drivers to have a clearer view of each other and more time in which to assess each other's intentions. The effectiveness of this tool depends upon whether motorists are likely to obey the stop line, which varies from place to place.

Recessed stop lines are also applicable for non-signalized crosswalks on multi-lane roads to ensure that drivers in all lanes have a clear view of a crossing pedestrian.



Sketch by Michael Kimelberg

Purpose:

- Improve visibility of pedestrians to motorists.
- Allow pedestrians to advance in a crosswalk before motor vehicles turn.

Considerations:

- Effectiveness depends on motorists compliance with the marked stop line.
- If placed too far in advance of the crosswalk, motorists may ignore the line.
- In some locations, a wider crosswalk may be an effective alternative.

Estimated cost

Low. There is no extra cost when the recessed stop line is installed on new paving or as part of repaving projects. A "STOP HERE" sign can be used to supplement the recessed stop line.

Photo by Peter Lagerwey

Recessed stop lines are used at this signalized mid-block crossing to improve sight distances and to give the motorist who initially fails to see the crosswalk more time to stop. The cyclist can advance ahead which aids in cyclist safety, particularly with right-turning motorists.

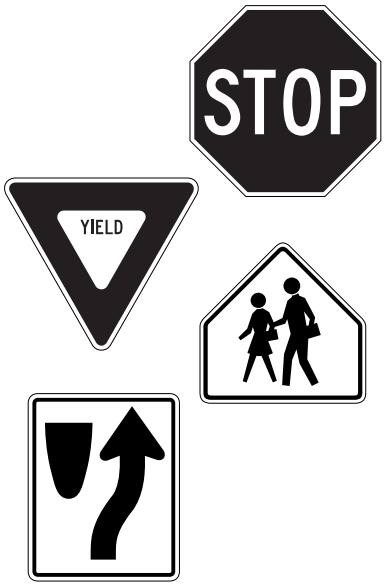
43. Add/Modify Signing

Signs can provide important information that can improve road safety. By letting people know what to expect, there is a greater chance that they will react and behave appropriately. For example, giving motorists advanced warnings of upcoming pedestrian crossings or that they are entering a traffic calmed area will enable them to modify their speeds. Sign use and movement should be done judiciously, as overuse breeds noncompliance and disrespect.

Regulatory signs, such as STOP, YIELD or turn restrictions require certain driver actions and can be enforced. Warning signs can provide helpful information, especially to motorists and pedestrians unfamiliar with an area. Some examples of signs which affect pedestrians include pedestrian warning signs, motorists warning signs, NO TURN ON RED signs, and guide signs.

Advance pedestrian warning signs should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area. A new fluorescent yellow-green color is now approved for use on non-motorized warning signs. This bright color attracts the attention of drivers because it is unique.

In some cases, signs may be used to prohibit pedestrian crossings at an undesirable location and re-route them to a safer crossing location, or warn pedestrians of unexpected driver maneuvers. All signs should be periodically checked to make sure they are in good condition, free from graffiti and continue to serve a purpose.



Manual on Uniform Traffic Control Devices (MUTCD)

Purpose:

- Provides regulations or information to road users as to what to expect and how to behave.

Considerations:

- Overuse of signs breeds noncompliance and disrespect. Too many signs can lead to visual clutter with the result that a driver is not likely to read or pay attention to any of the signs.
- Traffic signs must be in compliance with the Manual on Uniform Traffic Control Devices (MUTCD).

Estimated Costs:

$50–$150 per sign.

Photo by Barbara Gray

This sign instructs drivers to yield to pedestrians when turning at this intersection.

G. Other Measures

Photo by

44. School Zone Improvements

A variety of roadway improvements may be used to enhance the safety or mobility of children in school zones. The use of well-trained adult crossing guards has been found to be one of the most effective measures for assisting children to cross streets safely.[1] Sidewalks or separated walkways and paths are essential for a safe trip from home to school on foot or by bike. Adult crossing guards require training and monitoring and should be equipped with a bright orange safety vest and a STOP paddle. Police enforcement in school zones may be needed in situations where drivers are speeding or not yielding to children in crosswalks.

Other helpful measures include parking prohibitions near intersections and crosswalks near schools, increased child supervision, and the use of signs and markings, such as the school advance warning sign and SPEED LIMIT 25 MPH WHEN FLASHING. Schools should develop "safe route to school" plans and work with local agencies to identify and correct problem areas. Marked crosswalks can help guide children to the best route to school. School administrators and parent-teacher organizations need to educate students and parents about school safety and access to and from the school. Education, enforcement and well designed roads must all be in place to encourage motorists to drive appropriately.

Manual on Uniform Traffic Control Devices (MUTCD)

Purpose:

- Provide enhanced safety around schools.

Photo by Barbara Gray

Children leaving school in this Honolulu suburb walk their bikes to the intersection where a crossing guard controls movements.

44. School Zone Improvements, continued

One of the biggest safety hazards around schools is parents or caretakers dropping off and picking up their children. There are two immediate solutions: 1) there needs to be a clearly marked area where parents are permitted to drop off and pick up their children; and 2) drop off/pick up regulations must be provided to parents on the first day of school. Drop off areas must be located away from where children on foot cross streets or access the school. If parents or caretakers can be trained to do it right at the start of the school year, they are likely to continue good behavior throughout the year.

For a longer-term solution, it is preferable to create an environment where children can walk or bicycle safely to school, provided they live within a suitable distance. One concept that has been successful in some communities is the concept of a "walking bus," where an adult accompanies children to school, starting at one location and picking children up along the way. Soon a fairly sizeable group of children is walking in a regular formation, two by two, under the supervision of a responsible adult, who is mindful of street crossings. The presence of such groups affects drivers' behavior, who tend to be more watchful of children walking. Parents take turns accompanying the "walking school bus" in ways that fit their schedules.

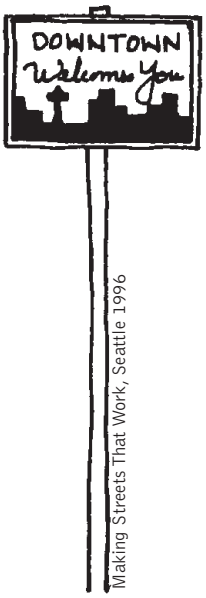
Photo by Dan Burden

Vehicles must slow down to enter the tight curve of this modern roundabout in a school zone in Montpelier, Vermont. The roundabout creates a safer interaction between vehicles and pedestrians.

45. Identify Neighborhood

Many neighborhoods or business districts want to be recognized for their unique character. This can enhance the walking environment and sense of community.

Examples of treatments include gateways, traffic calming, welcome signs, flower planters, banners, decorative street lighting, unique street name signs, and other details. Neighborhood identity treatments rarely provide any direct traffic improvements, but they help develop interest in enhancing the community.



Making Streets That Work, Seattle 1996

Purpose:

- Increases the visibility of a community and supports community efforts to define their neighborhood.

Considerations:

- Supports community efforts but has no direct traffic benefits.

Estimated Costs:

$50–$150 per sign. Some signs may cost more because they are usually custom made.

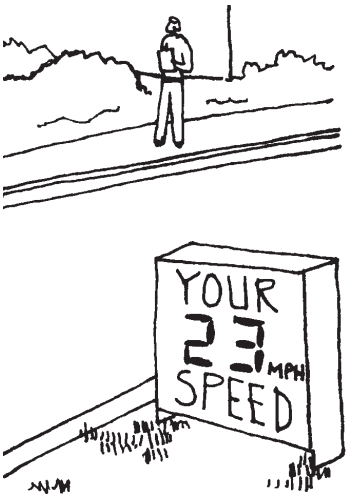
Photo by Peter Lagerwey

An identity sign in Seattle's Wallingford neighborhood marks an entry to the area.

46. Speed Monitoring Trailer

Speed monitoring trailers - sign boards on trailers that display the speed of passing vehicles - are used by police departments as educational tools that can enhance enforcement efforts directed at speed compliance. Speed radar trailers are best used in residential areas and may be used in conjunction with Neighborhood Speed Watch or other neighborhood safety education programs. They can help raise residents' awareness of how they themselves are often those speeding, not just "outsiders." Speed trailers are not substitutes for permanent actions such as traffic calming treatments to address neighborhood speeding issues.

Speed trailers can be used at several locations and should have occasional police monitoring and enforcement to maintain driver respect.



Making Streets That Work, Seattle 1996

Purpose:

- Enhance enforcement efforts through public education and awareness.

Considerations:

- Occasional enforcement is needed to supplement the speed trailers.
- Speed trailers are not a substitute for engineering measures.

Estimated Costs:

$10,000 plus the costs to move the trailer to different locations.

Photo by Dan Burden

Speed monitoring trailers let motorists know the speed limit and the speed they are traveling.

47. ADA (Americans with Disabilities Act) Design

People with disabilities who experience higher than normal levels of risk include developmentally restricted persons, users of wheelchairs, people who walk with special aids (including the temporarily impaired, such as people using crutches), and the visually impaired.

While improvements for persons with disabilities were mandated by the Federal Government to ensure access and mobility for those with physical limitations, most of these improvements benefit all walkers. Some of the items mentioned previously, such as adequate time to cross streets, well designed curb ramps, limited driveways, and sidewalks that are wide and clear of obstructions with minimal cross slope are examples of design features that will accommodate pedestrians with disabilities, persons using strollers, and indeed, all pedestrians.

All new construction or retrofit projects must include curb ramps (wheelchair ramps) that comply with ADA requirements. Agencies should review their street system to identify other barriers to accessibility and prioritize the needed improvements. Examples of barriers that are often overlooked include poles and signs in the middle of a sidewalk, steeply sloped driveways, and interruptions such as broken or missing sidewalk sections. An adequate level of surveillance and maintenance can also be important to providing accessibility, especially in winter months in areas where snow accumulates.

Purpose:

- Ensure that all people, including those with disabilities, have equal access to public facilities.

Considerations:

- While all streets should be upgraded to be accessible, public agencies should set priorities for high-use areas such as commercial districts, schools, transit facilities, etc. and retrofit as rapidly as possible.

Estimated Costs:

Varies depending on type of project.

Photo by

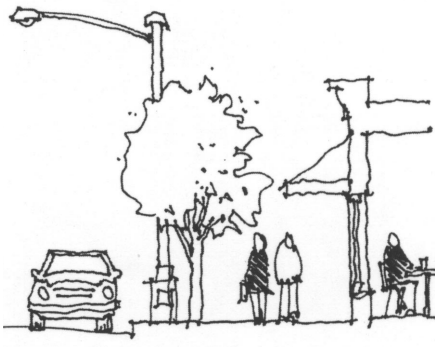
Street designs that accommodate people with disabilities create a better walking environment for all pedestrians.

