COMPREHENSIVE TRANSPORTATION PLAN

City of Tempe

Updated March 2008

TABLE OF CONTENTS

1 INTRODUCTION

The city of Tempe prides itself on being "transit friendly" and has allocated significant resources toward the development of transit options for many types of trips. The city of Tempe's transportation program, Tempe in Motion, promotes the use of alternative modes and maintains the goal of creating a livable community with a balanced transportation system that:

- is environmentally sustainable;
- is accessible to all Tempe residents, employees, and visitors;
- helps preserve neighborhoods;
- provides long-range transportation planning;
- promotes transit-oriented development, and
- involves citizens in the process and keeps them informed along the way.

Tempe is well on its way to achieving the city's vision to be a vibrant city, with a safe, efficient, and balanced transportation system that provides mobility for all, promotes clean air and conserves energy, preserves neighborhood livability, and enhances the quality of life for our citizens and guests. This Comprehensive Transportation Plan is a framework to achieve that vision to enhance Tempe's already successful multi-modal transportation program. This plan addresses pedestrians, bicycles, transit, and streets. Each transportation element includes existing conditions, goals and objectives, needs, and a 2030 project list that includes project description, time frame, and estimated costs.

This section describes the Comprehensive Transportation Plan's purpose, overall goals and objectives, existing conditions, and Tempe's land use and economical forecast through 2030.

LAND USE AND ECONOMIC CONDITIONS

The rapid influx of people into Maricopa County during the 1990s and the through 2000s resulted in unprecedented local and regional growth. According to the U.S. Department of Commerce, Maricopa County experienced the largest net gain in population for any U.S. county between 2000 and 2004. The corresponding increase in employment and business establishments has also been impressive with the emergence of new high technology employment centers and the growth of Arizona State University (ASU).

This plan anticipates and adequately plans for future transportation and transit needs in light of rapid population and employment growth in both the county and the city of Tempe. Emerging development and redevelopment trends must also be understood to ascertain the potential relationship between land use and transportation. In other words, the traditional long-range approach of providing infrastructure to keep up with growth must be examined along with innovative policy measures designed to focus growth on strategic locations where adequate mobility is assured.

Population Trends

As of 2004, Tempe was the seventh largest city in Maricopa County. Although Tempe's growth rate, .3 percent between 2000-2004, is least among the 25 municipalities located in Maricopa County, projections for 2030 show Tempe ranking tenth in population within the county.

Tempe is committed to providing options for all modes of transportation.

Because Tempe is built-out, meaning that there is very little land available for building, this growth is occurring through redevelopment and infill. Table 1.1 shows Tempe's past, current and projected population as well as the percent change by decade. Population projections shown for 2010 through 2030 indicate Tempe's annual growth will be less than one percent. The population of Tempe also grows based on Arizona

State University enrollment. Table 1.2 shows ASU enrollment since 1985. Enrollment at the ASU Tempe campus in 2007 was over 51,000 students.

Table 1.1 - City of Tempe Population Actual and Projected

Year	City of Tempe	Change By Decade	Percent Change
1960	24,897	n/a	n/a
1970	64,985	40,088	161.02%
1980	106,919	41,934	64.53%
1990	142,440	35,521	33.22%
2000	158,625	16,185	11.36%
2010	176,355	17,730	*11.18%
2020	189,183	12,828	*7.27%
2030	196,697	7,514	*3.97%

Source: City of Tempe Development Services Department and Maricopa Association of Governments', Socioeconomic Projections. *Projected Percentage Changes.

Table 1.2 - Arizona State University Statistics

ASU Tempe Campus Enrollment	
Year	Student Population
1985	39,094
1990	40,454
1995	42,040
2000	44,126
2005	51,612

Source: ASU Quick Facts, 2006

Employment Growth

The Maricopa County region continues to grow as a strong employment base. According to the Maricopa Association of Governments (MAG) 2005 Regional Report, in 2004 Maricopa County was ranked third in the nation as a best performing county, based on economic performance and the ability of a region to create and keep jobs. Maricopa County gained a total of 79,400 jobs between 2000-2004.

Maricopa County also boasts a low unemployment rate (3.7 percent) compared to the national rate (5.2 percent), which will be a major factor in more people choosing to live and work in the region.

As of 2004, Tempe had the third largest number of jobs in Maricopa County (163,700) only behind Phoenix (762,800) and Mesa (175,000). Tempe is the only municipality outside of the Indian Communities that has a higher employed base than population. In 2004, Tempe's population was 160,820 while Tempe's employment was 163,700.

As shown in the Table 1.3, the majority of employment in the city of Tempe will be office type employment and industrial.

Table 1.3 - Tempe Projected Employment by Type by Years 2000-2030

Year	Retail	Office	Ind	Other	Total
2000	32,971	36,846	57,925	34,651	162,393
2010	35,084	52,261	66,110	37,911	191,366
2020	39,562	72,954	74,559	40,392	227,467
2025	39,793	76,662	75,843	40,739	233,037
2030	40,108	82,230	77,514	41,247	241,099

Source: Maricopa Association of Governments', Socioeconomic Projections.

According to MAG regional analysis, Tempe currently has 2.55 jobs per household as opposed to the county average of 1.37 jobs per household in 2000. With projected population and employment growth, MAG has calculated Tempe's future jobs per housing balance to be 3.50 jobs per household.

Figure 1.1 identifies the average job concentration within Maricopa County. The highest concentration of jobs is shown in the northern third of Tempe, projected to have greater than 8,000 jobs per square mile, and the western quarter of the city, projected to have 4,000 to 6,000 jobs per square mile.

This indicates the importance of a regional transportation system to provide access to Tempe from neighboring cities. The city is a job destination and will require transportation services that will accommodate the job growth. This projected trend supports existing and planned urban centers and development throughout the region, instead of creating new urban or suburban cores and communities outside the urbanized area. This also means Tempe will continue to be a net importer of employees within the region.

Land Use

Tempe is considered a mid-size city encompassing 40.36 square miles with 4,056 people per square mile. Tempe is the second densest community in Maricopa County, only behind Guadalupe which contains 6,560 people per square mile and ahead of the larger municipalities (Phoenix, Mesa, Scottsdale, Glendale, etc.). Tempe is also one of six municipalities in Maricopa County that have over 95 percent of its municipal planning area incorporated.

Figure 1.2 shows the Tempe existing land use. The predominant land use in the city is residential. Figure 1.3 shows the city's projected year 2030 land use as adopted in the General Plan 2030. The city's anticipated residential density is shown in Figure 1.4. The city's predominant land use will remain residential. As mentioned before, Tempe is built-out. Future growth will occur through redevelopment and infill opportunities. This redevelopment will occur largely near the downtown core, ASU campus, Apache, and Rio Salado districts.

It will be important to concentrate multi-modal access in these areas. Land use policies and codes will contribute to a multi-modal character which should include bus pullouts, access to transit, sidewalks, signalized intersections, bike lanes, etc. Land use policies including mixed-use development, street-level retail, outdoor cafes, public plazas, etc. will encourage multi-modal travel.

Tempe General Plan 2030 Growth Areas

The General Plan 2030 identified seven growth areas in the city (See Figure 1.5). Six of the growth areas (ASU, Town Lake, Downtown, McClintock, Papago Park and Apache Redevelopment Area) are north of Broadway Road. The growth area in south Tempe is located at Warner Road and I-10.

Demographics and Statistics

The following general population demographic information is summarized from the 2000 Census unless otherwise noted. Comprehensive demographic information is available in the Annual Tempe Statistical Report. Additional statistics are provided within the elements of this plan, as they pertain specifically to each area. The importance of the following demographics for long range land use planning is to look at this snapshot in time, and project possible shifts in the population that could impact physical development, housing, recreation, education or public facility or service needs. Tempe's ideal geographic location and excellent transit and community services may attract different populations than are currently being served.

2000 Population and Dwelling Unit

The population of Tempe tends to fluctuate in conjunction with the Arizona State University school year. Normally, during the summer, multi-family housing catering to students in Tempe have higher vacancy rates. Because more than 50 percent of the housing inventory in Tempe is multi-family (apartments, townhouses and mobile homes), fluctuations in the vacancy rates during the summer and winter school breaks or during the school year reflect losses or gains of 4,000 to 5,000 people.

As of 2001, 17,573 students reported Tempe as their place of residence. With a 163,296 resident population and 67,375 total dwelling units, approximately 2.42 people reside within each dwelling unit in Tempe. Single-family households tend to be larger, with approximately 2.87 people per dwelling unit.

Age Structure For Years 2000 and 2030

Census data indicates that Tempe has a relatively young population, with more than 68 percent of its population younger than age 39 (See Figure 1.6).

2030 Projected Population and Dwelling Unit

Tempe's ability to grow is limited by the land available for expansion. Population growth is expected to continue at an increasingly slow pace relative to surrounding communities:

- In 2010, Tempe is projected to have a population of 174,769.
- In 2020, Tempe is projected to have a population of 183,466.
- In 2030, Tempe is projected to have a population of 196,697.

Using the 2000 household size of 2.42 persons per dwelling unit, it is projected that Tempe would need 78,512 dwelling units, or 11,137 more dwelling units than were available in 2000.

It is anticipated that this housing need will be met through infill and redevelopment, and be primarily multi-family housing.

2000 Transportation Conditions

In 2000, Tempe residents responded to census survey questions regarding primary means of transportation, and time taken to travel to work. Figure 1.7 shows that Tempe's peak time of travel appears to be between 7 and 8 a.m.

Almost 70 percent of Tempe residents take less than 24 minutes to get to work with 33 percent of those commutes being less than 15 minutes as shown in Figure 1.8. Tempe's central location, access to freeways and strong employment base contribute to this low travel time, and to Tempe's quality of life.

According to the 2000 Census, the predominant mode of transportation in Tempe was the single-occupancy vehicle as shown in Figure 1.9. It is critical that a balanced multi-modal transportation system be integrated with land use planning to accommodate the city's growth and preserve and maintain the quality of life that the city residents are seeking.

Tempe has about 37 acres of highway/freeway per 1,000 people and about 9.45 acres of highway/freeway per square mile (640 square acres). Although Tempe's population growth is expected to drop-off to less than one percent per year, surrounding communities will continue to have need for regional road infrastructure which may impact Tempe's land uses.

COMPREHENSIVE TRANSPORTATION PLAN

In order to achieve Tempe's vision, goals, and objectives, improvements and enhancements to Tempe's multi-modal facilities are needed.

The General Plan 2030 survey helped define quality of life issues important to residents. If choosing to move to another city, Tempe residents would look for good schools, open spaces, proximity to friends, safety, family activities, access to mass transit, restaurants, access to freeways, central location, and a small town atmosphere. These are all things considered of high value to the quality of life in Tempe. Things that would make Tempe a less desirable place to live include increased crime, overcrowding, increased traffic, increased taxes/cost of living, the loss of ASU as a part of Tempe, neighborhood decline, indoor and outdoor air quality decline and the city not being kept clean.

Purpose Of Comprehensive Transportation Plan

The purpose of this plan is to guide the further development of a citywide multi-modal transportation system integrated with the city's land use plans. It is based on the philosophy and strategies of the 2003 Council-adopted Comprehensive Transportation Plan. The intentions of the multi-modal elements within this document are to:

- coordinate local and regional land use and transportation decisions;
- create a more balanced transportation system and reduce reliance on the automobile;
- preserve neighborhood character;
- enhance streets to maximize safe and efficient use by all users such as pedestrians, bicyclists, transit riders, and motorists; and
- enhance the ability to drive to, from, and within Tempe, but not through Tempe.

This plan highlights the ability to move people, instead of focusing solely on improving the ability to move vehicles. In order to maximize the safety and efficiency of the transportation system in Tempe, objectives and strategies encourage the use of a variety of transportation options and a reduction in single occupancy vehicle trips. Effective land use planning that takes advantage of a development site's proximity to public transit furthers the plan's objectives. Integration of advanced transportation technology will also help to achieve the plan's objectives.

EXISTING CONDITIONS AND OPPORTUNITIES

Historically, transportation and land use planning have focused on the automobile as the primary mode of travel. For example, Tempe's streets were developed using a grid pattern of one-mile-square sections of land with major arterials at one-mile intervals. Disconnected collector and local streets, as well as other transportation features such as freeways and railroad rights-of-way, created barriers to pedestrian, bicycle, and transit modes of transportation.

Decades of federal policies that fostered automobile-dependent development at the expense of other modes such as pedestrian, bicycle, and transit, encouraged development sprawl, traffic congestion, and the denigration of air quality in the majority of this country's urbanized areas. Federal legislation such as the Clean Air Act Amendments (CAAA) and surface transportation acts (ISTEA, TEA 21, TEA-LU) recognized that communities cannot build their way out of the problems associated with traffic congestion and poor air quality through roadway expansion.

These legislative acts mandated that modes of transportation other than automobiles be given greater funding and development priority, that local needs be addressed in the planning process, and that all modes of transportation be integrated. These new directions have supported the efforts of cities to more effectively integrate land use and transportation planning.
Today, Tempe provides a desirable quality of life for its residents, employees, and guests. Tempe has a strong commitment to maintaining the characteristics that enhance livability and contribute to making it one of the best places in the country in which to live, learn, work, and play. The policies established by these elements of the plan reinforce this commitment and will help ensure that Tempe preserves its quality of life and becomes a sustainable community that offers a variety of transportation options to its residents.

The city of Tempe and the surrounding region face significant challenges in meeting the growth and mobility demands anticipated during the next twenty years. Population and employment in Maricopa County are projected to increase substantially, with a somewhat lower growth rate occurring in Tempe. This plan addresses these challenges by providing a long-range, strategic approach to implementing transportation improvements, services, and programs. The following considerations played a vital role in shaping this plan.

Sustained Mobility / Greater Accessibility

- Emphasize movement of people and goods instead of movement of cars, thereby encouraging reduction of single occupancy vehicle (SOV) trips. No single mode of transportation will be sufficient to meet the mobility needs of Tempe. Investments in rail and bus transit improvements, technological innovations, transportation system management and public policies and strategies that discourage use of the SOV will all be necessary to meet the mobility needs of the community.

Enhanced Quality of Life and Preservation of Neighborhood Character

- Provide transportation options for access to work opportunities, essential services and recreational opportunities.
- Preserve, enhance and/or create conditions amenable to pedestrians; encourage people to walk and shop in areas near their workplaces, transit stops, residences or schools; ensure that basic universal accessibility needs are met; preserve the city's neighborhoods and minimize the intrusion of additional traffic into neighborhoods.

Enhanced Environmental Quality

- Encourage a variety of travel modes and reduce reliance on the automobile in order to enhance environmental quality. Sustained commitments to improve air quality must be made and significant progress must be achieved in order to meet state and federal mandates.
- Continue strong commitments to areas such as clean fuels and advanced telecommunication infrastructure. Further progress will require a regional approach. Tempe's land locked central location warrants Tempe taking a leadership role.

Increased Economic Opportunities

- Support redevelopment efforts and promote sustained economic growth in selected areas of the city. Transportation planning and programming decisions should support the economic development/employment strategies of the city. Support for all facets of the city's economy, the efficient movement of people and goods, and

access to major intermodal transportation facilities (such as airports/freight/rail yards) must be consistently maintained. The continued economic vitality of the community is essential to the city's overall development goals. Opportunities for economic development linked to transportation improvements should be vigorously pursued.
- Encourage and improve existing economic ties with Phoenix Sky Harbor International Airport and other regional airports.
- Maximize the city's economic opportunities with all airports in the valley to take advantage of the city's central location.
- Promote the city's proximity to airports, to visitors and prospective companies locating in the valley.

OVERARCHING OBJECTIVES

Based on these considerations, the following objectives and implementation strategies were developed.

- Develop a functional relationship between the diversity of land uses in Tempe and the transportation systems that serve them.
- Identify strategies for strengthening cooperative land use and transportation planning and design efforts between the city of Tempe, Arizona State University, and other public and private stakeholders.
- Continue to actively involve neighborhood and community representatives in on-going planning and design of transportation systems, facilities, and services.
- Work to ensure that transportation solutions preserve and enhance Tempe's neighborhoods.
- Coordinate Comprehensive Transportation Plan development with Tempe's ordinances and relevant codes to maximize consistency with city goals.
- Incorporate the provisions of the Comprehensive Transportation Plan as the Transportation Element of the General Plan.
- Establish a strong visual identity and aesthetic for Tempe, its gateway entrances, and its neighborhoods.
- Coordinate with police and law enforcement entities to develop programs that heighten the community's awareness and compliance with traffic safety regulations.

VISION, GOAL & MEASURES OF SUCCESS

Vision Statement

Tempe… a vibrant city, with a safe, efficient, and balanced transportation system that provides mobility for all, promotes clean air, conserves energy, preserves neighborhood livability, and enhances the quality of life for out citizens and guests.

Overall Goal

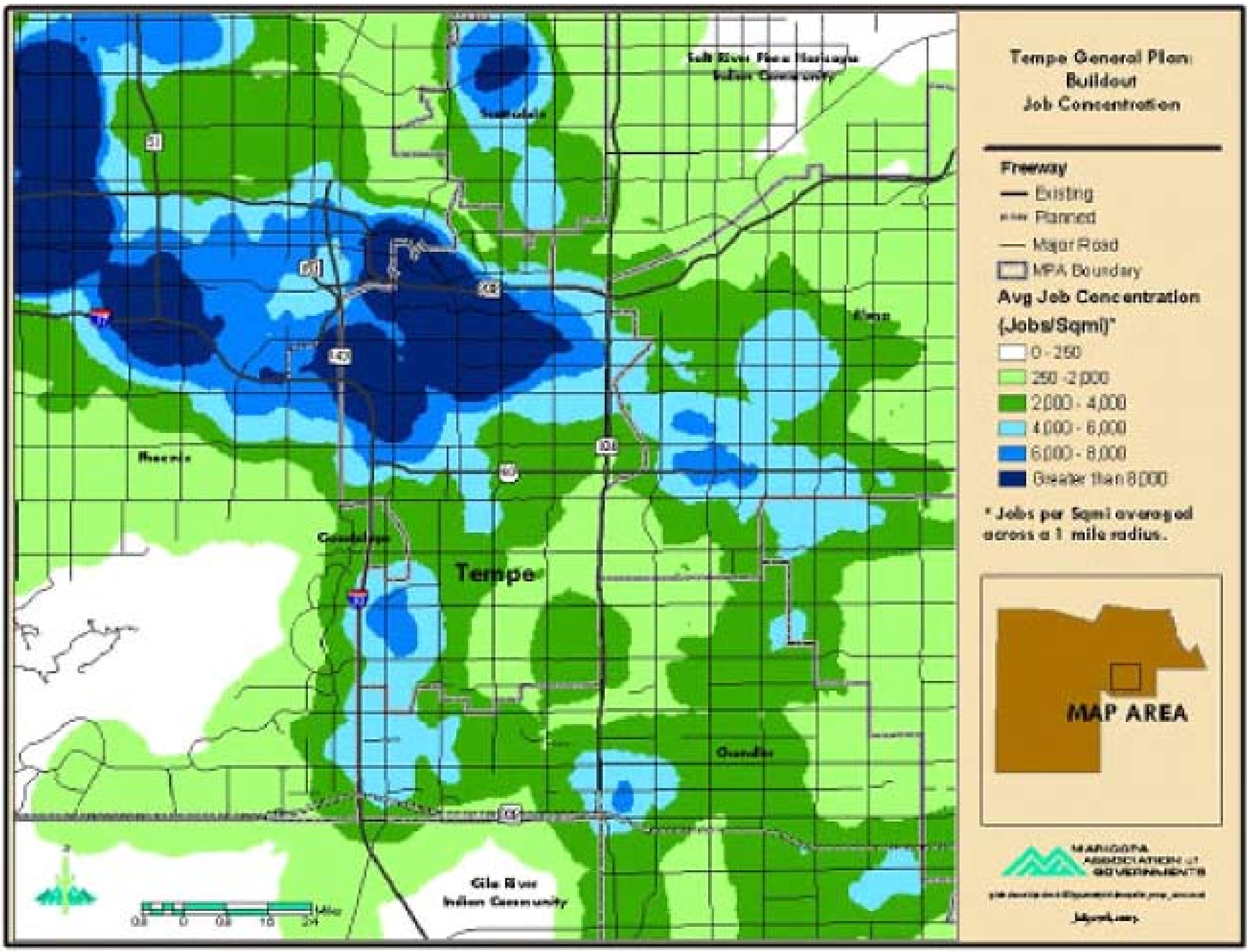
In keeping with the city's mission to make Tempe the best place to live, work, and play, the Comprehensive Transportation Plan will integrate with land use policy to ensure that a safe, efficient, and balanced transportation system is developed to serve Tempe now and in the future.

Measures of Success

The Tempe Comprehensive Transportation Plan will be a success when:
- The rate of single occupant vehicle miles traveled per capita within Tempe is at least reduced 20 percent by 2030.
- Transit trips as a percentage of all trips within Tempe at least double by 2030.
- All Tempe residents have access to fast and frequent (10 to 15-minute) transit service within a 5-to 10-minute walk of their home.
- One third of attendees use transit, bike, or walk to special events in Tempe.
- All Tempe neighborhoods have safe and convenient bicycle and pedestrian access to neighborhood schools, parks, shopping, and transit.
- Air quality "hot spots" are reduced within Tempe, and the city contributes to bringing overall regional air quality within attainment standards.
- Transportation improvements needed to implement Neighborhood Plans are in place by 2030.
- The majority of Tempe residents feel that their community has an excellent transportation system that contributes to making Tempe the best place to live, work and play.
- All city codes and ordinances work together to balance transportation and land use enhancing the quality of life in Tempe and supporting appropriate or sustainable economic development.

- A complete one-mile bikeway grid system is created.
- Connectivity of the regional transit network improves so that Tempe's citizens can get where they want to go.