48. On–Street Parking

On-street parking can be both a benefit and a detriment to pedestrians. On-street parking does increase the "friction" along a street and can narrow the effective crossing width, both of which encourage slower speeds; parking can also provide a buffer between moving motor vehicle traffic and pedestrians along a sidewalk. In addition, businesses reliant on on-street parking are more geared to pedestrian access. This attention can foster a more vibrant pedestrian commercial environment.

On the other hand, parking creates a visual barrier between motor vehicle traffic and crossing pedestrians especially with children. Therefore, where there is parking, curb extensions should be built where pedestrians cross. Parking needs to be cleared on the approaches to crosswalks.

At least 20 feet of parking should be removed on the approach to a marked or unmarked crosswalk and about 20 feet of parking should be removed downstream from the crosswalk. Some agencies require that parking be cleared back 30 to 50 feet from intersections for pedestrian safety reasons. Well-designed curb extensions can reduce these distances and increase the number of on-street parking spaces.



Sketch by Michael Kimelberg

Purpose:

- Provides motorist access to destinations along a street.
- Aids in speed reductions by increasing friction along the street.
- Provides a buffer between sidewalk edge and moving traffic.

Considerations:

- Parking may take up space desired for other uses, such as wider sidewalks or bicycle lanes.
- Approaches to crosswalks and intersections should be cleared and curb extensions added at crossing locations for pedestrian safety.

Estimated Costs:

$30–$150 per sign. Curb paint and stall marks or striping costs are additional (optional).

Photo by Cara Seiderman

On-street parking in Concord, MA shields pedestrians from moving traffic.

Chapter 5

Implementation and Resources

Photo by Dan Burden

Communities are asking that motor vehicle speeds be reduced on their neighborhood streets, that streets be made accessible to persons with disabilities and that streetscapes be improved to make them more inviting to pedestrians. The issues are safety, access and aesthetics. This chapter discusses some of the issues related to setting priorities and implementing needed pedestrian improvements.

Implementation

A. Getting Started

"Getting started" can be daunting - the needs are overwhelming, resources are scarce and staff time is limited. Every community is faced with the questions of "Where do I start?" and "How do I get going?" While it is not the intent of this guide to provide an exhaustive discussion of implementation strategies, some direction is useful.

Priorities: Since there are never enough resources to address all the needs, project priorities need to be established. To create priorities requires clear program objectives:

> ***Safety***: The number one objective should be to reduce the number and severity of crashes involving pedestrians. To accomplish this will require: a) a good understanding of the types of crashes that are occurring in your community, and b) application of appropriate countermeasures to address these crashes. The charts provided in this guide are intended to help select the countermeasures that will be most effective in addressing selected types of crash problems.
>
> ***Access***: The second objective should be to create an accessible community where all pedestrians, including those with disabilities, can reach their desired destinations. Typically, this begins with being able to safely walk along streets (i.e. sidewalks) and across streets at intersections and other appropriate locations.
>
> ***Aesthetics***: It is not enough to simply have a safe, accessible community - it should also be an aesthetic place to live and work. Landscaping, lighting and other pedestrian amenities help create a "livable community" and should be considered when making pedestrian improvements.

One step at a time: To create a safe, walkable community, take one step at a time. Sidewalks, curb bulbs and other pedestrian improvements are installed intersection by intersection, block by block. Individually, they do not create a safe, livable community. Collectively, they create the infrastructure needed for a great place to work, play and do business. In other words, the whole is greater than the sum of its parts.

Community concerns: Be very sensitive to community concerns. This is the only way to build community pride and ownership that is essential to long-term success. Some of the problems identified in this guide will not be an issue in your community and some of the countermeasures may be perceived as too expensive (at least initially). There are likely to be countermeasures that your community puts on hold for a few years until a community consensus is reached. Conversely, there are likely to be things you want to pursue that are not even mentioned in this planning guide.

Deliverables: It is very important to produce immediate deliverables that people can see. For example, a new section of sidewalk or a freshly painted crosswalk is visible while a transportation plan is a paper document that may never be seen or appreciated by the public. A program, to keep its momentum, needs some quick wins. They create the sense that something is happening, that government is responsive.

B. Construction strategies

There are many ways to get improvements constructed. Be creative, take advantage of opportunities as they present themselves. Some suggestions:

Regulation of new development and re-development: Developers can be required to install public amenities such as sidewalks, curb ramps and traffic signals. Additionally, zoning requirements can be written to allow for narrower streets, shorter blocks and mixed-use developments. The key is to focus on a few community priorities without creating disincentives to development.

Annual Programs: Consider expanding/initiating annual programs to make small, visible improvements. Examples include sidewalk replacement programs, curb-ramp programs, annual tree planting programs, etc. This creates momentum and community support. Since funds are limited, be careful about the projects you select.

- Give priority to locations that are used by school children, the elderly, those with disabilities and provide access to transit.
- Consider giving preference to requests from neighborhood groups, especially those that meet other priorities such as addressing a crash problem.
- Evaluate your construction options. Consider having city crews do work requested by citizens to provide fast customer service while bidding out some of the staff generated projects.

Capital Projects: "Piggybacking" pedestrian improvements on capital projects is one of the single best ways to make major improvements in a community. Sidewalks, pedestrian ramps, landscaping, lighting and other amenities can be included in road projects utility projects, and

private construction in public rights-of-way (i.e. cable television, high-speed fiber optics etc.). To accomplish this, there are several things that can be done.

- Contact all state and regional agencies, local public and private utilities that do work in public rights-of-way. Secure their five-year project lists as well as their long-range plans. Then, work with them to make sure that the streets are restored in the way that works for your city.
- Look internally at all capital projects. Make sure that every opportunity to make improvements is taken advantage of at the time of construction.
- Consider combining small projects with larger capital projects as a way of saving money. Generally, bid prices drop as quantities increase.

Public/Private Partnerships: Increasingly, public improvements are realized through public/private partnerships. This partnership can take many forms. Examples include: Community Development Corporations, Neighborhood Organizations, grants from foundations, direct industry support and involvement of individual citizens. In fact, most public amenities, whether they are traffic calming improvements, street trees or the restoration of historic buildings, are the result of individual people getting involved and deciding to make a difference. This involvement doesn't just happen, it needs to be encouraged and nourished by local governmental authorities.

C. Funding

There are numerous ways to fund projects and programs. Communities that are most successful at securing funds often have the following "ingredients of success":

Consensus on Priorities: Community consensus on what should be accomplished is absolutely essential to successfully funding a project. A divided or uninvolved community will find it very difficult to raise funds.

Hard Work: Funding a project is hard work; usually, there are no short cuts. It takes a lot of effort by a lot of people using multiple funding sources to successfully complete a project. Be aggressive, apply for everything. While professional grant writing specialists can help, they cannot substitute for community involvement and one on one contact (the "people part" of fund raising).

Spark Plugs (change agents): Successful projects typically have one or more "can do" people in the right place and the right time, who provide the energy and vision to see a project through. Many successful "can do" politicians get their start as successful neighborhood activists.

Leveraging: Funds, once secured, should always be used to leverage additional funds. For example, a grant from a local foundation could be used as the required match for a TEA-21 Enhancement grant.

D. Other resources

There are many other good resources on implementation and funding. The next section lists some of these resources along with contacts for obtaining copies.

The number in parentheses after an entry corresponds to the best source (listed by number in the last section titled "Sources for Information on Bicycle/Pedestrian Planning and Traffic Calming in the United States") for help in locating that document.

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Resources on the World Wide Web

There are dozens of web sites that contain information on pedestrian safety and mobility. About 75 of these sites (with hot links) may be found through the Pedestrian and Bicycle Information Center (PBIC) at the following address:

http://www.walkinginfo.org

The links included on the PBIC web site are organized by category (e.g. government agencies, professional organizations) and are as follows:

Government Agencies

U. S. Department of Transportation (USDOT)
Federal Highway Administration (FHWA)
FHWA Bicycle and Pedestrian Program
Transportation Equity Act for the 21st Century (TEA-21)
Pedestrian Safety Roadshow
FHWA Pedestrian and Bicycle Safety Research Page
FHWA Office of Highway Safety
Office of Highway Safety Pedestrian/Bicyclist Safety Program
House Committee on Transportation and Infrastructure
National Highway Transportation Safety Administration (NHTSA)
NHTSA Pedestrians, Bicycles, and Motorcycles Page
NHTSA National Child Passenger Safety Week Walkability Checklist
United States Architectural and Transportation Barriers Compliance Board (Access Board)
FHWA/NHTSA National Crash Analysis Center
Danish Road Directorate
Transportation Association of Canada

Professional Organizations

American Association of State Highway and Transportation Officials (AASHTO)
Institute of Transportation Engineers
Institute of Transportation Engineers Traffic Calming Page
Transportation Research Board
American Planning Association (APA)
Association of Pedestrian and Bicycle Professionals (APBP)
Bicycle Federation of America/National Center for Bicycling and Walking
National Bicycle and Pedestrian Clearinghouse
League of American Bicyclists
Human Powered Transportation Committee of the American Society of Civil Engineers
American Public Works Association
American Traffic Safety Services Association
National Safety Council
National Safety Council Highway Traffic Division
National Safety Council Partnership for a Walkable America
Walkable America Checklist

Other Organizations (Including Advocacy Organizations)

AAA Foundation for Traffic Safety
Massachusetts Bicycle Coalition
Bicycle Helmet Safety Institute
Better Environmentally Sound Transportation
Coalition for Alternative Transportation
Tri-State Transportation Campaign (New York/New Jersey/Connecticut)
WALK Austin
Transportation Action Network (TransAct)
America WALKs
Pedestrians Educating Drivers on Safety, Inc. (PEDS)
Walkable Communities, Inc.
Partnership for a Walkable America
American Council of the Blind--Pedestrian Safety
Rails to Trails Conservancy
Chainguard--Bicycle Advocacy Online
Vermont Bicycle and Pedestrian Coalition
Transportation Alternatives Citizens Group (New York City Area)
Travis County (AustinTX) SuperCyclist Project
Victoria Policy Institute
National Transportation Enhancements Clearinghouse
Surface Transportation Policy Project
Conservation Law Foundation
Roundabout Traffic Control Information Center
List of Pedestrian Associations