Figure 1.1 - Average Job Concentration Per Square Mile at Buildout



Maricopa Association of Governments Map

Figure 1.2 Existing Land Use

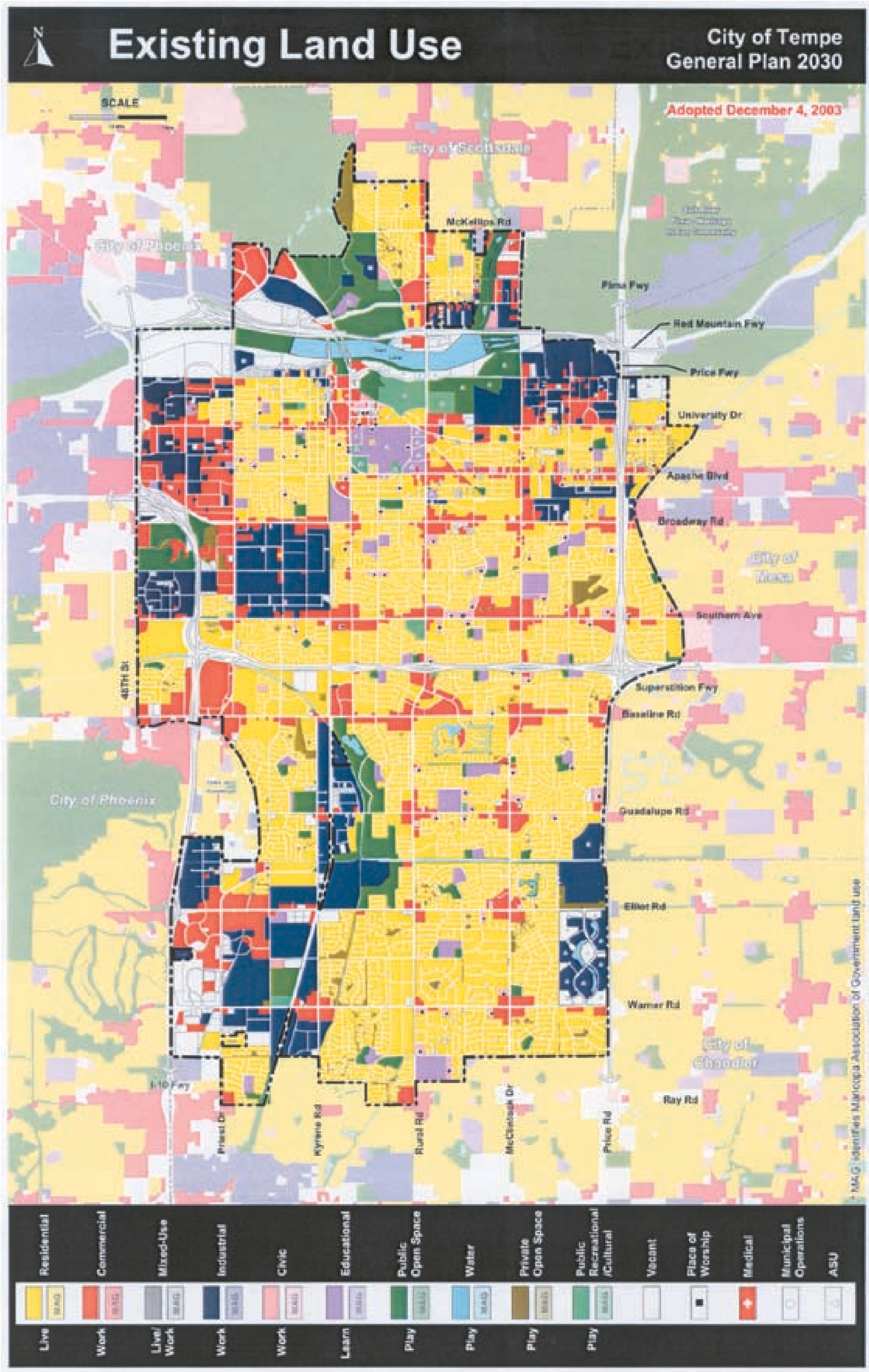


Figure 1.3 Projected Land Use

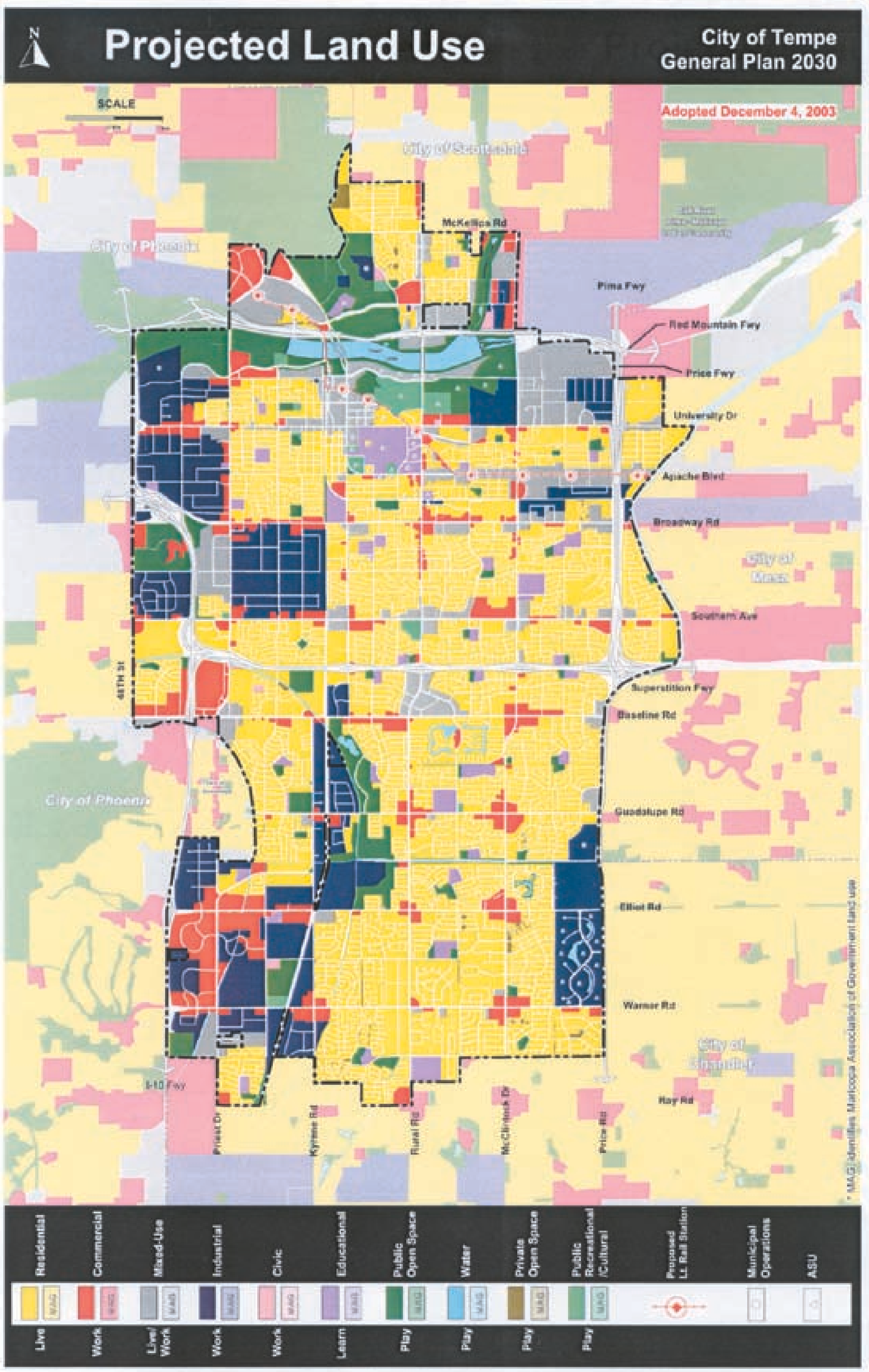


Figure 1.4 Projected Residential Density

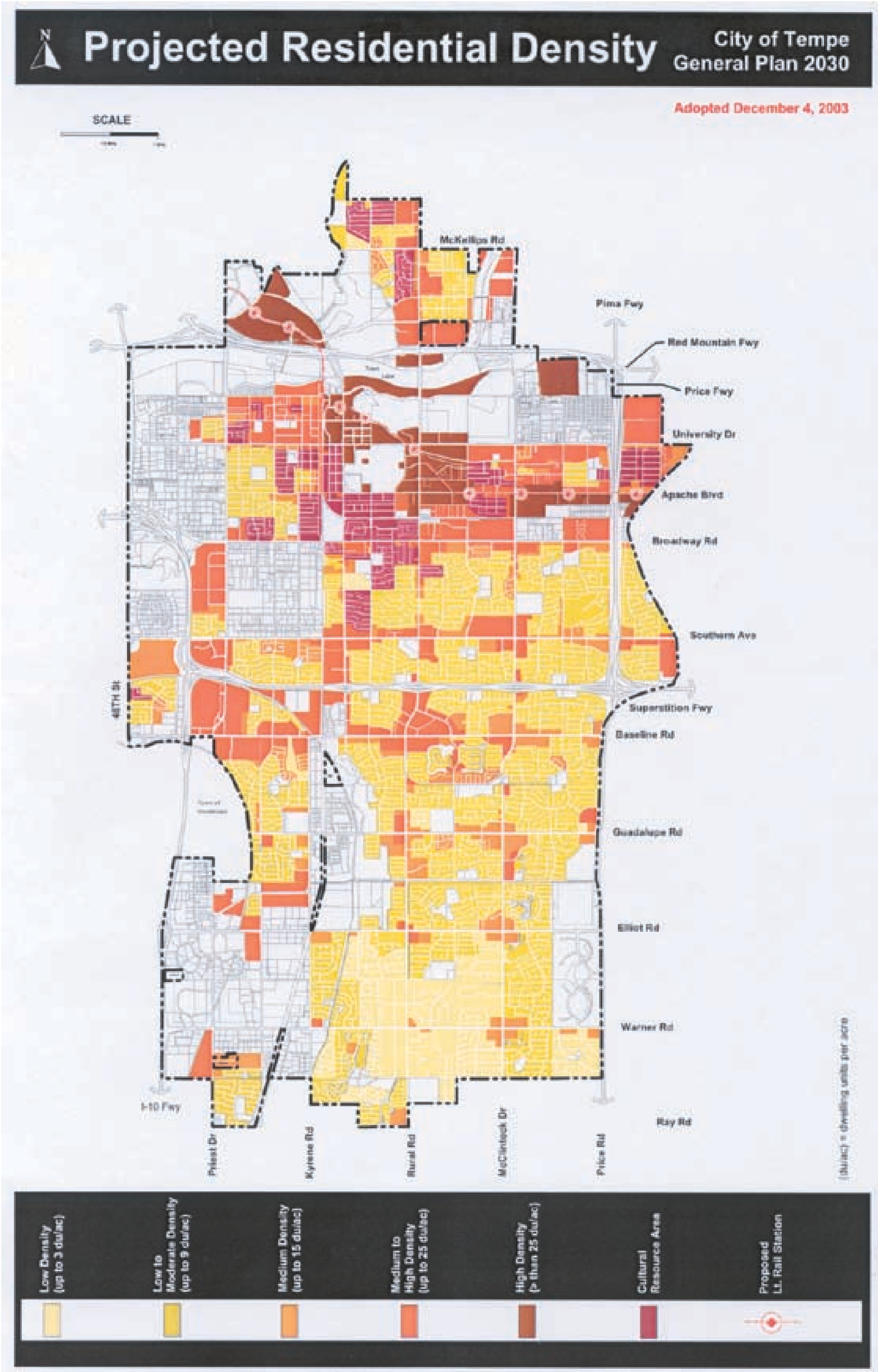


Figure 1.5 - City of Tempe Growth Areas

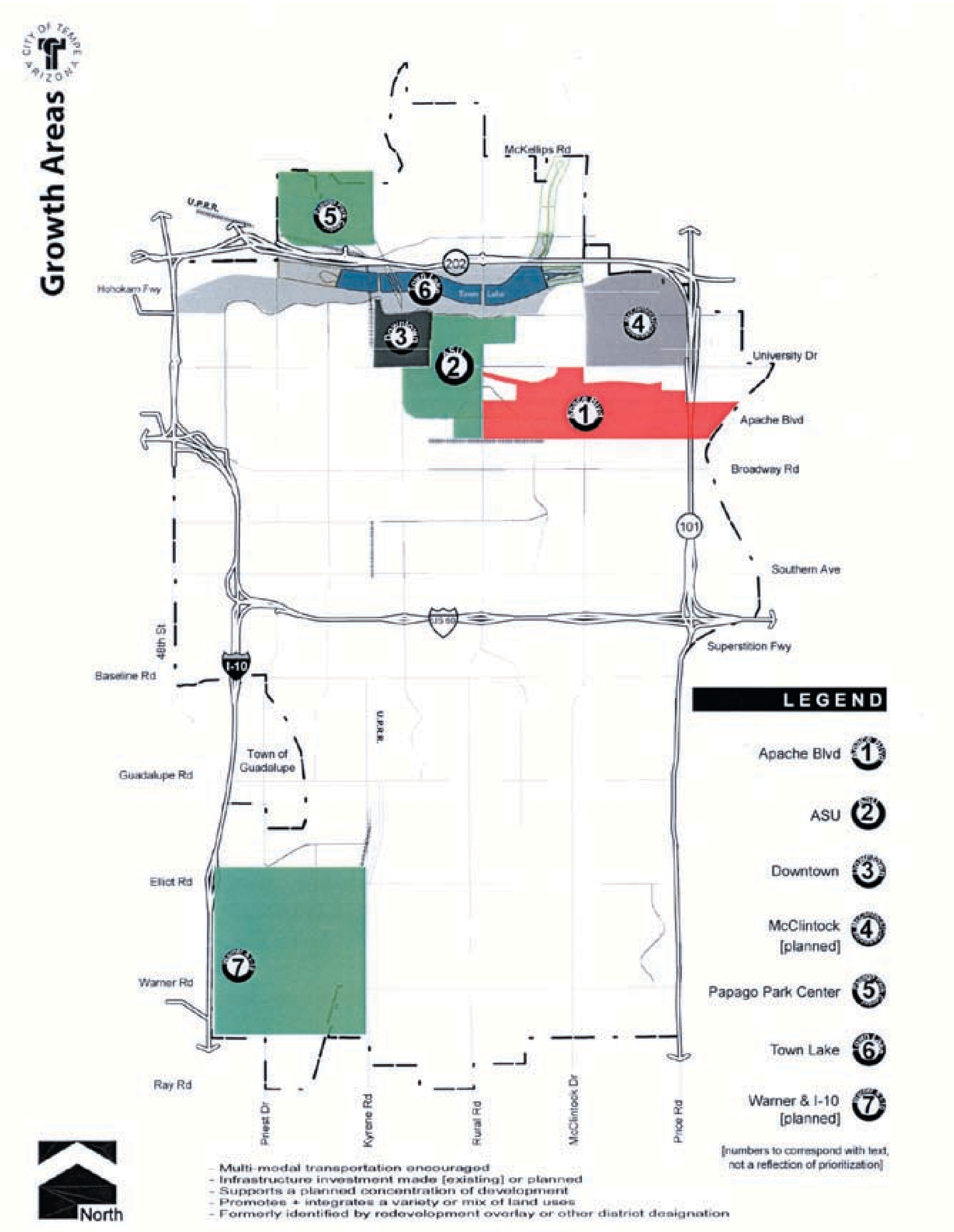


Figure 1.6 - Percentage of Population by Age Group - 2000

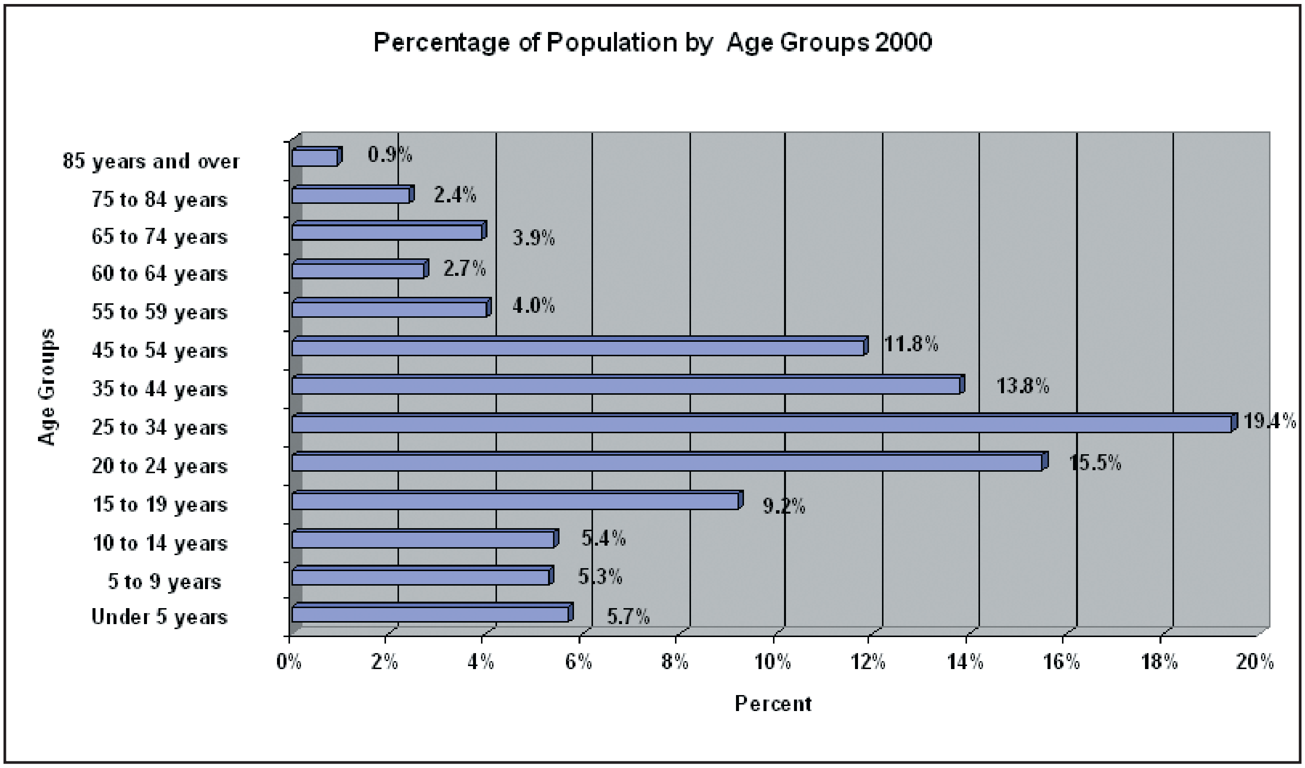


Figure 1.7 - Time of Day Leaving Home to Go to Work

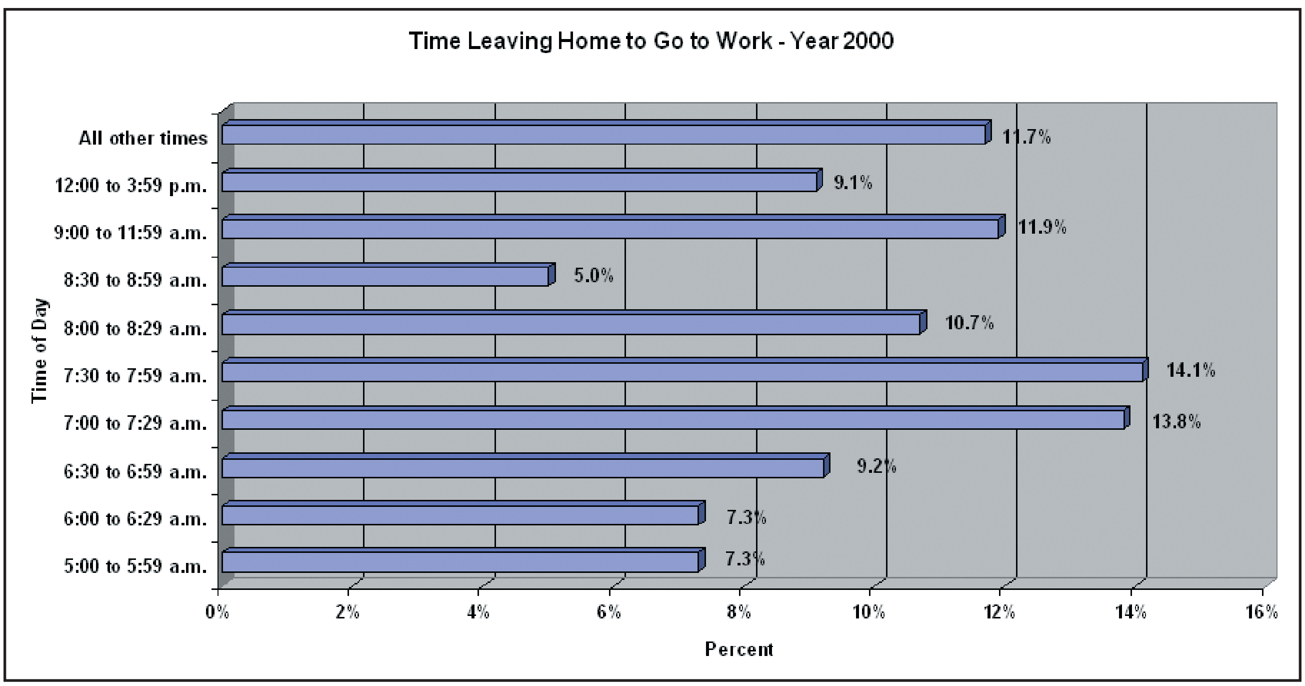


Figure 1.8 - Time Taken to Get to Work

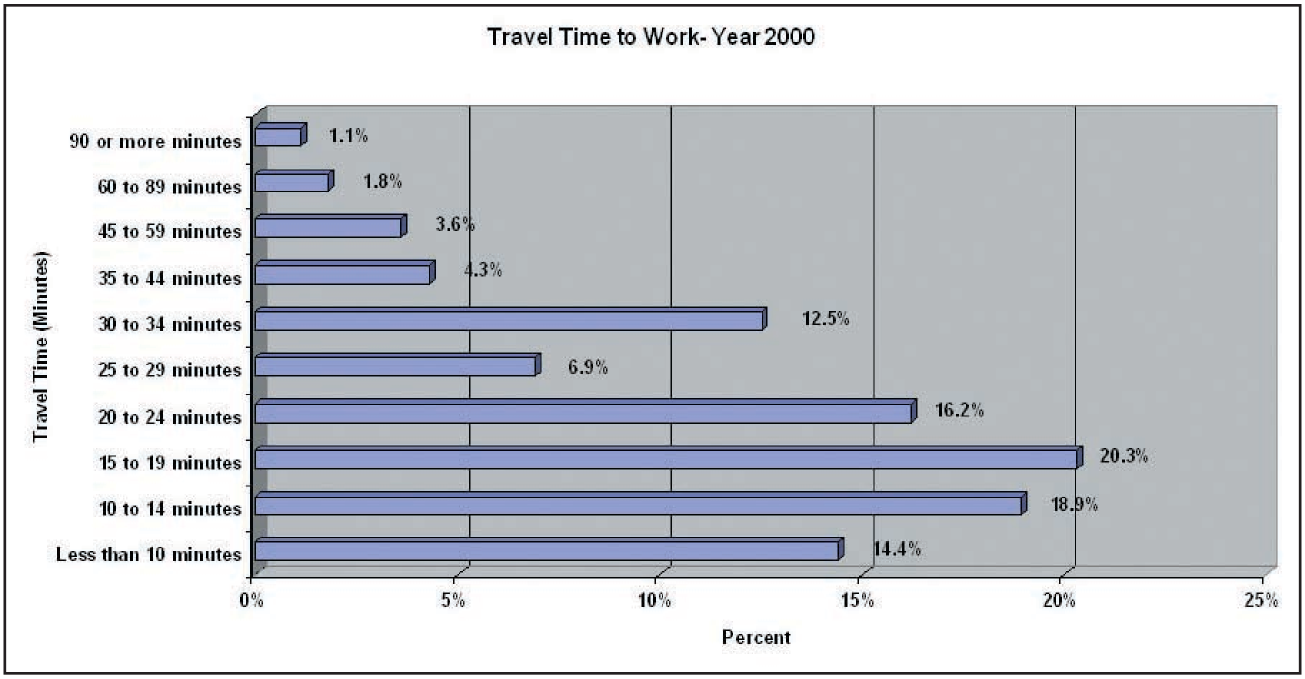
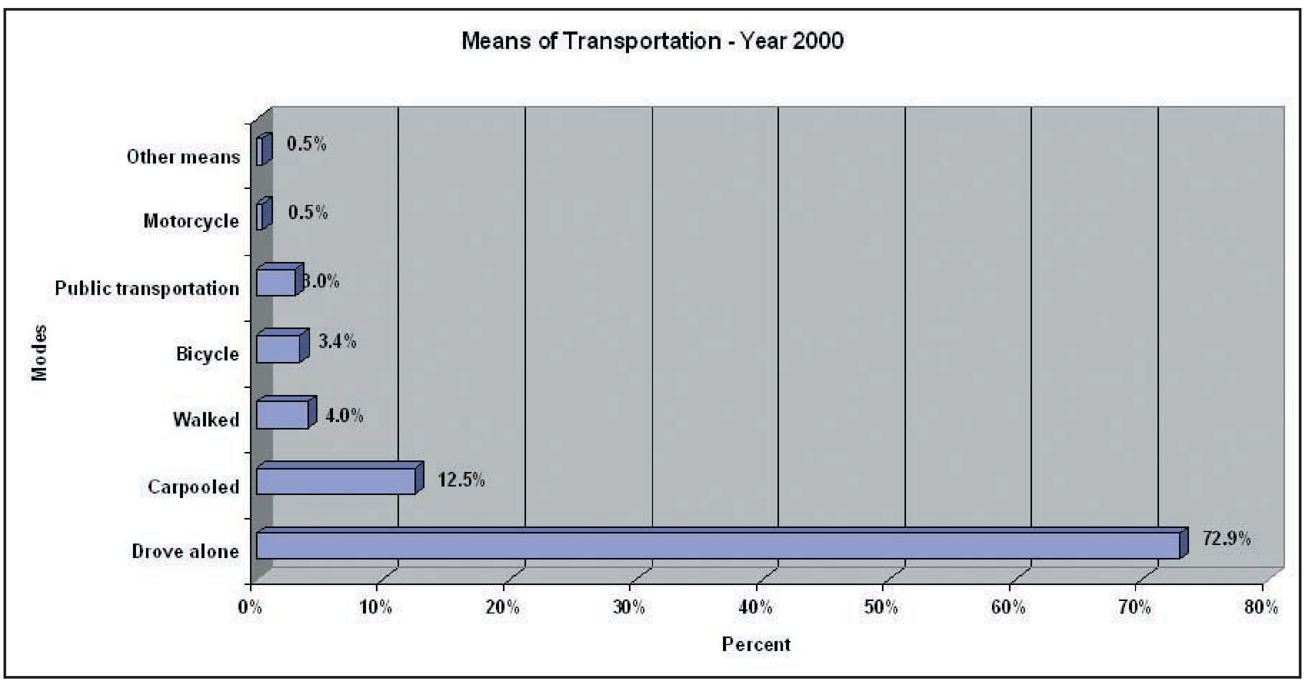


Figure 1.9 - Means of transportation and Carpooling



2 PEDESTRIAN NETWORK

INTRODUCTION

The city is a leader in the Maricopa County region in utilizing resources available to encourage walking as an alternative mode of transportation. Through implementation of various projects, including both public and private improvements, conditions for pedestrians have been enhanced greatly, particularly in the downtown core and in the vicinity of Arizona State University.