Local/State Sites

Florida Department of Transportation Pedestrian and Bicycle Safety Program
Oregon Department of Transportation Bicycle and Pedestrian Program
Wisconsin Department of Transportation Bicycle and Pedestrian Information
St. Louis Regional Bicycle and Pedestrian Advisory Committee
City of Portland,OR Pedestrian Transportation Program
City of Tallahassee, FL Bike and Pedestrian Program
City of Boulder, CO Transportation Planning
City of Cambridge, MA Environmental and Transportation Division
Montgomery County, MD Residential Traffic Calming Program
New York City Department of Transportation Pedestrian Information

Pedestrian and Bicycle Mailing Lists

Subscribe to Cyber Cyclery mailing list
Subscribe to Pednet mailing list

Pedestrian and Bicycle Link Pages

Links to pedestrian and bicycle sites provided by TransAct
Links to pedestrian issues and organization provided by PEDS
Links to pedestrian sites provided by Simpon Crowcroft
Links to bicycling organizations and resources provided by Bicycles, Inc.
Links to bicycling sites provided by Cyber Cyclery
Links to bicycle advocacy web sites provided by Chainguard
Links to bicycle education and safety sites provided by Chainguard
Links to government sites for bicycle issues provided by Chainguard
Links to state bicycle laws provided by Bicycle Coalition of Massachusetts

Pedestrian and Bicycle Studies and Statistics

Nationwide Personal Transportation Survey
Bureau of Transportation Statistics
BTS National Transportation Library Links to Pedestrian Transportation Research
BTS National Transportation Library Links to Bicycle Transportation Research
National Bicycling and Walking Study Five Year Status Report
Bike Plan Source Hot Topics provided by Tracy-Williams Consulting
Pedsmart--Application ITS Technology to Pedestrian Safety
Consumer Product Safety Commission Recreational Safety Publications
Northwestern University Traffic Institute
University of North Carolina Highway Safety Research Center

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Appendix A

Pedestrian Facility Case Studies

Photo by Dan Burden

“Woonerfs” or Living Streets

A retail woonerf or "living street"

Wall Street - Asheville, North Carolina

Wall Street was originally an alley that ran behind downtown businesses in Asheville. The alley was opened to traffic in the 1940's, but because of the narrow street design and a curve vehicle speeds were low and volume was minor. Over time, several businesses opened with their store fronts in the alley, and Wall Street became an underground arts district. In the 1970's the street was redeveloped to change the street character into a tourist destination and improve pedestrian amenities. After a decade of decline during redevelopment Wall Street is now a great place to be. It is home to several businesses, restaurants, a climbing wall and a church. Although there are no raised sidewalks, the slow vehicle speeds make this street very pedestrian friendly. The entire street was repaved using cobblestone-looking pavers. Everything is at grade and both sides of the street are separated from possible vehicle use by bollards and lamp posts. Parking was added to one side of the street at the request of the merchants, only leaving room for one-way travel at very slow speeds. Wall Street attracts a lot of pedestrian traffic with most people walking in the street.

Asheville’s redevelopment caters to pedestrians.

Residential woonerfs or "living streets"

The Cottages and Bridgewalk - Boulder, Colorado

In the early and mid-1980s, two moderate-income housing projects were developed in Boulder based on the Dutch concept of the "woonerf" or living street. The Cottages consists of 40 owner-occupied condominiums while Bridgewalk has 123 rental units. Each contains a single loop street which curves through the complex, around bollards and landscaping, to create a space to be shared by pedestrians, cyclists, and motor vehicles.

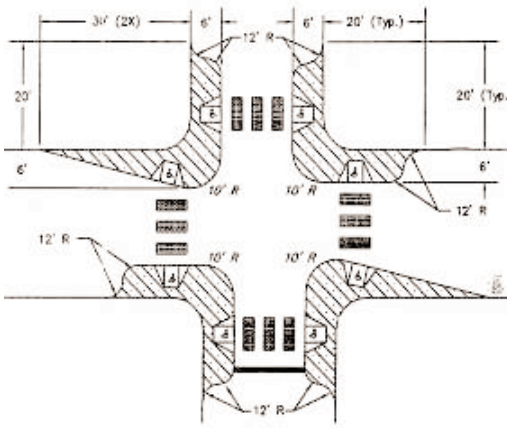
The Cottage’s shared pedestrian and vehicle space.

Comprehensive Traffic Calming Projects in Residential Neighborhoods

Raised Intersections, Curb Extensions, Chicanes, and More in a Residential Neighborhood

Cambridge, Massachusetts

Berkshire Street is in a mixed-use residential/commercial neighborhood, and home to a school, a library, and a playing field. Heavy volumes of children and other pedestrians cross Berkshire Street daily. High speeds were a major problem as many drivers used Berkshire as a cut through and ran stop signs. Several pedestrian collisions had occurred on Berkshire, mostly involving children. A variety of traffic calming treatments were implemented in 1997, including a raised crosswalk, raised intersections, curb extensions, and a set of mid-block chicanes. Chokers and raised intersections were also installed along nearby streets to slow vehicles and discourage cut-through traffic. The traffic calming measures were very effective; before the project, only 41% of the vehicles were traveling at or below the posted speed limit of 25 mph while afterward the compliance rate increased to 95%. The street improvements have also changed the entire atmosphere of the street, making it more livable and pedestrian friendly.

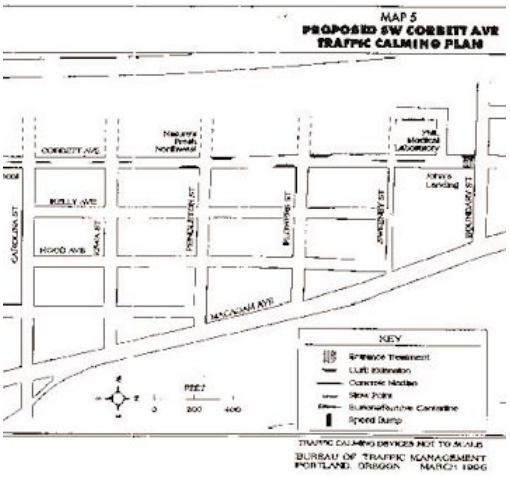


This set of chokers narrows the street width, which shortens the distance pedestrians have to cross, eliminates illegal parking at the intersection, tightens turning radii, and slows traffic, all without eliminating any lanes.

A Textured Crosswalk, a Median Barrier, and Other Improvements in a Mixed-Use Neighborhood

Portland, Oregon

SW Corbett cuts through a mixed single-family, apartment, and commercial neighborhood, but it also connects directly to downtown Portland and serves as a de facto collector and commuter route. The neighborhood traffic committee decided that it would be difficult to divert traffic and instead focused on improving the atmosphere for neighborhood pedestrians and cyclists. Curb extensions, pedestrian refuge islands, a textured crosswalk, a median barrier, three speed humps, and raised pavement markers were installed and the speed limit was dropped to 25 miles per hour. The improvements reduced speeds along the route and created a friendlier atmosphere for all modes of transportation.

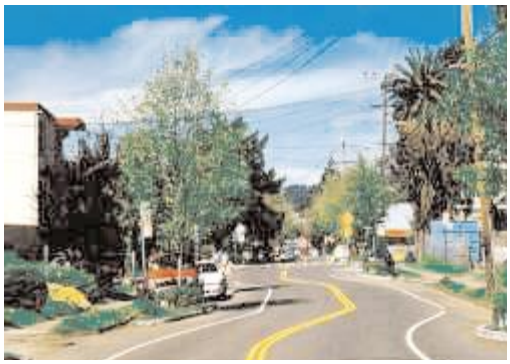


A comprehensive traffic calming plan transformed this Portland neighborhood into a more livable place.

Chicanes, Speed Humps, and Curb Extensions in a Neighborhood

Milvia "Slow" Street - Berkeley, California

In the mid-1980's residents of Milvia Street in Berkley, CA were distressed by the all-too frequent crashes on their street and worried about the traffic impacts of plans to build a new office building. Milvia is a residential street, but has in its near vicinity several childcare centers, a preschool, two elementary schools, a junior high school and a city park. Residents worked with the City and office developer to locate funds for and design a "slow street," with curb extensions and mid-block planters creating curvature in the street and one to two speed humps per block over the six-block section. As a result, the street operates at slower speeds and attracts a significant amount of pedestrian and bicycle traffic.



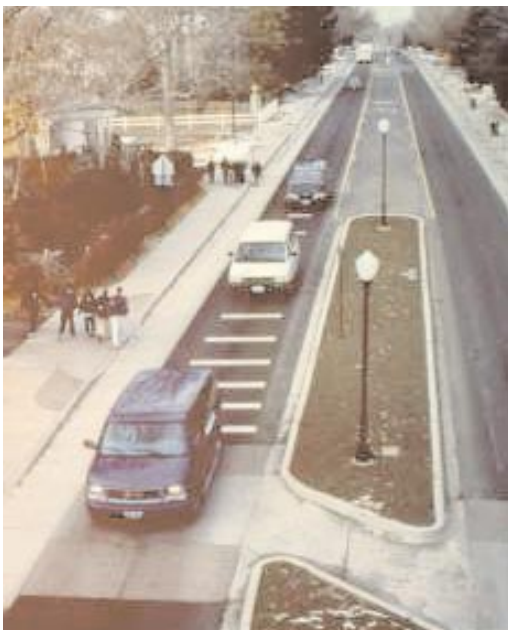
A curved slows the speed of cars.

Planted islands create safety and scenery.

Citizen Input Creates Solutions

Grand Junction, Colorado

Several years ago, First Street, a rural two-lane road with no curb, gutter or sidewalks, was beginning to develop speed and congestion problems. After reviewing possible design solutions with the project engineer, the City Council decided that expanding the street to three-lanes with medians was the best solution. However, the plans to redesign First Street by expanding the right-of-way were strongly opposed by many of the residents. After several public meetings the residents convinced the City to make a number of changes to the design plan. In order to reduce the project's impact on people's lives and property, the final design involved the construction of a center turn-lane with occasional medians to slow traffic and provide for safe pedestrian crossings. Five–foot sidewalks cutting back three feet at driveways to insure a level cross grade were installed on both sides of the street, in addition to curbs and five foot wide gutters for use as bike lanes. In addition, all of the local utilities and irrigation systems were diverted underground and historic lighting fixtures were added.



Wider sidewalks, bike lanes and raised crosswalks with a crossing island create a safer environment.