Being a university town, Tempe has provided pedestrian amenities that support its students and employees, in turn benefiting its residents and visitors. They rely on an easy to understand street network, a pedestrian friendly downtown core, and a citywide bus service to help them get acquainted with the area. These same amenities make Tempe appealing to neighborhood residents, commuting workers, tourists, university conference attendees and visiting friends.

The ASU campus provides a good pedestrian atmosphere.

EXISTING CONDITIONS

Tempe has been actively involved in creating a strong pedestrian network for a number of years. Pedestrian improvements are still needed throughout the city. Through implementation of various projects, both public and private improvements, conditions for pedestrians can continue to be greatly enhanced.

Why and Where People Walk in Tempe

According to a survey conducted by the city in late 2001, 70 percent of Tempe survey respondents who walk, do so for recreation/social purposes, while 30 percent walk as a mode of transportation or to get to other modes of transportation such as a bus. Of those that use walking as transportation, 93 percent also own a car and are, therefore, "choice" transportation walkers. Residents in the survey liked to walk in environments where the character of adjacent development is good, aesthetics are pleasing, and traffic is buffered. Thirty-four percent of respondents like to walk within their own residential neighborhoods, while 27 percent like downtown and ASU, and 20 percent like the lake, parks, and canals. The two biggest safety concerns mentioned were poor motorist behavior and the need for pedestrian-friendly street design. Other concerns were walk signal timing, accessibility, traffic volumes, and security.

Existing Pedestrian Network

Tempe's existing pedestrian network includes sidewalks, walkways, and multi-use paths. The existing system, however, does not currently provide for the needs of all pedestrians. A variety of facilities such as sidewalks, crosswalks and ADA curbs are needed to complete a pedestrian network. Currently, the majority of Tempe's collector and arterial streets have sidewalks and/or walkways. A list of current and programmed multi-use path projects, which also support walking, is included in Section 3, Bikeways and Multi-Use Paths, of this plan.

Sidewalks

The city of Tempe's sidewalk system is mostly complete. There are some arterial, collector, and neighborhood streets that do not have sidewalks. Table 2.1 lists street segments that do not currently have sidewalks.

Existing Pedestrian Planning Efforts and Programs

There are several existing pedestrian plans and projects in Tempe and the surrounding region. These plans and projects continue to shape Tempe's pedestrian network providing safe, convenient, accessible, and enjoyable environments.

Tempe implemented two capital improvement project on 5th Street between Farmer Avenue and Priest Drive and 13th Street between Mill Avenue and Hardy Drive. The goal of these projects was to calm the traffic by reducing the volume and speeds to appropriate levels for the neighborhood. Calming devices that were used on 5th Street include traffic chokers, bulb-outs, median chicanes, and speed tables. This project was part of the MAG Pedestrian Design Assistance Program which assists neighborhoods in designing traffic calming and pedestrian enhancements to streets.

Table 2.1 - City of Tempe Missing Sidewalks

Street	Between From	To	Distance Linear Ft
Arterial Streets			
Rio Salado	Priest	Ash	8,174
Curry	McClintock	Rural	2,302
McClintock	Rio Salado Bridge		2,653
University	Hacienda	George	2,317
Broadway	48th	52nd	176
Priest	Warner	Auto Loop	1,609
Priest	Warner	Orchid	3,710
Guadalupe/Kyrene Intersection			787
Total Arterial			21,728
Collector Streets			
52nd	University	4th St	336
Roosevelt	13th	17th Pl	1,096
Roosevelt	Southern	Fairmont	2,063
Hardy	Geneva	Southern	274
Kyrene	Baseline	Southern	7,400
Lakeshore	Carson	Minton	89
Total Collector			11,258
Neighborhood Local Streets			
Tempe Royal Estates			320
Tempe Royal Estates			787
First Street			2,941
Northwest Tempe Neighborhoods			23,671
Broadmor			21,399
University Heights			448
Escalante			2,578
Escalante			634
S Fair Lane/W Carson Street			3,832
Lakes Neighborhood			26,507
University-Estates/Park NA			4,500
Total Local			87,613
Total Estimated Missing Sidewalks 120,599 linear ft			

Tempe's Streetscape and Transportation Enhancement Program (STEP) is in place to encourage residents to get involved in neighborhood improvements and to discourage high-speeds thereby making neighborhoods more pedestrian-friendly.

The STEP allows residents to petition for traffic calming devices in neighborhoods where traffic speed is a problem.

Tempe has also completed several multi-use path projects while several are still underway. Completed project include:

- Country Club Way/US 60 Bicycle & Pedestrian Bridge
- Crosscut Canal Multi-Use Path
- Spence Avenue Multi-Use Path
- Kyrene Canal Multi-Use Path
- College Avenue Bicycle/Pedestrian Bridge
- Rio Salado Multi-Use Path

ASU pedestrian bridge.

Public Works Engineering Criteria

The city's Public Works Department has also created Engineering Design Criteria, which specifies guidelines that developers/builders should follow to help promote pedestrian-friendly designs. Below are some of pedestrian related guidelines:

- Encourage pedestrian and transit-user access to buildings by locating buildings at the minimum setback for arterial and arterial to collector intersections. The distance between bus stops and building entrances shall be minimized by using minimum setback requirements for locations of buildings on the site.

- Encourage pedestrian and bicycle access to the main building entrances from all sides of the site by providing more links to street frontages.
- Encourage buildings to locate closer to street intersections by minimizing the amount of parking allowed at street frontages, or by locating all parking behind or to the side of buildings.
- Encourage mixed-use development, allowing people to work where they live.
- New and existing cul-de-sacs and dead-end streets should provide connecting pedestrian and bike paths to the major streets.

The Multi-Use Path System Detailed Plan

The Multi-Use Path System Detailed Plan created in August 2000 was designed to identify and recommend specific alignments for multi-use path locations and cross-sections for paths in Tempe. As of June 1999, 12 miles of multi-use paths exist in Tempe. These paths are used for both pedestrian and bicycle travel and provide a place for recreational activities throughout the city.

Regional Planning Efforts

MAG has been a leading force in promoting awareness for the importance of pedestrian travel. The following efforts were made by MAG to promote pedestrian travel.

- Prepared the Pedestrian Plan 2000.
  - Outlines programs and actions to assist communities in promoting better pedestrian accommodations.
  - Establishes guidelines for pedestrian facilities within road right-of-ways.

- Completed the 2003 Regional Transportation Plan.
- Completed the Pedestrian Policies and Design Guidelines 2005.
  - Provides a source of information and design assistance to support walking as an alternative transportation mode.
  - Provides policies and specific guidelines to make all pedestrian areas and facilities safe, comfortable, and a destination for people who use them.

Sidewalks are only a part of the overall pedestrian facilities network.

MAG Pedestrian Plan 2000

MAG's Pedestrian Plan 2000 has forecasted potential pedestrian trip activity using a latent demand model, which predicts pedestrian travel by quantifying the level of pedestrian activity that would occur if conditions were ideal for walking. The forecasts include pedestrian activity for existing land-use conditions and year 2020 projected conditions. The model includes linked (walking trips that occur with assistance from other modes of transportation) and non-linked (trips that occur entirely by walking). The potential walking activity for these areas would include work trips, school trips, shopping trips, and recreational trips.

Based on existing land-use conditions, the greatest potential for pedestrian linked trips is on University Drive and Broadway Road between Mill Avenue and 48th Street and on Mill Avenue between University Drive and Southern Avenue. The greatest potential for pedestrian non-linked activity in Tempe is on Mill Avenue between Loop 202 and Southern Avenue, on Broadway Road and University Drive between Priest Drive and Mill Avenue, and on Rural Road between Broadway Road and Southern Avenue.

Based on potential 2020 land-use conditions, the greatest potential for pedestrian linked trips is on University Drive, Broadway Road, and Southern Avenue between McClintock Drive and 48th Street and on Rural Road, Mill Avenue, Priest Drive, and 48th Street between University Drive and Baseline Road. The greatest potential for pedestrian non-linked trips is on Mill Avenue between Broadway Road and Southern Avenue, on University Drive and Broadway Road between Mill Avenue and Priest Drive, and on University Drive between McClintock Drive and Rural Road. Under existing land-use conditions, the least potential for pedestrian linked trips is on Guadalupe and Elliot roads between 56th Street and McClintock Drive, and on Rural Road and McClintock Drive between Guadalupe and Warner roads. The least potential for pedestrian non-linked trips is on Elliot Road between Price Road and 56th Street, and on Baseline and Guadalupe roads between 56th Street and Rural Road.

Based on proposed 2020 land-use conditions, the least potential for pedestrian linked trips is on Elliot Road between Kyrene and Price roads, and on Rural Road and McClintock Drive between Guadalupe and Warner roads. The least potential for pedestrian non-linked trips is on Elliot Road between 56th Street and Price Road, and on Baseline and Guadalupe roads between 56th Street and Rural Road.

NEEDS/ISSUES

In Tempe, there is a strong interest in city-wide improvements to pedestrian conditions. Understanding the needs and characteristics of pedestrians and the factors that affect pedestrian travel will help Tempe continue to become a more pedestrian-friendly community.

All of Us Are Pedestrians

Every trip begins and ends as a pedestrian trip, so all of us are pedestrians at some point in our daily activities.

Arizona State law defines a pedestrian as:
"Any person afoot. A person who uses a manual or motorized wheelchair is considered a pedestrian unless the manual wheelchair qualifies as a bicycle. For the purposes of this paragraph, "motorized wheelchair" means a self-propelled wheelchair that is used by a person for mobility."

Policies & Design Guidelines:
"Pedestrians by choice are people who have access to a car and can drive, but choose to walk." People may choose to walk for transportation, fitness, enjoyment, social interaction, concern for the health of the environment, or a combination of these reasons.

What Are The Needs of Pedestrians?

Building a strong pedestrian-friendly community starts with the recognition that pedestrian needs are wide-ranging, and design solutions must respond to the needs of a diverse population.

All pedestrians need adequate facilities.

Recognizing why people do not walk in the first place is an important step in determining their needs as pedestrians. Insufficient infrastructure, physical barriers (canals, rivers, railroad tracks, or freeways), lack of curb ramps, major road separation from commercial districts, and long block lengths, and difficult street crossings are potential reasons why people do not walk.

Another common obstacle in the design of pedestrian facilities is assuming that one standard can be applied to fit an "average" population. For example, the speeds that pedestrians travel can vary greatly, yet pedestrian signals are often timed for average walking speeds of three to four mph. Children, older adults, and people with certain disabilities typically travel at much lower walking speeds of two mph.

Pedestrian needs are diverse, but generally, all pedestrians need a safe, interesting, and inviting environment.

Sharing the Street

Pedestrian facilities are an integral part of a transportation system. Adequate facilities will encourage and increase pedestrian travel. In order for pedestrians to share the street with vehicles, buses, bikes, and parked cars, they need to feel secure and comfortable, not threatened.

Pedestrian facilities should always be considered from the beginning of a project. Many street elements affect pedestrian travel. These include sidewalk corridors, curbs, intersections, and crossings. Design guidelines for these elements can be found in the Transportation Toolbox, a component of Tempe's Comprehensive Transportation Plan.

Pedestrian Safety

Pedestrian safety in Tempe is important. According to Table 2.2, the number of pedestrian-related accidents in Tempe has increased slightly from 2000 to 2004. The table also shows that pedestrian accidents are a small percentage of accidents overall, averaging 1.15 percent of total accidents. According to the 2002 Traffic Investigation report prepared by the Tempe Transportation Division, 42 percent of the accidents during that year occurred at intersections, while 58 percent occurred at mid-block locations. Pedestrian accidents occur throughout the city, not in one particular area.

In 2003, 27 percent of pedestrian related crashes involved children between the ages of 0-15 years in Maricopa County. This was the largest percentage of any age group. Twenty percent of all pedestrian related crashes involved young adults between the ages of 16-25 years.

Table 2.2 - Pedestrian Accidents from 2000-2004

Year	# of Ped Accidents	% of All Accidents
2000	69	1.21%
2001	71	1.27%
2002	76	1.29%
2003	70	1.11%
2004	91	1.40%

Developing a More Walkable Community

Secure, attractive, and active spaces provide focal points in the community where people can gather and interact. A continuous pedestrian network is the essential ingredient for making a walkable community. Successful walking/shopping districts have a variety of usable outdoor spaces interspersed with businesses, housing, and civic buildings. A series of well-designed public spaces encourages pedestrians to walk, explore, shop, and stay for a while. Whether a large civic plaza or a small pocket park, it is the integration and interconnection of outdoor spaces that makes a community great.

Great walkable communities develop through the concerted efforts of land use and transportation planning, urban design, and community participation. Tempe has implemented a Transit-Oriented Overlay District in the Downtown/Campus region of the city. For more information about the Pedestrian Overlay District, refer to the Community Development Code.

GOAL/OBJECTIVES/STRATEGIES

The goal of the Pedestrian Network Element is to recognize and encourage pedestrian travel as an important part of the transportation system.

Objectives

- Increase awareness that pedestrians are a priority in Tempe, and that pedestrian travel is an important part of the overall transportation system.
- Provide convenient and safe pedestrian access to destinations to promote neighborhood sustainability.
- Ensure accessibility for all.

Strategies

- Raise awareness about the characteristics and needs of pedestrians, including accessibility goals that go beyond mere compliance with the Americans with Disabilities Act (ADA).
- Develop public education and outreach techniques to promote pedestrian safety and compliance with pedestrian-related laws and regulations.
- Implement a transportation overlay district.

- Develop pedestrian network plans as part of neighborhood and other planning efforts.
- Implement programs and projects that increase pedestrian accessibility, safety, and security; enhance the pedestrian environment; and create engaging and interesting experiences for pedestrians.
- Improve the pedestrian network to include sidewalks on all streets in accordance with prescribed standards; street crossing improvements, as well as crossings at railroad rights-of-ways, canals, freeways, and other barriers to travel; and additional multi-use paths and crossings.
- Improve shading on all pedestrian paths to encourage pedestrian traffic.
- Implement improvements on designated Transit Streets and Green Streets to increase use by pedestrians, bicyclists and public transit. (See Chapter 5.)
- Implement transportation projects identified in Specific Area and Neighborhood Plans.
- Improve Streetscape Character — The community should support and be involved in pedestrian travel decisions. Streetscapes should be pedestrian-friendly, which could include wider sidewalks, street trees and landscaping for climate control and aesthetics, and street-side businesses with parking lots to the side or back of the building for easier pedestrian access. Diverse neighborhood characteristics should be considered in the planning decisions of pedestrian needs. The city should continue to encourage access to transit by improving circulation to and from transit facilities and transit centers.
- Encourage planning that provides a diversity of land uses (employment, shopping, businesses, services, parks, schools) within a five to ten-minute walk for all Tempe residents.
- Encourage development patterns and site configurations that maximize pedestrian access and circulation.
- Develop sustainable land uses that are supported by the community, including transit oriented development and development patterns where pedestrian travel and transit access are priority transportation modes.
- Evaluate the sidewalk system and pedestrian network to assess adequacy and implement specific improvements, such as eliminating gaps, removing barriers, and widening sidewalk capacity to facilitate and thereby encourage increased pedestrian travel.
- Improve the pedestrian network in Tempe to accommodate all types of pedestrians.

RECOMMENDED ACTIONS

Public Education and Pedestrian Outreach

Pedestrian Awareness

Tempe should continue to educate the general public on the importance of providing safe and accessible pedestrian facilities for all people. The design of specific pedestrian facilities, such as curb ramps and sidewalk surfacing should accommodate a wide range of people including those with disabilities. Refer to the Transportation Design Toolbox for more information on the design of accessible pedestrian facilities.

Walk to School Routes

School walk route plans are required in some parts of the country. Although Tempe has not implemented a citywide school walk plan, currently most elementary schools have a school walk route program. Many children are still bused to and from school. Participants in public meetings during the Comprehensive Transportation Plan process felt that more children would walk if better pedestrian facilities and safe walking routes were available.

School district and city representatives should consider developing a plan for safe walk routes to school. Procedures for developing school walk routes are listed in Table 2.3. School walk route plans can be an important tool for communities. It will give parents and teachers assurance that these routes are safe for children’s travel.

Table 2.3

Procedures for Developing School Walk Routes

- Form Safety Advisory Committee (SAC)
- Prepare base maps
- Inventory existing walking conditions
- Inventory traffic characteristics
- Design the walk routes
- Prepare the draft walk route maps
- Review the route maps with the SAC
- Have route maps approved by the school board
- Distribute and explain the maps
- Evaluate the program

Once the school walk route has been established, pedestrian safety deficiencies along the walk route need to be identified, then remedial actions can be considered and implemented as funding becomes available. Refer to Traffic Safety for School Areas produced by the Arizona State Department of Transportation for guidelines for identifying pedestrian safety deficiencies and developing remedial actions.

National events such as "Walk to School" and "Bike to Work" currently exist in many cities including Tempe. Tempe should continue to promote such events and provide pamphlets with information about the benefits of walking or bicycling. The city, in conjunction with the school district, should also distribute maps showing "school walk routes."

Pedestrian Safety Program

A more formal Pedestrian Safety Program can be implemented to encourage walking while promoting awareness about pedestrian safety. Educational materials such as flyers, posters, and pamphlets can be created to provide important information to pedestrians and motorists.

Pedestrian Maps

Maps that show pedestrian facilities throughout Tempe can help residents find safe walking routes to main destinations such as schools, shopping centers, and transit facilities. Maps can accommodate tourists wanting to get around in the city, while encouraging walking as a transportation option. A "walking tour" map can be created that highlights areas of interest in the city reachable by foot. Maps can be updated annually to highlight pedestrian-friendly facilities and improvement projects throughout the community.

Website Articles/Calendar of Events

The city can use its website to promote pedestrian travel and post events related to pedestrian activities. The website can also be a place for citizens to participate in the pedestrian program. Citizens can get walkability checklists online to review their neighborhoods and also can report any areas that may need improved pedestrian facilities. The website can also post non-motorized transportation options for city events, such as bus/shuttle schedules that would include a combination of walking and transit.

Incentives, Promotions, and Special Events

Public/Civic Space Programming

Tempe should encourage pedestrian travel by creating attractive, pedestrian-oriented public spaces such as sidewalk cafes, public benches, and public art. The city should continue to promote the Downtown "Art Walk" which provides a map that displays local art and encourages people to take a walking tour.

Free Transit to Special Events

Tempe should continue to work with Valley Metro to provide free transit for special events such as festivals or certain ASU sporting events. Free transit in the downtown core could be offered for a few days a year to promote transit and walking

PROJECT LIST

Table 2.4 shows a table of proposed pedestrian projects and programs through 2030. These projects include sidewalks, mid-block crossings, intersection improvements, and annual pedestrian programs. The project list categorizes each project by year and also includes location, type, and estimated cost. Completion of projects are phased. Phase I is 2006- 2010; Phase II projects are through 2011 to 2015; Phase III are from 2020 to 2025, and Phase IV are from 2026 to

2030. Figure 2.1 shows the projected or anticipated 2030 Bicycle and Pedestrian Facilities Map assuming completion of the pedestrian project list.

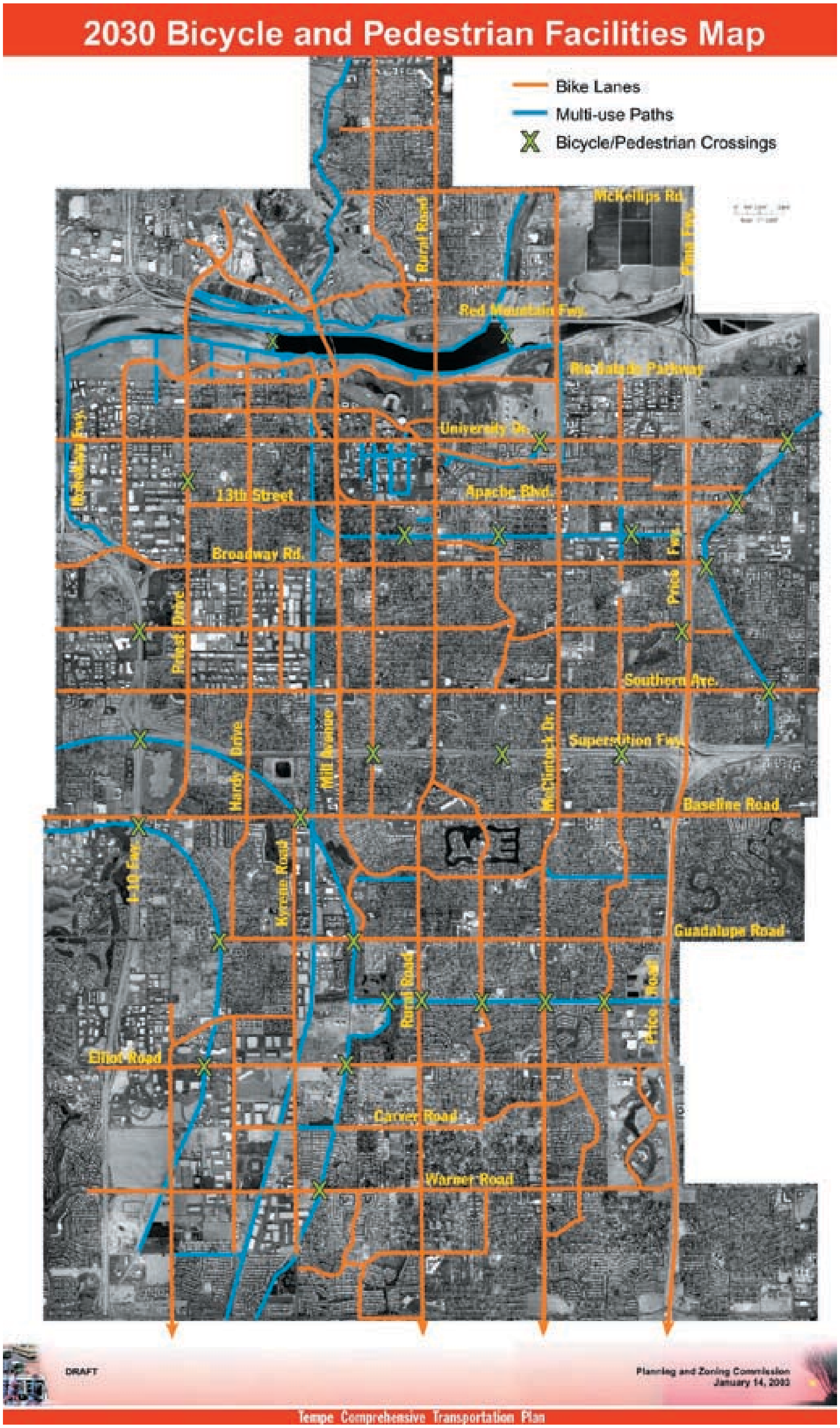
Table 2.4 - Pedestrian Project List - 2005-2030

LOCATION	TYPE OF WORK	YEAR	COST
Sidewalk Improvement Fund	Missing Sidewalks	Annual	$100,000/year
Street Reconstruction Fund	Ped Street Improvements	Annual	$200,000/year
Accessibility Improvements Funds	Curb Ramps	Annual	$100,000/year
Safe Routes to School Program	Program Implementation	Annual	$100,000/year
Curry: Scottsdale to McClintock	Ped. Improvements	Phase I	$543,800
University: Perry to Price	Ped. Improvements	Phase I	$500,000
Rio Salado: Priest to Ash	8-foot Sidewalk	Phase I	$359,656
Mill: Broadway to Southern	Ped. Improvements	Phase I	$150,000
Southern: Mill to Rural	Ped. Improvements	Phase I	$150,000
Rural: Guadalupe to Ray	Ped. Improvements	Phase I	$530,250
Rural at Western Canal	Mid-block Xing	Phase I	$175,000
Hardy at Western Canal	Mid-block Xing	Phase I	$175,000
Priest at Western Canal	Mid-block Xing	Phase I	$175,000
Curry: McClintock to Rural	8-foot Sidewalk	Phase I	$101,288
McClintock: Rio Salado to Bridge	8-foot Sidewalk	Phase I	$116,732
University: Hacienda to George	8-foot Sidewalk	Phase I	$101,948
Broadway: 48th to 52nd	8-foot Sidewalk	Phase I	$7,744
Priest: Warner to Auto Loop	8-foot Sidewalk	Phase I	$70,797
Priest: Warner to Orchid	8-foot Sidewalk	Phase I	$163,240
Guadalupe/Kyrene intersection	8-foot Sidewalk	Phase I	$34,628
UPRR at Kenneth	Crossing	Phase II	$100,000
UPRR at Tempe Canal	Crossing	Phase II	$100,000
UPRR at McClintock	Crossing	Phase II	$100,000
UPRR at Mill	Crossing	Phase II	$100,000
UPRR at Alameda	Crossing	Phase II	$100,000
McClintock at Western Canal	Mid-block Xing	Phase I	$175,000
52nd: University to 4th	6-foot Sidewalk	Phase II	$11,088
Roosevelt: 13th to 17th Pl	6-foot Sidewalk	Phase II	$36,168

Table 2.4 - Pedestrian Project List - 2005-2030, continued

LOCATION	TYPE OF WORK	YEAR	COST
Roosevelt: Southern to Fairmont	6-foot Sidewalk	Phase II	$68,079
Hardy: Geneva to Southern	6-foot Sidewalk	Phase II	$9,042
Kyrene: Baseline to Southern	6-foot Sidewalk	Phase II	$244,200
Lakeshore: Carson to Minton	6-foot Sidewalk	Phase II	$2,937
Baseline at Western Canal	Mid-block Xing	Phase II	$3,000,000
Guadalupe at Western Canal	Mid-block Xing	Phase II	$175,000
Tempe Royal Estates	4-foot Sidewalk	Phase III	$7,040
Tempe Royal Estates	4-foot Sidewalk	Phase III	$17,314
First Street	4-foot Sidewalk	Phase III	$64,702
Northwest Tempe Neighborhoods	4-foot Sidewalk	Phase III	$520,718
Broadmor	4-foot Sidewalk	Phase III	$470,734
University Heights	4-foot Sidewalk	Phase III	$9,856
Escalante	4-foot Sidewalk	Phase III	$56,716
Escalante	4-foot Sidewalk	Phase III	$13,948
S Fair Lane/W Carson Street	4-foot Sidewalk	Phase III	$84,304
Lakes Neighborhood	4-foot Sidewalk	Phase III	$583,154
University-Estates/Park NA	4-foot Sidewalk	Phase III	$99,000
UPRR at Bonarden	Crossing	Phase III	$100,000
UPRR at Country Club	Crossing	Phase III	$100,000
UPRR at McAllister	Crossing	Phase III	$100,000
UPRR at Western	Crossing	Phase III	$100,000
Warner at Western Canal	Mid-block Xing	Phase III	$175,000
Kyrene Canal at Warner	Mid-block Xing	Phase IV	$175,000
Highline Canal at Guadalupe	Mid-block Xing	Phase IV	$175,000
Highline Canal at Elliot	Mid-block Xing	Phase IV	$175,000
Highline Canal at Warner	Mid-block Xing	Phase IV	$175,000
TOTAL PROJECT COSTS plus annual programs ($500,000 per year)			**$10,779,083**

Figure 2.1 - 2030 Bicycle and Pedestrian Facilities Map



3 BIKEWAYS AND MULTI-USE PATHS

INTRODUCTION

Tempe has had a long-standing commitment to encourage bicycling through the development of bikeways and educational and promotional programs. In addition to serving the need for practical and inexpensive transportation for college students, Tempe residents are interested in increasing opportunities for recreational bicycling and commuting. The city's commitment dates back to 1971 when the first set of dedicated bicycle lanes in Tempe were implemented on College Avenue between Southern Avenue and Apache Boulevard. College Avenue is now the busiest bicycle route in the State of Arizona. The first Tempe Bicycle Plan was developed in 1973. It was the first comprehensive bicycle plan in the state. Since then, there has been a steady expansion of the city's bikeway network.

In 1991 the updated Tempe Bicycle Plan provided a revised bicycle system plan, as well as a policy framework for providing key bicycle amenities and promotional programs. While the 1995 Bicycle Facilities Update provided a new list of bicycle system projects, the basic policies contained in the 1991 Bicycle Plan continue to guide the rest of the bicycle program. In planning and developing the Tempe bicycle system, the city has used four different types of bikeways. Three of these are on-street facilities including bicycle lanes, bicycle routes and wide outside curb lanes. The fourth type of bikeway used in Tempe is the off-street multi-use path. One of the reasons for the mix of bikeway facility types is the city's goal to serve different types of bicyclists and different levels of experience.

Several people commute by bike to and from work in Tempe.

Tempe continues to provide bicycle facilities and amenities for everyone. In 2004, Tempe accomplished the following:

- Completed construction of 13th Street Bicycle/Pedestrian Improvements Project
- Completed bicycle lanes on First Street
- Completed design of Rio Salado south bank and Tempe Canal multi-use paths
- Completed Country Club Way and US 60 Bicycle/Pedestrian Bridge
- Secured federal grant funding totaling $5.465 million for Western Canal Multi-Use Path (six miles) and College Avenue traffic calming (2.5 miles)
- Secured $4.5 million in federal grant funding for pedestrian and bike improvements on Broadway Road, University Drive, Curry Road, Mill and Southern avenues
- Completed design concepts and secured $1.7 million federal grant for Rio Salado Multi-Use Path connection to Phoenix
- Secured $500,000 federal grant for Tempe Bike Station to be located in future downtown Tempe Transportation Center

EXISTING CONDITIONS

Present Bikeway System

Since the inception of the Tempe Bicycle Program, there has been considerable progress in developing the citywide bikeway network. There are now over 165 miles of bikeways consisting of bike lanes, wide outside curb lanes, bike routes, and multi-use paths. Existing bike lanes and multi-use paths are shown in Figure 3.1.

Development of the present bikeway network has considered the two fundamental dimensions of transportation: access and mobility. Providing good access has meant concentrating new bikeways in the vicinity of major bicycle traffic generators such as Arizona State University. Providing good mobility has meant building a bikeway network that spans the city with a high degree of connectivity. Arizona State University has been recognized as one of the largest generators of bicycle trips as the bikeway network has been developed.

ASU is served by on-street facilities from all directions. In addition, the bikeways presently serving ASU and nearby attractions such as Mill Avenue take varied forms. There are bike lanes on busy commercial streets such as University Drive offering direct access and there are also bike routes on quiet "back door access" streets such as Lemon Street and 10th Street.