Midtown Neighborhood Preservation Transportation Plan

Sacramento, California

Residents of the Midtown and East Sacramento neighborhoods were tired of drivers using their neighborhoods as a short-cut into downtown. In response, the City Council brought in a consulting firm to work with the community to create a plan for traffic movement within the area. The plan was developed by the community members with guidance from the consultants and then submitted to the City for approval. The Department of Public Works made a few minor adjustments, but the plan was essentially implemented as designed by the community. The improvements included conversion of two one-way streets with parking to two-lane two-way streets with parking on each side, five new traffic signals, several additional stop signs, crosswalks, pedestrian crossing islands at intersections, traffic mini–circles, and half-closures. Almost all of the traffic calming measures were completed by the summer of 1998 at a cost of just over $1,200,000. The result has been a much more livable and safe neighborhood for these Sacramento residents.

Pedestrian crossing islands were a key strategy for reclaiming neighborhood streets.

Neighborhoods reconnect along 55th Street

Boulder, CO

55th Street was a busy collector street, providing a direct north/south link between two arterials, carrying a volume of approximately 9,500 vehicles each day. However, the residential neighborhoods on either side of the street were completely isolated due to the lack of pedestrian linkages across 55th Street. In order to reconnect the neighborhoods on both sides of 55th Street, the City installed several raised crosswalks, raised intersections, new sidewalks on either side, and pedestrian crossing islands in order to mitigate the speeding cars. Now, there is much safer pedestrian access on both sides of the street and the once isolated neighborhoods have been reconnected for pedestrian travelers.

A pedestrian underpass which filled a gap in Boulder's existing trail system.

A raised intersection, designed to reduce traffic speeds and facilitate pedestrian crossings.

Slower auto speeds bring a neighborhood back to life

Naples, Florida

Naples is an affluent coastal residential community which stretches seven miles along Florida beaches, but is only 1 mile wide. Many beach-bound auto travelers cut and sped through residential neighborhoods. In response, Naples decided to undertake numerous traffic calming projects in order to slow down speeders and improve the appearance of the community. Seventh Avenue is a residential street that historically had problems with high through traffic volumes and speeders. In response, the City implemented a number of different treatments, including three medians to narrow the one-mile streets and reduce their perceived width. A median was added at the streets' entrances along with brick pavers to narrow the streets and indicate to drivers that they were entering a residential neighborhood. In addition, several roundabouts were added, an intersection was raised into a speed table and distinguished through brick paving, and intensive landscaping was added to make the street appear narrower and more attractive. As a result, speeds have dropped significantly and the street itself it a much more aesthetically pleasing place for residents and visitors.

Traffic Calming Strategies Promote Downtown Revitalization

Pedestrian improvements that turned a downtown around

Climata & Narcissus Sts. - West Palm Beach, Florida

Downtown West Palm Beach was a notorious area for crime problems. The wide streets of West Palm were viewed as escape routes by drivers, rushing to get out of downtown, stopping as little as possible. As part of an overall downtown redevelopment strategy, the City of West Palm redesigned its entire downtown, with the pedestrian in mind. The Climata/Narcissus street area became one of the first traffic calming/redevelopment projects for the City. The streets were narrowed, shifted laterally and visually calmed through trees, landscaping and storefront improvements. At the intersections, bulb-outs slowed turning traffic and offered improved pedestrian crossing. A public fountain and plaza were built at one intersection, attracting children and families. The pedestrians and shoppers returned, which helped to rejuvenate local business and act as an inspiration for other downtown improvement projects.

Landscaping and bulbouts create an atmosphere that is friendly to pedestrians as well as cars.

Downtown revitalization brings back a seaside community

Ft. Pierce, Florida

Fort Pierce is a seaside community located along the intercoastal waterway on the Atlantic Coast of Florida. While Fort Pierce was one of Florida's earliest transportation and commercial hubs, the rapid suburbanization and malling of St. Lucie County in the 1970s helped foster its decline. In the mid-1990's, private and public leaders decided it was time to rebuild their community. Since one of the major stumbling blocks to downtown revitalization was an inhospitable pedestrian environment, community charette (design workshop) was organized in January 1995 to produce a vision and plan for reconstructing the downtown, sponsored jointly by the city of Fort Pierce, the Main Street Fort Pierce Program and the regional planning agency. The charette resulted in the construction of several major projects within three years, including the development of a downtown roundabout and steetscape on Second Street. The streetscape project included the re-paving of Second Street, downtown's main road, expanding and re-tiling all the sidewalks with light colored brick, planting new palm trees and installing decorative street lights in the downtown. The next phase of the project reconfigured the street network of the waterfront area to improve traffic flow, improve the connection between the waterfront and downtown. and open the waterfront for redevelopment. All of the redevelopment improvements have generated significant new activity and interest in the downtown.

Improved design and landscaping improve the livability of downtown Fort Pierce.

A Main Street that came back to life

Hendersonville, North Carolina

Due to a regional shopping mall, the mountain town of Hendersonville, North Carolina watched its old downtown lose its place as the commercial and social center of the community. At night, the wide and straight roadway became a car race track for local teenagers. Inspired by a trip to Grand Junction, Colorado, local town leaders decided to reinvent Main Street as a specialty shopping center oriented to out of town visitors. However, the new Main Street first needed to develop an environment that could entice travelers out of their cars. In order to enhance the street for pedestrians, the new Main Street was narrowed from four lanes to two.

Bulb-outs shorten pedestrian crossing distance and slow down cars.

Mid-block curves were added with marked crosswalks at the peak of each curve. The curb extensions shorten pedestrian crossing distance at intersections, improve pedestrian visibility, force tighter/slower right turns onto Main Street, and reinforce the notion that the driver has entered a traffic calmed area. The area has also been landscaped with signs, flowers and trees. As a result, Main Street Hendersonville is once again bustling with pedestrians and shoppers.

Newly curved roads force motorists to drive slowly.

An Old Town revival

Eureka, California

In 1976, the Planning and Engineering Departments of Eureka, CA began to work together on the process of revitalizing the city's "Old Town" district. Over the next two years a variety of streetscaping improvements were made to beautify the area and make it more friendly to pedestrians, shoppers and tourists. This area included a wide variety of shops, historic Victorian houses, and the Carson Mansion. The City installed a variety of treatments along Second Street including curb extensions, S-Curves, raised islands, and brick sidewalks, crosswalks and intersections. In addition, parking was removed from each side of the street and sidewalks were expanded to a width of 12 feet. The Second Street potion of "Old Town" is now a significant attraction for tourists as well as local residents to visit, walk and shop. The area has a variety of establishments with sidewalk seating and high pedestrian volumes.

Part of Eureka's Second Street streetscaping featuring a raised intersection, brick crosswalks and Carter Mansion in the background.

A pedestrian promenade restores civic life

Santa Monica, California

The Third Street Promenade was a commercial district made into a pedestrian mall in the 1960's. Over the years it was neglected and fell into disrepair. In 1989, the City decided to revitalize the area by creating a set of design guidelines that promoted the preservation of historic buildings along Third Street, mandated a pedestrian scale to new development, and encouraged the addition of pedestrian amenities by property owners. Even though a road was constructed with removable bollards at the end of each block as part of the redevelopment project to appease the concerns of business owners, the bollards have never been removed because of the Promenade's overwhelming success as a pedestrian-only space.

An overview of the Third Street Promenade.

School Related Safety Improvements for Students

A Modern Roundabout near a middle school

Keck Circle - Montpelier, Vermont

At the beginning and ending of the school day, Main Street in Montpelier suffered from congestion as parents dropped off middle school students and drivers speed through a T-intersection used by students and senior center residents for crossings. The city chose to install a modern roundabout, Keck Circle. The roundabout's design requires that drivers slow to roughly 15 miles per hour when entering the circle and drivers are warned to watch for pedestrians. Additionally, the smooth flow through the roundabout reduced traffic congestion in front of the school.

Vehicles must slow down to enter the tight curve of the roundabout, creating a safer interaction with pedestrians.

Pedestrian refuge island at a busy crosswalk between a park and a Boys and Girls Club

Bellevue, Washington

The crosswalk on 100th Avenue in Bellevue, WA links the Boys and Girls Club with Bellevue Downtown Park. In February of 1997, a six-year-old boy was struck but not injured while crossing this four-lane street at a crosswalk. Cars in three of the four lanes had stopped but one had not. Following the crash, the Bellevue Transportation Department replaced one of the two southbound lanes with a center turn lane. At the crosswalk, this turn lane now contains a pedestrian refuge island, narrowing the street and providing a safe haven for crossing pedestrians.

The refuge island allows children to cross the street in two short trips instead of waiting for a clearing long enough to cross the entire street.

Gated pedestrian refuge island next to a high school

12th Avenue - Tucson, Arizona

Twelfth Avenue is a very busy arterial street, adjacent to a high school. To enter/exit the school, students crossed against speeding traffic, resulting in many near incidents. Students were also congregating in front of a restaurant directly across from the school entrance, upsetting the restaurant owner. An 88-ft long median was installed in the cen-

ter turn lane. The crosswalk was separated into two legs, the first connecting the school entrance with the island, the second connecting the far end of the island to a transit stop further down the street than the restaurant. The island was gated so that entry and exit are possible only at the two far ends, and the crosswalks were marked with ladder striping and signed with overhead yellow flashers and several crossing signs. The median reduces potential pedestrian/vehicle conflicts by offering mid-street pedestrian refuge. The gated design is effective in channeling pedestrian crossings at the crosswalks and directing students away from the restaurant.

The gates on this pedestrian island direct students' attention to the oncoming traffic.

Sidewalks, Modern Roundabout, and Bike Path near several schools

Grandview Drive - University Place, Washington

The City of University Place decided to begin their pedestrian improvement and traffic calming program on Grandview Drive, a two-lane residential route that has schools at both ends of the project area yet no sidewalks or other pedestrian amenities. Sidewalks, street trees, curb and gutter, bike lanes, and landscaped medians were added, narrowing the roadway and providing a more attractive, pedestrian-oriented atmosphere. Additionally, a roundabout was installed at the busiest intersection and adjacent to two schools. The project has reduced speeds by five miles per hour and changed the community's attitudes about traffic calming and pedestrian improvements.

The addition of bicycle lanes and sidewalks created space for pedestrians while medians and landscaping narrow the street width and slow traffic.