Town Lake and Papago Park are also large generators of bicycle traffic. Access to these areas has improved with the construction of bike lanes on the Mill Avenue bridge. Several multi-use paths have been constructed in these areas and the recreational use of these paths means that they function as destinations in their own right. The lack of bicycle facilities on the Priest Drive and Rural Road bridges over the Salt River limits the bicycle accessibility of this area. The 1995 Bicycle Facilities Update Plan contains a project to add bicycle lanes to the Priest Drive bridge under the "Ultimate Plan" set of high-cost projects.

Another bicycle traffic generator is the Arizona State University Research Park in the southeast section of the city. As the primary street in this campus, River Parkway has bike lanes throughout its length. Bicycle lanes and routes have also been constructed on quieter streets in this area such as Country Club Way and Secretariat Drive. Unfortunately, the River Parkway bike lanes can only be accessed from the north by the high-traffic street of Elliot Road, which has no bicycle facilities. The 1995 Update contains a few projects to link the park with quiet residential streets to the northwest under the long range set of projects.

Existing bike lane along an arterial roadway in Tempe.

Facility Types and Design Standards

Many of the present on-street bike facilities have been constructed at a low cost through routine street resurfacing and restriping programs. The decision on whether to use bike lanes, a bike route or a wide outside curb lane is made on a case-by-case basis. Bike lanes are generally used for the arterial and collector streets while using signs to create bike routes is the preferred choice for neighborhood streets.

The 1991 Tempe Bike Plan had a companion document called the Facilities Guidelines. This document still governs the design standards for current on-street bikeway construction projects. Essentially, the document adopts national design standards for bike facilities that have been created by the American Association of State Highway and Transportation Officials (AASHTO) and the Manual on Uniform Traffic Control Devices (MUTCD).

Bicycle Parking

Bicycle racks have proliferated across Tempe as a result of an ordinance requiring their installation with certain developments. In addition, the city completed an illustrative brochure for developers called "Bicycle Racks: A Guide to City of Tempe Requirements." ASU has also been aggressive in installing bike racks. Racks are installed with an even coverage across campus and then additional racks are provided on a request basis.

Education Programs

With the assistance of the Tempe Transportation Commission, several programs exist to promote and educate citizens on bicycle issues. The best known annual event is the Tour de Tempe, which is a 15-mile free recreational ride around town highlighting many of Tempe's most popular bikeways. Another event is Bike Month, held every Spring as a series of events aimed at celebrating bicycling and providing various means of encouraging more bicycling. The city creates and distributes a Tempe Bicycle Map. This is a colorful guide to all Tempe bikeways and it includes a large amount of information on bicycle laws, safe riding habits, and numerous sources for more information.

Multi-Use Path System

As part of the Tempe Bikeway Program, the city has been aggressive in the development of recreational bicycle facilities. The recreational bicycle system, by definition, is less concerned with route directness and connectivity. Instead, rights-of-way offering uninterrupted travel are sought. Fortunately, Tempe has many such opportunities in the form of canals and abandoned railroad rights-of-way. Based on these unique opportunities, the city prepared the Multi-Use Path System Detailed Plan in 2000. Recognizing that there is a common set of design considerations with proposed multi-use trails, the city prepared this document to establish guidelines on these matters. The guidelines include geometric design standards, signage, landscaping, cost estimates and mid-block crossings. Pleasant multi-use paths on both sides of the Salt River were the first projects to be completed. Many more projects have been completed and continue to be built throughout the city. Following is a list of some of the recently completed multi-use path projects.

- Country Club Way/US 60 Bicycle & Pedestrian Bridge – located over the US 60 Freeway at the Country Club Way alignment located between McClintock Drive and Price Road. The bridge connects Rotary Park and the Ward School campus on the north side of the freeway with Cole Park and Bustoz Elementary School on the south side of the freeway. The facility connects both sides of the freeway, linking the schools, parks, neighborhoods and other activity centers. The completed project also incorporates lighting, landscaping and connected multi-use paths.

- Crosscut Canal Multi-Use Path – In March 2003, the city of Tempe completed construction of this path, providing new opportunities for bicyclists, joggers and pedestrians to enjoy the amenities and recreational opportunities of Papago Park and the Papago Salado area. The 1.25 mile path, which is accessible to people in wheelchairs, runs along the west bank of the Crosscut Canal in north Tempe between Canal Park and McDowell Road.

- Spence Avenue Multi-Use Path – In April 2002, the city and Arizona State University celebrated the opening of this path, a one-eighth mile path connecting neighborhoods east of Rural Road and south of Apache Boulevard with the ASU campus. The path provides cyclists and pedestrians with a dedicated, non-motorized corridor to ASU and allows them to circumvent the Apache Boulevard and Rural Road intersection, which is one of the highest traffic volume intersections with the highest bicycle/vehicle accidents in the city. The project was a unique partnership between ASU, the city of Tempe and Arizona Department of Transportation (ADOT).

- Kyrene Canal Multi-Use Path – In August 2002, construction was completed on this path. It provides a link from south Tempe neighborhoods to Kiwanis Community Park and Ken McDonald Golf Course. The project served as mitigation for the adjacent Salt River Project power plant expansion. Salt River Project built this non-motorized path, working closely with the neighbors and the city. The Kyrene Canal Path system is two miles long and includes lighting and landscaping, and is accessible to people with disabilities.

Kyrene Canal Multi-Use Path in Tempe.

- College Avenue Bicycle/Pedestrian Bridge – As part of the US 60 freeway renovation project, the city of Tempe and ADOT replaced the old College Avenue Bicycle/Pedestrian Bridge with a new, more attractive and functional bridge. This new bridge is more accessible for users, including people with wheelchairs, bicycles and strollers. In addition, the new bridge included an artist-designed feature to enhance the experience of adjacent property owners, users of the bridge and motorists on US 60. The bridge connects Evans School and Palmer Park on the south side of US 60 with neighborhoods on the north side of US 60.

- Rio Salado Multi-Use Paths – Located on the north and south banks of the Tempe Town Lake, artist Laurie Lundquist used concrete and steel to create a multi-use path with shade/bench structures. Completed in 1999, this project provides bicycle and pedestrian connections along Tempe Town Lake.

Current projects include:

- Western Canal Multi-use Path Project - This project includes constructing a new bicycle and pedestrian path along the Western Canal. The path will extend for six miles connecting parks, schools, and other destinations in Tempe. The project includes a path with lighting, landscaping and public art.

- Rio Salado South Bank Multi-Use Path – This path will extend the linear park and pathway system in the Rio Salado area from Hardy Drive/Tempe Arts Center to Priest Drive. It will provide path linkages on the south bank to Priest and Hardy drives, the Town Lake downstream dam, the Tempe Arts Center and other portions of the Town Lake and Rio Salado Park. The project involves coordination with the Tempe Arts Center and a rehabilitation/ revegetation project in the Salt River channel and banks. The project involves creating a half-mile concrete, lighted, and landscaped path facility with a public art element.

- Tempe Canal Multi-Use Path – This project involves the design and construction of a new three-quarter mile long, twelve foot wide concrete path facility, located along the west side of the Tempe Canal from University Drive and extending south to the Union Pacific Railroad (UPRR), then west along the UPRR to Price Frontage Road. The project includes landscaping, a public art element, and will be lighted with a Crime Prevention Through Environmental Design approved fixture. Two arterial street crossings (Apache Boulevard and University Drive) with specialized pedestrian treatments will also be included in the project. The project will meet all Americans with Disabilities Act (ADA) guidelines and comply with the standards of the AASHTO.

NEEDS/ISSUES

Bicycle Safety

The most important consideration in bicycle planning is that, while some adults are comfortable bicycling on streets with high traffic volumes and speeds, most are not. This presents a significant challenge for bicycle planning in communities with built-out roadway systems. Some of the strategies for addressing this have been more successful than others. A few communities have tried the same approach used with pedestrians – developing bikeways in the street right-of-way, but with a physical barrier from motor vehicle traffic. This has been done by placing a curb between general traffic and the bike lane or by placing parking between general traffic and the bike lane. Both methods have been unsuccessful. Where these facilities meet the intersections, poor visibility and a false sense of security on the part of the cyclists result in high collision rates.

Bicycle safety in Tempe is important. According to Table 3.1, the number of bicycle-related accidents in Tempe has been increasing over recent years. The table also shows that bicycle accidents are a small percentage of accidents overall, averaging 3 percent of all accidents. According to the 2002 Traffic Investigation report prepared by the Tempe Transportation Division, 53 percent of the accidents during that year occurred at intersections, while 47 percent occurred at mid-block locations. Bicycle accidents occur mostly in the northern half of the city. Clusters of accidents occurred along Mill Avenue, University Drive, and Rural and Baseline roads.

Table 3.1 - Tempe Bicycle Accident Data 2000-2004

Year	# of Bike Accidents	% of All Accidents
2000	210	3.24%
2001	187	2.96%
2002	150	2.55%
2003	165	2.96%
2004	219	3.83%

College Avenue Bicycle/Pedestrian bridge

The city of Tempe has developed a set of standard bikeway treatments that have been more successful at addressing bicyclist safety. Striped bicycle lanes have proven to be the best way to make cyclists comfortable using a high-traffic/high-volume street. The city adheres to the standards in the national MUTCD for signing and pavement markings that indicate that these bike lanes are for the exclusive use of cyclists. When limited right-of-way or other constraints prevent addition of a full-standard bike lane, the city has also built unmarked wide outside curb lanes to increase the buffer for cyclists on high-traffic/high-volume streets. Multi-use paths are a type of bikeway that have great potential to satisfy the safety concern of cyclists. When these facilities are designed with an alignment that is completely independent of a street – e.g. along a canal or through a large park – they are the ideal answer to the safety concern for adult and child bicyclists alike. These paths should only follow a street when there are very few driveways and intersections because of conflicts with motorists pulling onto and off of the street. Also, occasionally safety can become a concern relative to conflicts between bicyclists and pedestrians on the paths. This is generally related to the level of activity on the path and can be mitigated through striping and signing treatments.

Bicyclists Needs

There is a mix of bicyclists in Tempe – commuters, recreationalists, and those who ride to run errands. In 2001, the city of Tempe conducted a bicyclist and pedestrian survey. The survey found that:

- Sixteen percent of respondents bicycle for commuting
- Two percent bicycle for errands
- Eighty one percent bicycle for recreational/social activities

Approximately 34 percent of the respondents who bicycle for transportation do so relatively infrequently – twice per week or less. The most common obstacles to bicycling were:

- Traffic – (36 percent)
- No Bike Lane/ Inadequate Lanes – (24 percent)
- Weather – (16 percent)
- Physical obstacles – (12 percent)
- Distance – (nine percent)
- Family responsibilities – (two percent)
- Bike limit on bus – (one percent)

Eighty percent of survey respondents said they would bicycle more if the bikeway system were expanded.

These survey results show that bike planning should call for the development of different types of facilities suited to the different types of bicycling and different users.

Many cyclists are uncomfortable traveling on high-traffic/high-speed streets. However, bicyclists that are commuting and running errands want to go to the same places that motorists do and these destinations cannot be reached by residential streets alone. For this reason, the development of bike lanes on arterial streets is an important component of any bicycle plan.

Another general consideration for the cycling environment is surrounding land use. Cycling levels will tend to be higher in areas where different land uses are mixed. This land use pattern shortens trip distances and breaks-up the monotony of the view from the bicycle. A related point is that cyclists enjoy bicycling through environments that are animated. When the surrounding sidewalks are filled with pedestrians, sidewalk cafes, etc., it adds a human-scale to the street for cyclists.

While they cannot always be addressed, there are several other aspects of bicycling comfort. Since it requires significantly more physical exertion, cyclists avoid climbing steep grades. Also, starting from a stop requires much more exertion than maintaining your speed on a bicycle, so routes that require frequent stops are undesirable. In hot climates like Tempe's, shade on the bicycle route is always an amenity. However, bicycling involves some "self-cooling" because of the breeze generated by bicycling at a moderate speed. For this reason, shade is more critically needed at stopping points.

Having widespread availability of bicycle parking is also key to encouraging cycling – particularly for errand and commuting cycling. Bicycle parking is most commonly provided with bike racks. The racks must have a design that supports the bike properly and allows the cyclist to lock the bicycle's frame to the rack.

GOAL/OBJECTIVES/STRATEGIES

The goal of the Bikeways element is to recognize and encourage the use of the bicycle as an important part of the transportation system.

Objective

- Provide safe and convenient bicycle access from neighborhoods to schools, parks, shopping, transit, employment, and other destinations.

Strategies

- Implement the provisions of the Tempe's adopted Bicycle Plan and Bicycle Facilities Plan Update.
- Adopt and implement design and development standards that require secured bicycle parking.
- Improve the bikeway system in Tempe to ensure that the travel network and facilities will accommodate all types and levels of bicyclists.
- Improve the bikeways network by including bike lanes on all arterial streets; street crossing improvements; crossings at railroad rights-of-ways, canals, freeways, and other barriers to travel; and additional multiuse paths and crossings.
- Implement improvements on designated Transit Streets and Green Streets to encourage increased pedestrian and bicycle travel and transit use. (See Chapter 5.)
- Participate in regional bikeway planning efforts to ensure that Tempe's bikeways connect with those of neighboring communities and that Tempe's system is an integral part of the overall regional system.
- Continue to implement programs and special events that raise awareness about bicycling safety, the needs of bicyclists, and the availability of bicycling opportunities in Tempe including special events related to bicycling in the community.

RECOMMENDED ACTIONS

Expand the Bikeway Network

Creating a citywide bikeway network with strong connectivity is a central goal of this plan — but it comes with challenges. Much of Tempe is developed around a one-mile grid of major arterial streets; north-south streets such as Rural Road and McClintock Drive, and east-west streets such as Broadway Road and Southern Avenue. These streets represent the obvious bicycle deterrent of high traffic levels. However, they are the most direct and connective of Tempe's streets and they serve many of the businesses and attractions that cyclists would like to access.

The projects recommended in this plan address this dilemma with a few different strategies. First, streets that are connective, but with lower traffic volumes, have been targeted for on-street facilities. Many of these projects were identified in the 1995 Bicycle Facilities Plan Update, and are now in place. Examples are the Alameda Drive bike route and the College Avenue bike lanes.

Another strategy has been to forge bicycle connections between low-volume streets that did not originally connect. One example is a proposed project to construct bicycle paths to make direct connections between cul-de-sacs in the ASU Research Park and residential streets in the neighborhood to the west. A second example is the present Superstition Freeway bicycle/pedestrian overpass at College Avenue. College Avenue now retains lower motor vehicle traffic volumes because of the freeway interruption, but the bicycle/ pedestrian overpass allows cyclists to travel uninterrupted from Kiwanis Park to ASU.

A third strategy has been to construct full-standard bicycle lanes on the high-volume arterials in the city. University Drive is one example. It is recognized that not all cyclists will be comfortable on these streets, but for those who are, excellent access and direct routes are provided. Because these projects are often very expensive due to the need for widening the street, they were programmed under the category of "Ultimate Plan" in the 1995 Update Plan.

Striped bicycle lanes provide a safe and secure place for bike riders in street right-of-ways.

Bicycle Incentives, Promotions and Events

Educational Outreach

- Programs that raise awareness about bicycle safety and the needs of bicyclists.
- Ongoing updates and distribution of Tempe's bikeways map.

Special Events

- Bike Month
- Free transit to special events
- Tour de Tempe bike ride

Project Implementation

The approach to implement the bicycle projects recommended in Table 3.2 should parallel the approach for general transportation projects. A special resource to the bicycle program, however, is the well-established Tempe Transportation Commission. The commission should continue to assist in the review of all bicycles projects, as well as review large transportation projects for bicycle accommodation. The commission should periodically discuss new bicycle planning issues and update the Bicycle Plan. Design of all facilities should comply to national standards.