A Recycled Bridge Provides Pedestrian Access for Students

Aire Libre Elementary School - Phoenix, Arizona

In the early 1990s two schools in Phoenix were both in the difficult position of needing a pedestrian bridge. An expressway near Mercury Mine Elementary was being widened so it's bridge would no longer be wide enough. At roughly the same time students at Aire Libre Elementary were running across the Greenway Parkway, which had been built along their route to school. The City opted to move the 72-ton Mercury Mine bridge six miles to a new site over the Greenway Parkway. The new ramps, and footings were designed with the help of a local artist to look as if the bridge had always belonged there. The "new" bridge is not only aesthetically pleasing, but reusing this resource was approximately $500,000 cheaper than building a new bridge for the school.

A recycled bridge provides a safe pedestrian route for students in Phoenix

Other Treatments

Covered Bike Parking That's More Than It Seems

Monroe Street - Corvallis, Oregon

The City of Corvallis determined that it needed to address the growing number of pedestrian injuries in its downtown. There was also a demand for more bicycle parking on the main commercial corridor bordering Oregon State University. To resolve these problems, the City installed three curb extensions, each containing a covered bike parking structure. The curb extensions improved pedestrian safety by reducing the crossing width of the intersection and providing improved sight lines for pedestrians. The bicycle parking is being used extensively and the covered bicycle parking also serves as a protected bus stop for transit patrons. With strong support for the project from local businesses, there are already plans for several more curb extensions to be installed.

Covered bike parking benefits pedestrians as well by creating a narrower crosswalk through curb extensions..

Speed humps create safety on a residential street

Tucson, Arizona

Langley Avenue/Kingston Drive is a residential street which was used as a cut through for commuters. Not only was the street a favorite short-cut for late-night drivers trying to avoid intersections and the police, but there were also several crashes involving speeding vehicles crashing into houses. Since the neighborhood streets had no sidewalks, neighborhood residents avoided walking or bicycling on their own streets due to the large number of speeding motorists. Instead of stop signs, the city engineering department recommended speed humps, and their construction was financed by the residents themselves. Six speed humps were installed, which led to a significant reduction in speeding vehicles as well as traffic volume. As a result, people feel safe walking, pushing strollers, and letting children ride bikes in the street even though the neighborhood still has no sidewalks.

Speed humps help prevent speeding in this residential neighborhood.

Intersections designed with safety in mind along Springwater Corridor

Portland, Oregon

The Springwater Corridor is a 13 mile long, 10' to 12'–wide former railroad right-of-way converted by the City of Portland into a multi-use trail. Since the trail goes through three cities (Portland, Milwaukie and Gresham) and two counties (Multnomah and Clackamas), it is heavily used by pedestrians, bicyclists and equestrians for both transportation and recreation. Along the length of the trail there are several road crossings, from small residential streets to four-lane arterials, so special care was taken to make the crossings as safe as possible for both motorists and non-motorized trail users. While some of the smallest crossings have no markings, others have ladder-style crosswalks and the largest intersections have signals with pedestrian crossing islands. The signals at these intersections face both motorists and trails users, who can activate the signal by a variety of different methods. Pedestrians can push a traditional push-button, cyclists activate a loop underneath the path and equestrians can activate a higher push-button. The result is a much safer environment for all trail users.

Marked crosswalks and signals make intersections safe for pedestrians, bicyclists and motorists.

Appendix B

Priorities and Guidelines for Providing Places for Pedestrians to Walk Along Streets and Highways (Revised Draft)

Photo by Dan Burden

by:

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for the Federal Highway Administration

August 17, 2000

I. Introduction

According to the AASHTO Green Book: "Providing safe places for people to walk is an essential responsibility of all government entities involved in constructing or regulating the construction of public rights-of-way."

It is a basic principle that there be well designed, safe places for people to walk along all public rights-of-way. How this will be accomplished will depend upon the type of road, whether it is new construction or a retrofitted area, and funding availability.

On February 24, 1999, FHWA Administrator Kenneth R. Wyke in a memorandum to field offices stated, "We expect every transportation agency to make accommodations for bicycling and walking a routine part of their planning, design, construction, operations and maintenance activities." Again, in February 28, 2000, Administrator Wyke sent a memorandum to the field offices in transmitting the new Design Guidance Language called for in TEA-21. The guidance entitled "Accommodating Bicycle and Pedestrian Travel: A Recommended Approach – A US DOT Policy Statement on Integrating Bicycling and Walking into Transportation Infrastructure," states that bicycling and walking facilities will be incorporated into all transportation projects unless "exceptional circumstances" exist. The exceptional circumstances are spelled out, and he asked the division offices to work with State DOTs in the implementation of the guidance.

Government agencies at the state, regional and local level are developing regulations for funding, installing and retrofitting sidewalks. Because there is a great need to improve sidewalk facilities and limited resources, it is important for these transportation agencies to direct funding to sidewalk improvement and installation projects that will be most beneficial to the safety and mobility of all citizens.

This document is intended to provide agencies at the state, regional and local level with tools they can use to develop guidelines for creating places for people to walk.

This document is limited to creating guidelines for sidewalks, which address only one of three major pedestrian needs; the ability to cross a street, and intersection design are the two others that merit further consideration.

II. Basic Principles

Many communities may wish to revisit their roadway planning and rehabilitation criteria. Policies, standard plans, subdivision regulations, and right-of-way requirements should be considered to make sure that sidewalks are included in new construction and rehabilitation projects.

A. Goals and Objectives

Typically, communities should focus on 1) Improving conditions for people who are currently walking (including improved accessibility to sidewalk facilities for pedestrians with disabilities); 2) Increasing levels of walking and 3) Reducing the number of crashes involving pedestrians. Setting targets will help in the development of criteria for installing and retrofitting sidewalks.

B. Pedestrian Facilities

There are several ways in which pedestrians can be accommodated in the public right-of-way:

1. Sidewalks. Sidewalks, provided on both sides of a street, are generally the preferred pedestrian facility. They provide the greatest degree of comfort for pedestrians and the presence of sidewalks has been associated with increased safety for pedestrians. The Uniform Vehicle Code defines a sidewalk as that portion of a street between the curb lines, or the lateral lines of a roadway, and the adjacent property lines, intended for use by pedestrians. In most cases, sidewalks are paved, usually in concrete. To comply with Federal ADA guidelines, newly constructed sidewalks must be accessible to people with disabilities.

2. Off-road paths. An off-road path – paved or unpaved – can be an appropriate facility in rural or low-density suburban areas. Paths are generally set back from the roads and separated by a green area or trees. Paths can be flexible in that they can deviate from the exact route of a road in order to provide more direct access for key destinations. Paths that generally follow the roadway alignment are sometimes known as "side paths."

3. Shoulders. Wide shoulders on both sides of a road are the minimum requirement for providing at least a possible place for people to walk. They are not as safe as paths or sidewalks, but they are better than nothing. Shoulders are also beneficial for motorists and cyclists, and future sidewalks or paths should be created in addition to, not in replacement of, the shoulders.

4. Shared streets. In very limited unusual circumstances it may be possible to allow shared use of a street for people walking and driving. These are usually specially designed spaces such as pedestrian streets or "woonerfs," and guidelines for developing these kinds of places can be found elsewhere (see, e.g., the Pedestrian Facility User Guide).

C. New Construction and Retrofitting

Places for people to walk should be provided in all new construction, retrofitting will require priorities to be set, and these guidelines are intended to help identify where the need is greatest for adding sidewalks and other facilities.

III. New Construction

A. New Sidewalk Installation

All new construction must include places for people to walk, on both sides of a street or roadway. New construction in urban and suburban areas should provide sidewalks.

B. Phased Development of Sidewalks

In developing and rural areas, it may be acceptable – although less desirable – to start with shoulders and unpaved paths and then phase in sidewalks as development accelerates. Criteria for installing sidewalks along with new development should be implemented with the following in mind:

1. **Space for Future Sidewalks:** Space for future sidewalks must always be secured and/or reserved when a new right-of-way is being created or an existing one is being developed. If roadways are to be widened, additional right-of-way must be acquired; existing sidewalks should not be narrowed to accommodate a wider roadway.
2. **"Triggers" for Future Sidewalks:** In rural settings, if sidewalks are not installed at the time of development due to lack of need or density, guidelines are needed to determine when sidewalks will be required and how they will be funded. For example, sidewalks might be required on residential streets once an area has a density of more than four dwelling units per acre; and on arterial streets once they

are within a school walking zone or have transit service.

3. **Funding for Future Sidewalks:** If sidewalks are not installed at the time of development, there needs to be clear regulations as to whom (developer, property owners, or governmental agency) will pay for the sidewalks. Whoever is paying for the road must pay for the sidewalk. If there is money for a road, there is money for a sidewalk. Developer contributions to sidewalks must be set aside in an account at the time of development.

C. Retaining Rural Character

There is a desire in some residential developments to retain a "rural" atmosphere. Very often this occurs in places that are not truly rural but rather suburban or exurban (they may have been rural before being developed). It is frequently in such places that pedestrian crashes occur that are directly attributable to pedestrians not having places to walk. To address both the goal of having safe places to walk and that of the community to retain a certain atmosphere, path systems can be developed that do not look like traditional sidewalks but do meet walking needs. Even in "rural" areas, people do want to walk and should be provided for.

Developers in outlying areas may argue that the land use will never fully develop into a pedestrian area. Given that people walk despite not having facilities – for exercise, going to friends' houses, accessing transit, etc. – it is neither rational nor acceptable to build places that do not have places for people to walk. Residential developments that were added in suburban areas until recently typically had sidewalks and function very well.

Sidewalks may not be needed on short residential cul-de-sacs (200 feet or less), if there is a system of trails behind the houses and driveway aprons are properly constructed for pedestrians with disabilities. However, it is not a good practice to have an entire neighborhood without sidewalks.

D. Sidewalk Continuity

Sidewalks should be continuous; interruptions may require pedestrians to cross a busy arterial street midblock or at an unsignalized location to continue walking. Sidewalks should also be fully accessible to side streets and adjacent sidewalks and buildings.

IV. Retrofitting Sidewalks

Many of the streets built in recent decades do not have sidewalks, and these streets need to be retrofitted. In other cases, existing sidewalks need replacement. Establishing priorities for installing sidewalks involves three steps: 1) develop a prioritized list of criteria; 2) develop a methodology for using the criteria to evaluate potential sites; and 3) create a prioritized list of sites for sidewalk improvements.