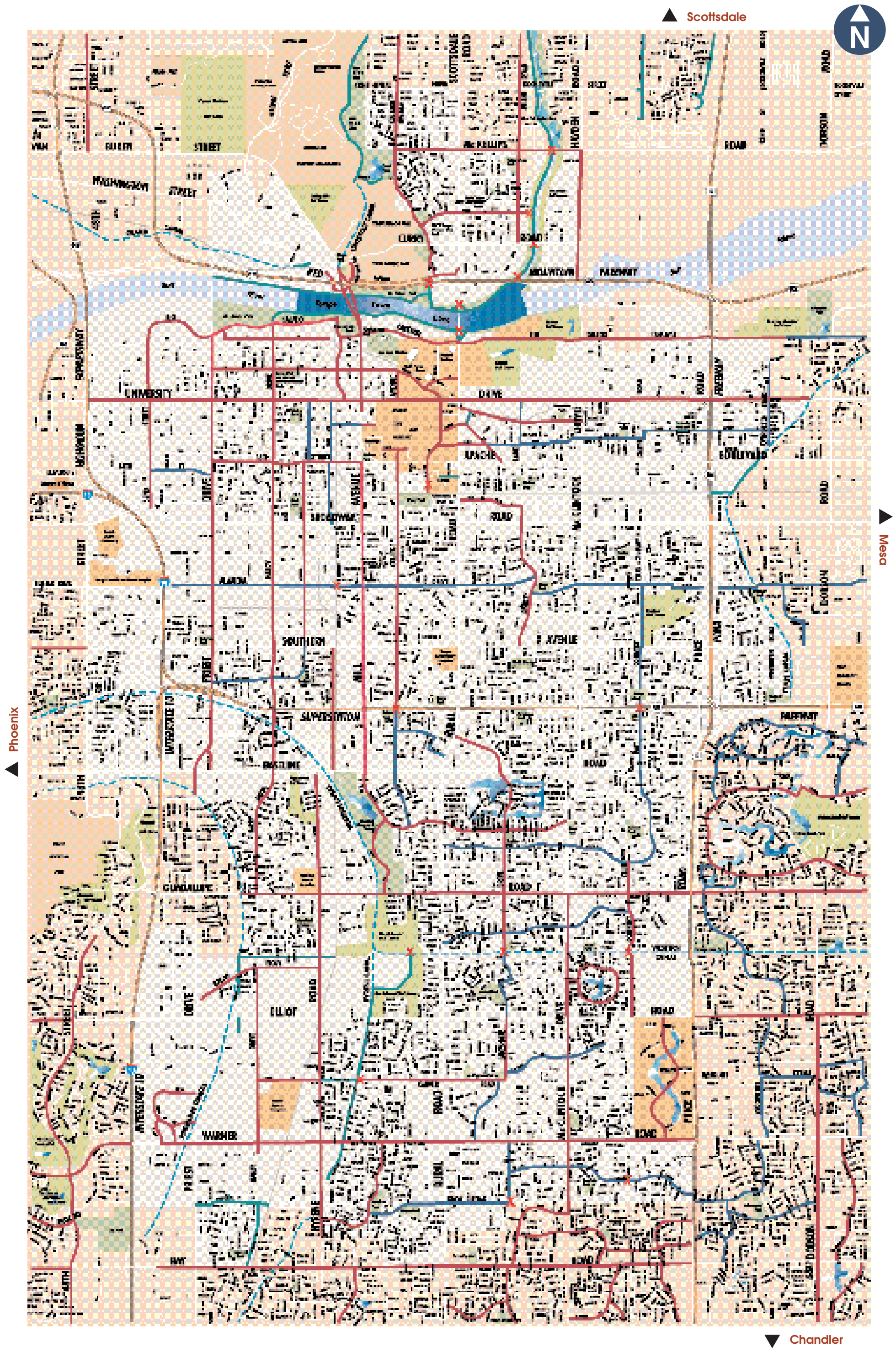
PROJECT LIST

Table 3.2 includes a list of projects for bicycle lanes, street improvements and crossings, as well as additional multi-use paths. This project list includes projects to be completed through 2030. The project list categorizes each project by year and also includes location, type, and estimated cost. Priority projects are indicated through 2010, while other projects are listed through 2015, 2020, and 2030.

Table 3.2 Bikeways and Multi-Use Paths Project List 2005-2030

LOCATION	TYPE OF WORK	YEAR	COST
Rio Salado: Mill to Priest	Multi-Use Path	Phase I	$1,600,000
Western Canal: Price to Southbank I-10	Multi-Use Path	Phase I	$9,600,000
Tempe Canal: University to UPRR	Multi-Use Path	Phase I	$985,000
Rio Salado: Priest to Hohokam Freeway	Multi-Use Path	Phase I	$1,600,000
Downtown Tempe	Bicycle Station	Phase I	$582,837
Western Canal @ I-10	Grade Sep. Xing	Phase I	$4,000,000
Priest: Van Buren to University	Bike Lane	Phase I	$100,000
Van Buren: Curry/Washington to Priest	Bike Lane	Phase I	$100,000
Grand Canal: Center to Priest	.5 mile Multi-Use Path	Phase I	$800,000
Crosscut Canal: Marigold Lane to Mill	1 mile Multi-Use Path	Phase I	$2,100,000
Tempe Canal: UPRR to US 60	1.5 mile Multi-Use Path	Phase I	$3,000,000
El Paso Gasline: Rural to Kiwanis Park	.5 mile Multi-Use Path	Phase I	$800,000
Rio Salado Upstream Dam	Grade Sep. Xing	Phase II	$4,000,000
Balboa/Alameda @ 101	Grade Sep. Xing	Phase II	$4,000,000
Alameda at 1-10	Grade Sep. Xing	Phase II	$4,000,000
Baseline and Western Canal	Grade Sep. Xing	Phase II	$4,000,000
Highline Canal: Knox to Guadalupe	2.5 mile Multi-Use Path	Phase III	$3,000,000
Rio Salado: SB Rural to McClintock	1 mile Multi-Use Path	Phase III	$1,600,000
US 60 @ Dorsey	Grade Sep. Xing	Phase IV	$4,000,000
All Railroad R-O-W	10 mile Multi-Use Path	Phase IV	$12,000,000
TOTAL PROJECT COSTS			**$61,867,837**

Figure 3.1 Tempe Bikeway Network



Bicycle Lane
A portion of a roadway designated for preferential or exclusive use of bicycles and defined by pavement markings, curbs, signs or other traffic-control devices (see symbol). Bicycle lanes are a minimum of four feet wide.

Bicycle Route
A segment of a system of bikeways designated by signage only and typically on residential streets only.

Multi-Use Path
A paved facility completely separate from the roadway and motorized traffic designated for non-motorized, mixed use. Multi-Use paths are a minimum of 10 feet wide.

Wide Outside Curb Lane
A portion of roadway which has been designated for shared use by bicycles and motorized traffic, characterized by a curb lane which is of such width that bicycle and motorized traffic can be accommodated in the same lane (may or may not have an edge stripe).

4 TRANSIT

INTRODUCTION

The city of Tempe, as a member of Valley Metro, provides fixed-route transit service in the city of Tempe and in neighboring cities. Valley Metro also provides regional routes that link Tempe to activity centers throughout the region. The city of Tempe also provides free high frequency bus circulator services, the Flash Forward/Back, Flash to University Drive and Orbit. These routes link downtown Tempe with ASU and also connects Tempe neighborhoods via routes that serve both downtown and ASU.

Orbit Neighborhood Circulator in Tempe

In addition to fixed-route transit, the city of Tempe also participates in the East Valley Dial-a-Ride service for senior citizens and persons with disabilities. This service is scheduled through advance reservations and offers connections to/from fixed route service and other Dial-a-Ride providers in the region.

Other regular transit service currently operating within the Tempe area includes ASU campus shuttles. The ASU West Express Shuttle provides a direct link between the Tempe and West campuses, and the ASU East shuttle provides connections between the ASU East Campus, Mesa Community College (MCC) and the ASU Tempe Campus.

The METRO light rail, currently under construction, will begin service in 2008. The city of Tempe is actively involved in station area, planning, and construction for the light rail segment through Tempe.

EXISTING CONDITIONS

Transit Routes and Facilities

Key elements of transit service within the city of Tempe include:

- Service on all major arterials from approximately 5 am to 1 am.
- Weekday peak period fixed route service frequency of 15-30 minutes.
- Weekday peak period express bus service to downtown Phoenix every 30 minutes.
- Free circulator buses linking downtown Tempe, ASU and residential neighborhood areas, operating at 10-15 minute service frequencies throughout the day.
- Special events service.
- Dial-a-Ride service.
- ASU campus shuttles linking the Tempe campus with East and West ASU campuses and MCC.

Since the city began making improvements in 1996, bus ridership in Tempe has continued to increase. There were more than 7.9 million bus boardings (including FLASH and Express service) during calendar year 2005 compared to 1.2 million in 1996. Tempe currently has 86 bus pullouts, 187 bus shelters, and 94 percent of all bus stops have seats.

Transit options should be available to everyone in Tempe

Local Bus Routes

Local bus routes supplement regional bus service and provide bus access to many activity centers in Scottsdale, Phoenix, and Mesa in addition to Tempe. Bus service in Tempe operates seven days a week from approximately 4:30 am to 1 am, Monday through Saturday and from

5 am to 10:30 pm on Sunday. Most Tempe bus routes operate every 15 minutes from 6 am to 9 am and 3 pm to 6 pm, Monday through Friday. Bus service is also available on all major holidays with service following Sunday schedules. All Tempe buses are wheelchair accessible, and are equipped with bike racks.

Valley Metro Routes

Sixteen Valley Metro routes traverse Tempe, with both peak period express and regional fixed route service throughout the day. Service is provided seven days a week on all routes except the express services.

Flash Forward/Back and Orbit

The Flash Forward/Back is a free local area shuttle serving ASU and downtown Tempe every 10 minutes on weekdays. All Flash buses are wheelchair accessible and equipped with two bike racks.

The Orbit neighborhood circulator system uses small mini-buses to serve residential areas and connect them to local destinations such as downtown Tempe, Arizona State University, shopping areas, other neighborhoods, major bus and future light rail routes, schools and multi-generational centers. Tempe currently operates five, free Orbit routes – Mercury, Venus, Earth, Mars and Jupiter, which run every 15 minutes, seven days a week from 6 am to 10 pm.

Dial-a-Ride

Valley Metro East Valley Dial-a-Ride provides shared-rides for senior citizens age 65 and older, and persons with disabilities. The service operates in the cities of Tempe, Scottsdale, Mesa, Chandler, and Gilbert. Dial-a-Ride service generally operates daily from 4 am to 1 am.

ASU Campus Shuttles

The Arizona State University campus shuttles operate on weekdays in the fall and spring semesters. These routes are operated exclusively by Arizona State University. The ASU West Express shuttle links the Tempe Campus to the ASU West Campus located in northwest Phoenix adjacent to Glendale. The ASU East shuttle provides connections between the ASU Tempe Campus, MCC in Mesa, and the ASU East Campus in Mesa.

Transit Centers

There are currently two primary facilities or areas located in the city of Tempe that serve as key transit transfer centers. Each of these areas, described below, accommodate a high concentration of bus routes and allow for passenger connections between specific routes.

- College Avenue Bus Stops – The College Ave. corridor between 5th St./Veterans Way and University Drive serves as the downtown Tempe and ASU Transit Center. This corridor currently accommodates approximately 14 bus routes.
- Arizona Mills Mall – Three bus bays and a passenger loading area are located on the east side of the mall property and currently provide an interface with four bus routes. This location is accessed by bus via a driveway connecting to Priest Drive between the Superstition Freeway and Baseline Road.

Park-and-Rides

Valley Metro coordinates a system of publicly and privately owned park-and-ride lots throughout the Phoenix area. There are currently five lots in the Tempe area that are provided and maintained in conjunction with privately owned local businesses. These lots facilitate connections to fixed-route transit services that offer access to local and regional activity centers.

Promoting Transit

The city of Tempe provides a variety of additional amenities that supplement bus transit services. The supporting infrastructure and services listed below help to enhance access for patrons and encourage use of the transit system.

- Bicycle Program and Amenities – The city's Bicycle Program helps with the coordination and project development of bicycle/pedestrian paths, crossings and on-street bike lanes. The city also hosts special events to encourage bicycling as an alternative to automobile travel.
- Transit-related bicycle services provided by the city include the Bike-on-Bus Program, which offers bike racks on buses, plus bike lockers and racks within activity centers served by the transit system.
- Pedestrian Program – The city's Pedestrian Program sponsors special events that promote and encourage walking as an alternative mode

of travel. In addition, the city has successfully completed its first major neighborhood pedestrian/traffic calming project on Fifth Street between Farmer Avenue and Priest Drive. The project included new bike lanes, widened sidewalks, narrowed traffic lanes and additional traffic calming features. These improvements enhance access to the Orbit Venus route that operates along this segment of 5th Street.

Bicyclist riding a Metro-Valley bus route.

- Art in Transit Projects – As part of the city's commitment to cultural services, art projects have been successfully incorporated into the Tempe transit system. Buses, shelters, bike lockers and racks have been developed with unique artwork and innovative themes. These projects offer unique and aesthetic character to the local transit amenities.
  - Youth Bus Pass Program – This program allows students ages 6 to 18, who provide proof of residency, age, and school enrollment, to ride the bus for free with the consent of a parent or legal guardian.
  - Arizona State University U-Pass Program – This program allows all eligible ASU faculty, staff and students to ride existing Valley Metro bus routes for free, including the Phoenix Rapid and regional express buses.

Transit Ridership

The city of Tempe has been successful in attracting excellent transit ridership for travel demand within the city in addition to connections throughout the Phoenix area. Total ridership for all Tempe routes for 2005 was 7,956,175. Table 4.1 shows total bus ridership from 2000-2005. According to this table, annual ridership is steadily increasing.

Table 4.1 - Transit Ridership 2000-2005

Year	Total Ridership
2000	4,590,206
2001	5,766,882
2002	6,349,098
2003	7,098,259
2004	7,732,576
2005	7,956,175

Planning and Design Studies

Planned METRO Light Rail Service

Construction in under way for the METRO light rail initial line segment. Figure 4.1 shows the light rail alignment through Tempe. A total of nine stations and three park-and-ride lots are planned for Tempe. The METRO light rail stations have been designed to enhance the passenger experience by maximizing shade, safety and ease of use. The stations were also designed to complement their immediate surroundings and the neighboring community. The station platform area will be approximately 16 feet wide by 300 feet long for passengers boarding or exiting trains in either direction. Stations will be located in the center of the street, and passengers can access the stations from a lighted intersection. The Maricopa County Association of Government's (MAG) "Transportation Improvement Program for 2006-2010," includes $970,590,220 of projects in Tempe associated with light rail construction.

Regional Transit System (RTS) Study

This document, published by MAG, was complete in November 2003. The Transit Section includes recommended improvements to the existing transit network. In Tempe, proposed improvements include service with greater peak frequency on some existing routes. A high capacity Bus Rapid Transit (BRT) route is proposed through Tempe along Rural Road. BRT Routes operate as overlays on corridors served by local fixed route service, but provide higher speed services by operating with limited stops and with other enhancements, such as bus only lanes or signal priority systems. BRT Freeway routes are also proposed though Tempe on Loop 101, I-10, and Loop 202. These use existing and proposed high occupancy vehicle (HOV) facilities to connect remote park-and-ride lots with major activity centers, including core downtown areas.

NEEDS/ISSUES

The city of Tempe's transit program, Tempe in Motion, promotes the use of alternative modes of transportation and encourages "getting around Tempe in anything but a car." Since the passage of Tempe's 1996 dedicated transit sales tax, the city has embarked on an implementation program of transit improvements. The majority of this program was implemented between 1997 and 2005. Table 4.3 outlines the remaining projects that are either ongoing or yet to be fully completed.

GOAL/OBJECTIVES/STRATEGIES

The goal of the Transit Element is to coordinate Tempe's Transit Plan with the overall transportation plan to support increased ridership.