A. Criteria

The following are suggested criteria for establishing priorities. Select three or more of them when developing your own set of criteria. The key is to select criteria that produce the outcomes desired for your community:

1. **Speed:** There is a direct relationship between speed and the number and severity of crashes; high-speed facilities may rank higher if speed is a criterion.
2. **Street classification:** Arterial streets should take precedence, because they generally have higher pedestrian use (due to more commercial uses), a greater need to separate pedestrians from motor vehicles (due to higher traffic volumes and speeds), and arterials are the main links in a community.
3. **Crash Data**: Pedestrian crashes seldom occur with high frequencies at one location, but there are

clearly locations where crashes occur due to a lack of sidewalks. Usually, there is a pattern of pedestrian crashes up and down a corridor, indicating a need to provide sidewalks throughout, not just at crash locations.

4. **School Walking Zones:** School walking zones typically extend to _ mile from an elementary school. Children are especially vulnerable, making streets (especially arterials) in these zones prime candidates for sidewalk retrofits.
5. **Transit Routes:** Transit riders need sidewalks to access transit stops. Arterials used by transit are prime candidates for sidewalk retrofits.
6. **Neighborhoods with Low Vehicle-Ownership:** Twenty percent of our population have a disability and 30% of our population does not drive. Walking is the primary mode of transportation for many of the people in this country. People with disabilities live throughout the community. If they are not seen in the community, it may be due to the fact that adequate facilities are not provided. In addition, car ownership is lower and crash rates are often higher in low- and moderate-income neighborhoods with lots of children. Therefore, some locations with high pedestrian use (neighborhoods with more children and elderly persons and where vehicle ownership is low) should be given special consideration for sidewalks.
7. **Urban Centers/Neighborhood Commercial Areas:** Areas of high commercial activity generate high pedestrian use, even if they are primarily motorists who have parked their car. Sidewalks are needed to improve safety and enhance the economic viability of these areas.
8. **Other Pedestrian Generators:** Hospitals, community centers, libraries, sports arenas and other public places are natural pedestrian generators where sidewalks should be given priority.
9. **Missing Links:** Installing sidewalks to connect pedestrian areas to each other creates continuous walking systems.
10. **Neighborhood Priorities:** Local residents usually know where sidewalks are most needed. Neighborhood groups or homeowners associations can provide a prioritized list of locations where they see a need for sidewalks. Agencies should be cautious about using this criterion, as it is not desirable to let neighborhood pressure override addressing a key safety concern.

B. Methodology

The two recommended methodologies for selecting locations for improvements are: a) the overlapping priorities method, and b) the points method. Establishing priorities should consume only a small percentage of a program budget - the level of effort put into prioritization should be proportionate to the size of the capital budget.

There is no single right way to select which criteria to use when developing priorities. The criteria and methodology should balance safety measures, such as vehicle speeds and pedestrian crash data, pedestrian usage measures, such as proximity to schools or commercial areas, continuity between origins and destinations, and accessibility for pedestrians with disabilities.

1. Overlapping Priorities Method: The easiest and cheapest way to identify overlapping priorities is through graphical representation; the intent is to identify locations that meet multiple criteria. This methodology is especially useful in cases where there is not a lot of staff time and funding for detailed analysis. It can be accomplished using a GIS system or it can be done by hand.

The best way to describe this methodology is by example. Assume that priorities are going to be developed based on transit routes, proximity to schools, people with disabilities, and neighborhood commercial areas. Start with a map of your jurisdiction. Using a colored pen, identify those arterials that have high transit use; draw a half-mile circle around every elementary school and around locations that attract peo-

ple with disabilities; and color in the neighborhood commercial areas. This visual approach will make areas of overlapping priorities become immediately clear. The streets without sidewalks within the overlapping areas are the highest priority for retrofitting sidewalks.

2. Points Method: A weighted points system can be used where staff time and funding are available for more detailed analysis, or if there is a large amount of capital available for sidewalk construction. If there are a lot of competing projects, a more sophisticated point system can be used to explain to the public why certain projects were funded and others were not.

A point system can be developed in many ways; the system should be simple and produce desired outcomes. Any and all of the criteria listed above can be assigned a range of numbers and then be used to analyze the need for improvements at given locations. For example, a corridor could be assigned points based on the number of 'walking along roadway' crashes over a five-year period; the number of buses that travel the corridor during peak times; and the proximity to elementary schools. This method is time consuming because it will be necessary to analyze multiple locations with sidewalk needs to create a list of priority projects.

3) Prioritized List: Both the overlapping priorities and the points methods will produce an initial list of prioritized projects. The next step is to refine the list so that it works, using common sense. One important consideration is that when roadways are resurfaced, rehabilitated, or replaced, curb ramps must be added if there are pedestrian walkways. In addition, the Department of Justice considers bus stops to be pedestrian walkways requiring access for people with disabilities, so areas near transit should be given priority accordingly. Other important questions include: Are priority locations ones that might be expected? Are there many surprises? Are priority locations in line with community priorities and expectations? Are some priorities at locations with very low pedestrian use? If the answer to these questions is "yes," then the criteria or the methodology should be revised to create outcomes that better reflect expectations and desires. The methodologies should be used to prioritize known needs, not to create a new set of priorities that don't make sense.

The final step is to create packages of fundable projects. The prioritization process should result in reasonable packages that decision-makers can embrace and support. For example, it may be possible to install sidewalks on one side of every arterial within a half mile of every elementary school, for five million dollars over a period of five years. Or, it may be possible to replace sidewalks in neighborhood commercial areas for two million dollars over a period of three years. The objective is to take what may appear to be an unsolvable problem (endless need for more funds), and to package it in such a way that it begins to address some of the most critical pedestrian needs in a community.

V. Sidewalk Design Guidelines

Sidewalk Placement in Large and Small Cities

Continuous sidewalks should be placed along both sides of all fully improved arterial, collector and local streets in urban and suburban areas. In low density residential areas (1 to 4 dwelling units per acre), sidewalks may be provided on one side of the street, although sidewalks are preferred on both sides. Sidewalks should connect to side streets and adjacent buildings. Accessible crossings should be provided across median islands, frontage road medians and other raised islands.

Seattle Example

Seattle recently completed an inventory of all sidewalks in the city using a three-step process:

1. An intern was hired to review aerial photographs to determine if a sidewalk existed. This information was then recorded as a new layer on the existing GIS street database.
2. The intern field checked all locations where there was some uncertainty regarding the presence of a sidewalk (about ten percent of the aerial photos were not clear).
3. Each of thirteen neighborhood groups that cover the city were given a draft copy of the inventory and asked to check for errors.

The total effort took the equivalent of one full time person working for six months in a city of 530,000 population, 84.3 square miles of land use and 1,652 roadway miles (1,202 residential street miles and 450 arterial miles). Once the inventory was completed, the information was combined on a map with three other types of information:

1. **School Walking Zones:** a colored circle identified a half-mile area around each school;
2. **Pedestrian Generators:** a second color was used to identify a half-mile area around key pedestrian generators such as hospitals, libraries and community centers;
3. **Neighborhood Commercial Areas:** a third color was used to identify the dozen neighborhood commercial areas in Seattle (about one for each of the major neighborhood areas).

Once the map was printed, it was very easy to see where the three colors overlapped, two colors overlapped etc. The final step was to have the computer calculate the sidewalk deficiencies in the overlapping areas. They found, for example, that there were less than two miles of arterial streets that were within school walking zones, a pedestrian generator area and a neighborhood commercial area, that did not have sidewalks on either side of the street.

There were close to three miles of arterial streets that were within school walking areas but outside of neighborhood commercial areas and pedestrian generators, that did not have sidewalks on either side of the street. This compared to a citywide deficiency of more than twenty miles of arterial streets that lacked sidewalks on both sides of the street.

By developing these and other numbers, the pedestrian program was able to put together packages of information that demonstrated what could be accomplished with additional funding. What everyone thought to be an unsolvable multi-million-dollar problem was reduced to a series of smaller, fundable projects that decision-makers could endorse. The result was increased funding and a new optimism that meaningful progress could be made on solving Seattle's sidewalk deficiencies

Sidewalks, Walkways and Shoulders in Rural Areas

A safe walking area must be provided outside the motor vehicle traffic travel way. Sidewalks along rural roads should be well separated from the travel way. Isolated residential areas should have a pedestrian connection to the rest of the rural community for school access, shopping and recreational trips.

In off-road path – also known as a side path -- is a type of walkway used in some rural settings. This path may be paved or unpaved, and is separated from the roadway by a grass or landscaped strip, without curbing. This maintains a rural look but is safer and more comfortable than a shoulder.

Where it is impractical to provide a sidewalk or walkway along a rural road, a paved or unpaved shoulder should be provided as a minimum. Paved shoulders are preferred to provide an all-weather walking surface, as they also serve bicyclists and improve the overall safety of the road. A five-foot wide shoulder is acceptable for pedestrians along lower-type highways. Greater width, up to 8 to10 feet is desirable along high-speed highways, particularly with a high number of trucks. An edge line should be marked to separate the shoulder form the travel way.

Sidewalk Width

The width of a sidewalk depends primarily on the number of pedestrians who are expected to use the sidewalk at a given time – high-use sidewalks should be wider than low-use sidewalks. "Street furniture" and sidewalk cafes require extra width, too. A sidewalk width of five feet is needed for two adult pedestrians to comfortably walk side by side, and all sidewalks should be constructed to be at least this width. The minimum sidewalk widths for cites large or small are:

Local or collector streets	-5 feet
Arterial or Major streets	- 6 to 8 feet
CBD areas	- 8 to 12 feet
Along parks, schools and other major pedestrian generator	- 8 to 10 feet

*8 foot minimum in commercial areas with a planter strip,
12 foot minimum in commercial areas with no planter strip.

These widths represent a clear or unobstructed width. Point obstructions may be acceptable as long there is at least 36 inches for wheelchair maneuvering (no less than 48 inches wide as a whole), but every attempt should be made to locate street lights, utility poles, sign posts, fire hydrants, mail boxes, parking meters, bus benches and other street furniture out of the sidewalk. When that is not possible, sidewalk furnishings and other obstructions should be located consistently so there is a clear travel zone for pedestrians with vision impairments and a wider sidewalk should be provided to accommodate this line of obstructions.

Similarly, when sidewalks abut storefronts, the sidewalk should be built two feet wider to accommodate window shoppers, and to avoid conflicts with doors opening and pedestrians entering or leaving the buildings.

Many 4-foot sidewalks were built in the past. This width does not provide adequate clearance room or mobility for pedestrians passing in opposite directions. All new sidewalks should be 5 feet or wider.

Sidewalk Buffer Width

Buffers between pedestrians and motor vehicle traffic are important to provide greater levels of comfort, security and safety to pedestrians. Landscaped buffers provide a space for poles, signs and other obstructions, they serve as a snow storage area and they protect pedestrians from splash. The ideal width of a planting strip is 6 feet. Minimum allowable landscape buffer widths are:

Local or Collector Streets	- 2 to 4 feet
Arterial or Major Streets	- 5 to 6 feet

With a landscaped buffer between the sidewalk and the street, care must be taken to ensure that the bus stops are fully accessible to wheelchair users and have connections to the sidewalk. Irrigation may be needed in areas of low precipitation.

Buffers also provide the added space to make curb ramps and landings accessible. When the ramps and landings are designed properly, they are also better utilized by others pushing strollers or pulling carts and luggage.

If a planting strip is not provided between the sidewalk and roadway, then the sidewalk width should be a minimum of 6 feet.

Where landscaped sidewalk buffers cannot be provided due to constraints, on street parking, a shoulder or a bike lane can serve to buffer pedestrians from motor vehicle traffic lanes. The overriding principle is that a narrow sidewalk should never be placed right next to moving traffic.

Sidewalk Surface

Concrete is the preferred sidewalk surface, providing the longest service life and requiring the least amount of maintenance. Asphalt is an acceptable walkway surface in rural areas and in park settings and crushed granite may also be an acceptable all-weather material in parks or rural areas, but they generally require higher levels of maintenance and are less desirable for wheelchair users.

Sidewalks may be constructed with bricks and pavers if they are constructed to avoid settling; bricks should be easy to replace if they cause a tripping condition. There are stamping molds that create the visual appearance of bricks and pavers; these have the advantages of traditional concrete without some of the maintenance issues and roughness associated with bricks and pavers. There are commercially available products that produce a variety of aesthetically pleasing surfaces that are almost impossible to distinguish from real bricks and pavers. However, bricks and/or pavers can create too rough a surface for people with disabilities and, therefore, it may be appropriate to use bricks or pavers only for sidewalk borders in certain situations.

It is also possible to enhance sidewalks aesthetics while still provide a smooth walking surface by combining a concrete main walking area with brick edging where street furniture (lights, trees, poles, etc.) can be placed. For example, in a CBD, a 15 foot total sidewalk width might include 8 foot clear concrete sidewalk with 7 foot edge.

Sidewalk Grade and Cross Slopes

Sidewalks should be built to accommodate pedestrians of all abilities and should be as flat as practicable. Sidewalks should be held to a grade of 5% or less, if possible. However, sidewalks that follow the grade of a street in hilly terrain cannot meet this requirement, for obvious reasons, and may be the same grade as the street. The maximum grade for a ramp is 1:12 (8.3%).

The maximum sidewalk cross slope is 1:50 (2%) to maintain stability for wheelchair users and still provide drainage. At least 3 feet of flat sidewalk area is required at the top of a sloped driveway to accommodate wheelchair use. In some cases, it may be necessary to bend the sidewalk around the back of the driveway to achieve 3 feet level.

Curb Ramps

Curb ramps must be provided at all intersection crossings (marked or unmarked) and mid-block crosswalks for wheelchair access. These ramps also accommodate strollers, carts, the elderly and pedestrians with mobility limitations. Curb ramps should be as flat as possible, but must have a slope no greater than 1:12 (8.3%). Abrupt changes in elevation at the top or bottom should be avoided. The minimum curb ramp width is 36", but 48" is the desirable minimum. If a curb ramp is located where pedestrians must walk across the ramp, the ramp must have flared sides of no more than 1:10 (10%) slope. These flares are not needed where ramps are placed in a landscaped area. Curb ramps also require a minimum 36" clear passage (48" or more desirable) at the top.

Two separate curb ramps, one for each crosswalk, should be provided at each corner of an intersection. Diagonal curb ramps provide no directional guidance to vision-impaired pedestrians, and force wheelchair users to maneuver in the crosswalk. Raised islands in a crossing must have at least a 48" cut-through level with the street; this is generally preferable to curb ramps, which force wheelchair users to go up and down.

Obstacles along the Sidewalk

The distance to the bottom of signs placed in or right next to a sidewalk should be at least seven feet above the sidewalk surface to avoid injury to pedestrians. Bushes, trees and other landscaping should be maintained to prevent encroachment into the sidewalk. Jurisdictions should adopt ordinances requiring local property owners to trim the landscaping they place along their frontage to maintain clear and unobstructed sidewalks. The jurisdictions should provide an inspection procedure or a system of responding to sidewalk encroachment and maintenance complaints.

Guy wires and utility tie downs should not be located in or across sidewalks at heights below seven feet. When placed adjacent to sidewalks or pedestrian walkways, the guy wires should be covered with a bright yellow (or other high visibility) plastic 'guard' to make the wire more visible to pedestrians. Guy wires of any color will not be visible to blind pedestrians and must not be located within the pedestrian route. Other obstacles include controller boxes, awnings, temporary signage, and similar items.

Minimum ADA Requirements

The easiest way to visualize the above minimum ADA requirements (grade, cross-slope and clear width) is with the concept of a "continuous passage." Sidewalks must provide a continuous route at a 2% maximum cross-slope at a minimum width of 3 feet. This does not mean that 3 feet is an acceptable sidewalk width, just that at no point shall the level area be less than 3 feet wide; this applies mainly at obstructions, driveways and curb ramps.

Snow

Municipalities that do not do snow removal on sidewalks should have an ordinance requiring property owners to clear snow. When the latter is the case, municipalities should educate property owners as to why this is important and have enforcement efforts in place to ensure compliance.

Bus Stops and Shelters

It is generally preferable to place bus shelters between the sidewalk and the street, or between the sidewalk and adjacent property, so that waiting passengers do not obstruct the flow of pedestrians along the sidewalk. Benches and other street furniture should be placed outside the walking paths to maintain the accessibility of the walkway and to provide good pedestrian service. In addition, curb ramps should be provided at bus stops because it is not always possible for the bus to pull close enough to the curb to deploy a lift.

Lighting

Good street lighting improves the visibility, comfort and security of pedestrians. It is impractical to pro-

vide lighting in most rural areas In urban areas, it is important to light at least the intersections and other pedestrian crossing areas. Lighting is also recommended in areas where there is a high concentration of nighttime pedestrian activity, such as churches, schools, and community centers. Where continuous lighting is provided along wide arterial streets, it is desirable to place the lights along both sides of the street. Continuous streetlights should be spaced to provide a relatively uniform level of light. In shopping districts or in downtown areas with high concentrations of pedestrians, it may be desirable to provide pedestrian level lighting, in addition to the street lighting to improve the comfort and security of pedestrians. The preferred pedestrian-level lights are mercury vapor or incandescent. Low-pressure sodium lights may be more energy-efficient, but are undesirable because they create considerable color distortion. Pedestrian-level lighting may also be installed in selected areas of pedestrian activity to create a sense of intimacy and place.

Other Design Considerations

Sidewalks should be built within the public right-of-way or in a sidewalk easement along the right-of-way. This will provide access to the sidewalk for maintenance activities, and will prevent the adjacent property owners from obstructing or removing the sidewalk in the future.

Care must be taken to avoid planting trees or large bushes in the landscape buffer area that will obscure the visibility of a pedestrian attempting to cross or enter a street and an approaching motorist. Trees with large canopies planted between the sidewalk and street should be generally trimmed up at least eight feet high and bushes should be kept to about 30 to 36 inches in height. Trees with large caliper trunks may not be appropriate near intersections and in other situations where they may block visual sight triangles.

Meandering sidewalks are sometimes used where a wide right of way is available and there is a desire to provide a high level of landscaping, such as in a park or along a waterway or other natural feature. It is often believed that meandering sidewalks create a more pleasant walking environment. The reality is they unnecessarily create a longer walking distance and are inappropriate for sidewalks along a street.

Sidewalks should be built along both sides of bridges. Pedestrian rails are required along the outside of the bridge. On bridges with high-speeds, concrete barriers between the traveled way and the sidewalk may be considered to shield pedestrians from errant vehicles. However, this adds cost, weight and width to the bridge, and the transition from barrier to guard rail or curb at each end often creates an awkward transition for pedestrians, who must detour around the barrier to access the bridge sidewalk.

Rollover curbs should not be used next to sidewalks as they encourage motorists to park on planting strips or sidewalks. They are problematic for the visually impaired since they don't create a definitive edge between the street and adjacent uses.

Sidewalk Depth: Concrete sidewalks should be built to a minimum depth of 4 inches, and to a minimum depth of 6 inches at driveways.

VI. Sidewalk Cost Considerations

The actual cost of providing sidewalks will be different for each region of the country, and varies with the seasons. Actual bid prices are also influenced by how busy contractors are at the time of construction.

The cost of constructing sidewalks alone is relatively low; typical bids run between $20 and $30 a square

yard, which roughly translates to $12 to $20 a running foot for 6' wide sidewalks. Therefore, sidewalks on both sides of the roadway can run roughly between $150,000 to $250,000 per mile (costs from Oregon DOT, 1999).

Factors to consider when calculating the cost of sidewalks:

1. **Presence of curb and gutter:** The costs of providing curb and gutter, which presumes the need to also provide a street drainage system, run much higher than the cost of sidewalk. A standard perpendicular curb ramp and top landing need a minimum border width of almost 12 feet at intersections if there is a 6" curb. A 4" curb reduces the minimum border width to 10 feet. Yet on many urban streets, this work must be performed prior to installing sidewalks. If this is the case, only the cost of sidewalks and curb ramps should be attributed to expenditures for pedestrians – sewers are provided to drain the roadway surface used by motor vehicle traffic.
2. Number of driveways: To comply with ADA, many existing driveways must be replaced with ones that provide a level passage at least 3' wide. Retrofitting driveways can cost $2000 or more. It can also be advantageous to inventory all existing driveways to see if any can be closed, resulting in cost-savings.
3. Number of intersections: While intersections represent a skip in the sidewalk quantities, the cost of providing ADA ramps at each corner and additional traffic control at each intersection should be considered.
4. Obstacles to be removed: The costs for moving or removing obstacles such as power poles, signposts and fire hydrants vary too much to be itemized here; these costs must be calculated individually for each project.
5. Structures: While minor sidewalk projects rarely involve new structures such as a bridge, many projects with significant cuts and fills may require retaining walls and or culvert extensions. The costs of retaining walls must be calculated individually for each project.
6. Right-of-way: While most sidewalk projects can be built within existing rights-of-way, especially infill projects, some may require some right-of-way takings or easements. An alternative to acquiring right-or-way is to narrow the roadway, which should only be done after ensuring that cyclists are accommodated adequately (through bike lanes or shoulders, at a minimum of 5 feet).
7. Miscellaneous factors: Planters, irrigation, benches, decorative lampposts and other aesthetic improvements cost money, but they are usually well worth it if the impetus for the project is to create a more pleasant and inviting walking environment.

When project costs appear to be escalating due to one or more of the above listed items, especially retaining walls or acquiring right-of-way, consideration may be given to narrowing the sidewalk in constrained areas. The full sidewalk width should be resumed in non-constrained areas – this is preferable to providing a narrow sidewalk throughout, or dropping the project because of one difficult section.

Tips to reduce total costs:

1. **Stand-alone vs. integrated within another project:** Sidewalks should always be included in road construction projects. Stand-alone sidewalk projects cost more than the same work performed as part of a larger project. Sidewalks can be "piggy-backed" to projects such as surface preservation, water or sewer lines, or "undergrounding" utilities. Besides the monetary savings, the political out-fall is reduced, as the public doesn't perceive an agency as being inefficient (it is very noticeable if an agency works on a road, then comes back to do more work later). The reduced impacts on traffic are a bonus to integration.
2. **Combining Projects:** Cost savings can be achieved by combining several small sidewalk projects into one big one. This can occur even if the sidewalks are under different jurisdictions, or even in different localities, if they are close to each other. The basic principle is that bid prices drop as quantities increase.

VII. Bibliography and List of References

AASHTO. A Policy on Geometric Designs of Highways and Streets, 1984.

ITE Design of Pedestrian Facilities Recommended Practices Report

Others

Acknowledgements

These revised draft guidelines were developed by the UNC Highway Safety Research Center under a contract with the Federal Highway Administration entitled, "Evaluation of Pedestrian Facilities." Carol Tan Esse is the Contract Manager. Review comments are requested.

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TABLE 1. GUIDELINES FOR NEW SIDEWALK/WALKWAY INSTALLATION.

Roadway Classification and Land Use	Sidewalk Requirements	Future Phasing
Highway (rural)	None. Minimum of 5 ft shoulders required on both sides.	Secure/preserve ROW for future sidewalks that may be needed if schools, bus stops, etc. are added.
Highway (rural/suburban - less than 1 d.u. / acre)	One side may be adequate. Min. of 5 ft shoulders required.	Secure/preserve ROW for future sidewalks. Second side may be needed if schools, bus stops, etc. are added
Suburban Highway (1 to 4 d.u. / acre)	Both sides preferred. One side required.	Second side required if density becomes greater than 4 d.u. / acre.
Major Arterial (residential)	Sidewalks on both sides required.	
Collector and Minor Arterial (residential)	Sidewalks on both sides required.	
LOCAL STREET (Residential - less than 1 d.u. / acre)	One side may be adequate. Minimum of 5 ft shoulders required on both sides.	Secure/preserve ROW for future sidewalks. Second side may be needed if schools, bus stops, etc. are added
LOCAL STREET (Residential -1 to 4 d.u. / acre)	Both sides preferred. One side required.	Second side required if density becomes greater than 4 d.u. / acre or if schools, bus stops, etc. are added
LOCAL STREET (Residential - more than 4 d.u. / acre)	Sidewalks on both sides required.	
All Streets (commercial areas)	Sidewalks on both sides required.	
All Streets (industrial AREAS)	Sidewalks on both sides preferred. One side required.	

Appendix C

Proposed Recommendations for Installing Marked Crosswalks

Photo by Cara Seiderman

Produced for Federal Highway Administration

by:

The University of North Carolina
Highway Safety Research Center

July, 2000

The primary intent of these recommendations is to help improve the safety and access for pedestrians in crossing streets, as opposed to just being a tool to say "no" to marked crosswalks. Marked crosswalks are best used in combination with other treatments. Before removing a crosswalk or making a decision not to install a crosswalk at a given location, treatments to reduce motor vehicle speed (e.g., traffic calming measures), the number of lanes, and/or other measures to facilitate pedestrian street crossings (e.g., traffic signals with pedestrian signals, raised medians) should be fully explored.

Marked pedestrian crosswalks may be used to delineate preferred pedestrian paths across roadways under the following conditions.

(a) At stop signed or signalized locations where vehicular traffic might block pedestrian traffic when stopping for a stop sign or red light;

(b) At non-signalized street crossing locations in designated school zones. Use of adult crossing guards, school signs and markings, and/or traffic signals should be used in conjunction with the marked crosswalk, as needed.

(c) At non-signalized locations where engineering judgment dictates that the number of motor vehicle lanes, pedestrian exposure, the average daily traffic (ADT), the posted speed limit, and the geometry of the location would make the use of specially designated crosswalks desirable for traffic/pedestrian safety and mobility. This must consider the conditions listed below and also in table 1.

Marked crosswalks alone (i.e., without traffic signals and pedestrian signals) should not be used under the following conditions:

(a) Where the speed limit exceeds 40 mph.

(b) On a roadway with four or more lanes without a raised median or crossing island which has (or will soon have) a daily traffic volume (ADT) of 12,000 or above.

(c) On a roadway with four or more lanes with a raised median or crossing island which has (or will soon have) an ADT of 15,000 or above.

The intent of table 1 is to provide initial guidance on whether an uncontrolled location might be a candidate for a marked crosswalk and, therefore, whether an engineering study should be completed at that location. An engineering study should be used to analyze other factors including (but not limited to): gaps in traffic, approach speed, sight distances, illumination, the needs of special populations and distance to the nearest traffic signal.

The spacing of marked crosswalks should also be considered, so that they are not placed too close together. Overuse of marked crosswalks may breed driver disrespect for them, and a more conservative use of them is generally preferred. Thus, it is recommended that in situations where marked crosswalks are acceptable (see table 1) that a higher priority be placed on their use at locations having a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians per peak hour). In all cases, good engineering judgment must be applied.

Other Factors

Distance of Marked Crosswalks from Signalized Intersections

Marked crosswalks should not be installed in close proximity to traffic signals, since pedestrians should be encouraged to cross at the signal in most situations. The minimum distance from a signal for installing a marked crosswalk should be determined by local traffic engineers based on pedestrian crossing demand, type of roadway, traffic volume, and other factors. The objective of adding a marked crosswalk is to

channel pedestrians to safer crossing points. It should be understood, however, that pedestrian crossing behavior may be difficult to control merely by the addition of marked crosswalks. The new marked crosswalk should not unduly restrict platooned traffic, and should also be consistent with marked crosswalks at other unsignalized locations in the area.

Other Treatments

In addition to installing marked crosswalks (or in some cases, instead of installing marked crosswalks), there are other treatments that should be considered to provide for safer and easier crossings for pedestrians at problem locations. Examples of these pedestrian improvements include:

- Providing raised medians (or crossing islands) on multi-lane roads.
- Installing traffic signals (and pedestrian signals) where serious pedestrian crossing problems exist.
- Reducing the pedestrian exposure distance for pedestrians by:
  - providing curb extensions
  - providing pedestrian islands
  - reducing four-lane undivided road sections to two through lanes with left-turn bay (or a two-way left turn lane), sidewalks, and bicycle lanes.
- When marked crosswalks are used on uncontrolled multi-lane roads, consideration should be given to install advance stop lines be installed as much as 30 ft prior to the crosswalk (with a sign: "STOP HERE FOR CROSSWALK") in each direction to reduce the likelihood of a "multiple threat" pedestrian collision.
- Bus stop should be located on the far side of uncontrolled marked crosswalks.
- Installing traffic calming measures on local streets to slow vehicle speeds and/or reduce cut-through traffic. Such measures may include:
  - Raised crossings (raised crosswalks, raised intersections, speed humps)
  - Street narrowing measures (chicanes, slow points, "skinny street" designs)
  - Intersection designs (traffic mini-circles, diagonal diverters).
  - Others (see ITE Traffic Calming Guide for further details)(17)
- Providing adequate nighttime street lighting for pedestrians in areas with nighttime pedestrian activity where illumination is inadequate.
- Designing safer intersections and driveways for pedestrians (e.g., crossing islands, tighter turn radii), which account for the needs of pedestrians.

In developing the proposed U.S. guidelines for marked crosswalks and other pedestrian measures, consideration was given not only to the research results in this study, but also to crosswalk guidelines and related pedestrian safety research in England, Germany, the Netherlands, Canada, Norway, Hungary, Sweden, and Australia. (11,13,14,15,16?,?.....). More details of these foreign guidelines and studies are provided in the full FHWA report.(4) More details of pedestrian facilities are given in the 1999 "Pedestrian User Guide: Providing Safety and Mobility" for FHWA,(19) the ITE Design and Safety of Pedestrian Facilities,(20) the ITE Traffic Safety Toolbox,(21) the City of Seattle Guide entitled, Making Streets that Work,(22) among others.

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Table 1.

Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

Roadway Type	Vehicle ADT ≤ 9,000			Vehicle ADT > 9000 to 12,000			Vehicle ADT < 12,000-15,000			Vehicle ADT > 15,000		
	< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	< 40 mph	< 30 mph	35 mph	> 40 mph	< 30 mph	35 mph	> 40 mph
2-Lanes	C	C	C	C	C	C	C	C	X	C	X	X
3-Lanes	C	C	C	C	C	C	C	X	N	X	N	N
Multi-Lane (4 or More Lanes) With Raised Median†	C	C	C	C	C	C	X	X	N	X	N	N
Multi-Lane (4 or More Lanes) Without Raised Median	C	C	C	C	X	X	X	N	N	N	N	N

* These guidelines include intersection and midblock locations with no traffic signals or stop sign on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations which could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, substantial volumes of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor necessarily result in more vehicles stopping for pedestrians. Before installing new marked crosswalks, an engineering study is needed to show whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volumes, vehicle speeds, sight distance, vehicle mix, etc. may be needed at other sites. Whether marked crosswalks are installed, it is important to consider other pedestrian facility enhancements, as needed, to improve the safety of the crossing (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic calming measures, curb extensions). These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.

C =Candidate sites for marked crosswalks. Marked crosswalks must be installed carefully and selectively.

X =May or may not need additional pedestrian crossing facilities in order to mark a crosswalk. Pedestrian crash risk may increase if crosswalks are added without other pedestrian facility enhancements. Marked crosswalks at these locations should be closely monitored and removed, if necessary.

N =Marked crosswalks are not recommended, since pedestrian crash risk may be increased with marked crosswalks. Additional pedestrian crossing facilities should be considered for these locations.

The raised median or crossing island must be at least 4 ft wide and 6 ft long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and AASHTO guidelines.