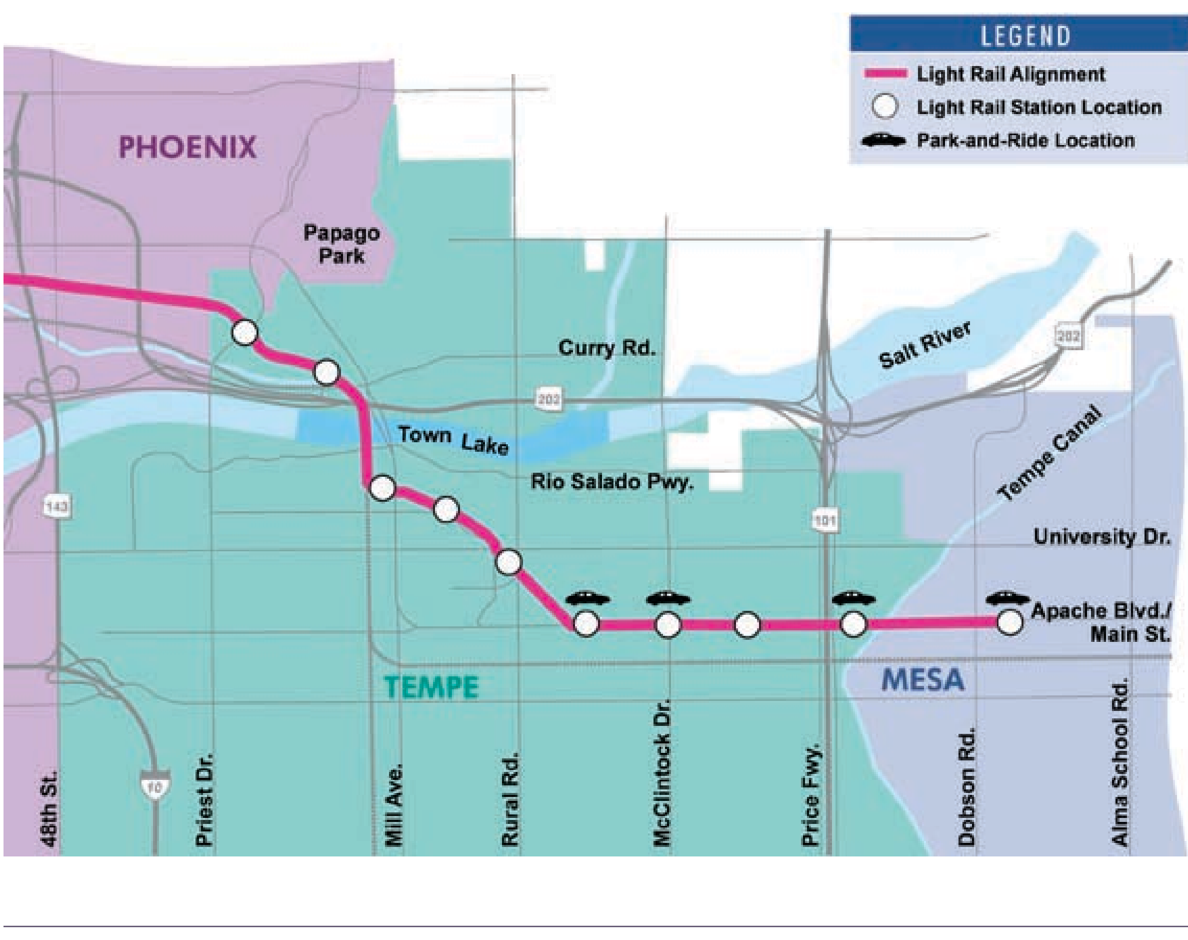
Objectives

- Increase available transit modes and services to support ridership increases and an expanded transit mode share.
- Facilitate connections among transportation modes.

Strategies

- Ensure that fast and frequent transit service is provided, with service at 10- to 15-minute intervals with no more than a 5- to 10-minute walk from any location within Tempe.
- Ensure that peak transit loads associated with special events can be accommodated.
- Continue to develop programs that provide incentives for using transit, including use of transit to attend special events.
- Expand and improve express bus service between Tempe and key regional locations and develop supporting facilities, including direct access ramps and HOV lanes.

Figure 4.1 Light Rail in Tempe



- Analyze the viability of, and develop, regional Bus Rapid Transit (BRT) corridors where appropriate.
- Implement METRO Light Rail Transit (LRT) project.
- Implement final recommendations for the Scottsdale/Tempe High Capacity Corridor.
- Coordinate and cooperate with the ongoing Chandler High Capacity Study.
- Study the viability of commuter rail along the Union Pacific corridor.
- Consider fixed guideway transit along Rio Salado Parkway.
- Continue to coordinate with all neighboring cities and the region on regional transportation planning programs and projects.
- Coordinate with land-use planning efforts to promote transit-oriented development, and enhance access to transit throughout the city.
- Improve the transit system in Tempe to ensure that the network and facilities will accommodate all types of transit users.
- Integrate Intelligent Transportation System (ITS) technologies into transit system plans and services.
- Implement improvements on designated Transit Streets and Green Streets to encourage increased use by pedestrians, bicyclists, and transit. (See Chapter 5.)
- Implement the provisions of a pedestrian overlay district.
- Modify bus routes to support future light rail stations.
- Develop regional park-and-ride facilities at regional centers or connection points.
- Develop Transit/Transfer Centers in downtown serving LRT, and at other major transfer locations.

RECOMMENDED ACTIONS

Maximizing the potential of transit service and enhancing the productivity of service in high-density areas is the emphasis of the transit objectives. Both a reinforcement of previous plan strategies and tactics were developed to meet these objectives. The strategies described below are organized by fixed route improvements, capitol improvements, and operations, administration and planning strategies.

Fixed Route Improvements

Increase Service Frequency

This strategy involves the continuation of service improvements that were initiated as part of the previous Tempe Transit Plan program. Several routes have been enhanced to include 15-minute peak service frequencies. Additional 15-minute peak service improvements are recommended for the remaining routes that have experienced notable ridership increases and are not operating on duplicate route patterns. Additionally, 10-minute peak period service frequencies and 15-minute off-peak frequencies are recommended for implementation on routes that demonstrate notable ridership increases or for routes that are approaching peak load capacities.

Modify Bus Route Patterns to Serve as Feeders for Light Rail Stations

The METRO light rail planning and design process established a preliminary bus feeder concept to accommodate light rail station access. The bus feeder system will rely on the modification of current route patterns and will be refined as station planning issues are resolved along with traffic and transit operational considerations. Table 4.2 provides a preliminary summary of current bus routes that will serve the planned light rail stations within Tempe.

Table 4.2 – Light Rail Station Bus Feeder Interface

Light Rail Station	Feeder Routes
Apache Boulevard/Loop 101	40, 575, Orbit Mercury & Mars
Apache Boulevard/ Smith Martin Lane	40
Apache Boulevard/ McClintock Road	40, 81
Apache Boulevard/ Dorsey Lane	40
University Drive/Rural Road	72, FLASH, Orbit Mercury & Jupiter
Veterans Way/College Ave	40, 44, 56, 62, 65, 66, 72, 76, 92, Orbit Mercury, Venus, Earth & Jupiter
3rd Street/Mill Avenue	56, 62, 66, 76, Orbit Earth
Washington Street/ Center Parkway	56
Washington Street/Priest Drive	1, 56

Table 4.3 - Programmed Transit Projects

Planned Improvements	
Fixed Route	**Status**
15-min. peak period service on all routes.	15-min. peak service has currently been implemented on several routes. Those without 15-min. peak service include routes 1, 44, 65, 66, 76, 92, 108, Red Line, and Express buses. However, many of these routes serve common roadway segments and provide a blended frequency of 15 min. or less within certain areas of Tempe.
Extend hours to 5:00 am – 1:00 am.	All routes begin service at 5:00 am or earlier. The only routes that do not operate until 1:00 am include routes 1, 44, 76, 108, and Red Line.
Implement Rio Salado route (dependent upon new development activity).	On-hold pending future development and prioritization of service improvements.
Capital	
Complete design and construction of downtown Tempe Transportation Center.	Confirmed recommended location north side of Fifth St., between Forest Ave. and College Ave. This facility will be completed as part of the LRT project.
Locate and design bicycle/pedestrian improvements (on-going).	Requests have been made for other projects along College Ave. from Apache Blvd. to US 60.
Continue bus pull-out implementation where feasible.	A Bus Pull-out Priority Study was completed in May 2000 that identified a process and prioritization strategy for future implementation.
Continue rail design/construction	Construction underway
Locate and design second transit center (south).	Pending
Determine need for and locate/design additional transit center(s).	Pending
Operations, Administration and Planning	
Develop and implement public outreach and education program (on-going).	Activities include: comprehensive marketing, education and PR plan; open houses and neighborhood meetings as needed.
Evaluate service performance (on-going).	Benchmarks approved by Council 12/97 and incorporated into regional and local service contracts.
Evaluate express route improvements.	Participating in Regional Transit System Study being conducted by RPTA. The study will result in the development of a Regional Transit System Plan for Valley Metro.
Participate in regional Major Investment Studies.	Currently participating in Scottsdale/Tempe/ South Transit Corridor Study and MAG High Capacity Transit Plan.

Express Bus and Limited Stop Services

Currently there are two express bus routes that originate in Tempe and provide service to downtown Phoenix. Two additional routes also pass through Tempe enroute to downtown Phoenix, but originate in Chandler and Mesa. These services provide a limited number of trips to downtown Phoenix in the morning and a complimentary set of return trips in the evening. In addition to these regionally oriented express services, many of the bus routes operating in Tempe cross through multiple cities and provide long-distance regional connections. However, they provide numerous access points within local communities, therefore increasing travel times for longer trips.
Regional connections related to Tempe that are recommended for additional express route consideration and analysis include:

- Downtown Phoenix (reverse commute)
- Scottsdale
- Mesa
- Chandler
- Sky Harbor

Current transit corridors that are recommended for limited stop analysis to supplement current transit services include:

- Rural Road/Scottsdale Road – Route 72
- Broadway Road – Route 45
- Baseline Road – Route 77

Transit Streets

"Transit streets" are street corridors (typically arterials) that serve important functions as transit routes. Bus routes with 15-minute (or less) service frequency during the peak, and streets that share space with the light rail corridor are examples. Transit streets may include arterials that are inside and outside pedestrian overlay districts, and these streets will be improved for accessibility to transit by pedestrians and bicyclists.

Capital Improvements

Tempe Transportation Center Project Description

The Downtown Tempe Transportation Center, which will be located at Veterans Way and College Avenue, is situated at the base of Hayden Butte ("A" Mountain), east of the existing Police and Courts Facility. The project includes a three-story, 40,000 sq. ft. building, an exterior shaded courtyard, and a transit plaza serving the new METRO light rail and local, and regional bus patrons.

The ground floor will include retail (cafe, newsstand, drycleaner, gift shop, etc.), transit store, security office, and bicycle valet (with bike repair and accessories). The second floor will include the city of Tempe Transportation Offices and a community/conference room. The third floor will house the Transit Operations Center and additional office space. The facility is scheduled to open in Summer 2008.

South Transit Center

As transit service frequency is enhanced and upgraded throughout the Tempe area, there is greater opportunity for transfers among the various transit routes and an increased need for intermodal facilities to accommodate transit access. While downtown Tempe currently serves as the primary interface for transit services, there are also concentrations of transit services in the south Tempe area. Based on the current route patterns in south Tempe and the regional planning process related to the Scottsdale/ Tempe North/ South Transit Study, the following target areas should be evaluated for future transit center implementation.

- Arizona Mills Mall
- Vicinity of Mill Avenue and Baseline Road
- Vicinity of Guadalupe Road and Rural Road

Valley Metro bus in Tempe.

Park-and-Rides

The MAG Park-and-Ride Study completed in January 2002 identified park-and-ride lot system recommendations for the MAG Long Range Transportation Plan. Both near-term and long-term recommendations were presented based on criteria developed for target area and site evaluation. For programming purposes, the location of Loop 101/ Apache Boulevard/Broadway Road was identified as a new facility within the Tempe area. This facility would provide access to the METRO light rail at the eastern edge of Tempe.

Currently, the park-and-ride system throughout Tempe is comprised of private lots located within commercial centers that are jointly operated with Valley Metro. Most of the lots are along express bus routes that serve connections between Tempe and downtown Phoenix, or routes that connect south Tempe to the downtown area. Past studies have also identified locations along I-10 and the Price Freeway as target areas for further study. These locations include:

- I-10 and Baseline Road
- I-10 and Elliot Road
- I-10 and Warner Road
- Price Freeway and Southern Avenue
- Price Freeway and Elliot Road

Additional locations that could be considered for park-and-ride evaluation include:

- Arizona Mills Mall
- Tempe Diablo Stadium Complex

These locations are well oriented to express bus routes and could provide opportunities for shared parking arrangements to accommodate transit patrons. Future express bus analysis should also be combined with the analysis of park-and-ride opportunities at strategic locations. Park-and-ride facilities can be very effective in providing convenient access to transit services while still offering transit patrons the flexibility of using their private vehicle for linked trips between their home and transit stops or stations. The city of Tempe has also made effective use of shared parking facilities for special event parking and shuttle purposes. Additional opportunities could be explored to maximize this application, specifically at locations with non-concurrent parking demand characteristics.

Bus Pullout Program

The city of Tempe has made a commitment to the implementation of bus pullout bays throughout the Tempe transit system. Benefits offered by pullouts include:

- Increased safety for passengers while boarding and alighting buses.
- Reduced disruption to general traffic lanes due to bus stops.
- Improved opportunities for buses to re-enter traffic ahead of traffic signal.

The Tempe Bus Pullout Priority Study identified a process and prioritization strategy for the future implementation of bus pullout projects. See Table 4.4. Priorities were based on key factors such as traffic volume and bus frequency. While these priorities respond to operational considerations, actual implementation may change due site constraints, engineering considerations, costs and joint funding opportunities. The screening, ranking and problem identification steps outlined in the study will be used as a general guide for future implementation considerations.

Operations, Administration and Planning

Bus Priority Planning and Design Guidance

To date, the city of Tempe has implemented an extensive transit system with the intent of providing comprehensive coverage along the primary arterial street network. Transit service frequencies have been incrementally enhanced as part of the Tempe transit improvement program to help maximize the effectiveness of the system. The city has also advanced the desire to minimize the expansion of roadway capacity. These principles will increase the importance of efficient transit operations as overall travel demand grows in the future. In order for the transit system to serve as a viable and competitive travel mode, and to minimize the impact of roadway congestion on transit service, priority treatments for buses on Tempe streets should be further explored.

As the city of Tempe conducts future roadway corridor planning activities, transit priority applications can be considered to address deficiencies in transit operations or to provide added enhancement to bus routes that accommodate significant demand levels. These considerations could be explored through the development of a toolbox of transit system priority applications and related strategy selection process. Since it is likely that bus priority applications would be examined due to capacity issues at an intersection or a series of intersections along a corridor, the competing interests of providing exclusive treatments for buses while potentially impacting general traffic must be considered. Careful analysis of intersection and corridor traffic operations should be performed on a case-by-case basis if changes to laneage or signal timing for bus priority are proposed. A general strategy selection process should employ:

- Development of a corridor and/or intersection profile (documentation of the physical and operational characteristics for both the transit and traffic system).
- A preliminary screening process for the most applicable transit priority strategies.
- Simulation or testing of corridor and/or intersection operations with candidate transit priority strategies in place.
- Summary of benefits and impacts related transit priority applications.

A toolbox of transit priority strategies could be developed to examine two general techniques:

- Physical strategies (queue bypass lanes, exclusive bus lanes, etc.)
- Signal timing strategies (queue jump phase, signal priority treatments, etc.)

Developing a guidance process for examination of transit priority techniques could help to ensure that a full range of options is considered and that locally significant issues are taken into account as part of the evaluation process. The jurisdiction will need to determine if potential impacts incurred by a specific application are acceptable compared to the potential improvements to transit operations.

Transit Marketing and Education

Keys to a successful transit system include accessible, frequent and reliable service. In addition, effective marketing and education are critical to promote the awareness of transit as a travel option. The city of Tempe continues to make a strong commitment to the marketing of transit service within the community. Bus system information is readily available via printed or electronic maps and schedules. Internet websites provide extensive information related to the Tempe transit system. The city promotes transit and alternative modes throughout the business community, ASU and other local institutions. Promotional campaigns at local community events are also used to convey useful information regarding transit service.

A continuation of transit marketing and education is critical to the ongoing success of the Tempe transit system.

Participate in Regional Major Investment Studies

The city of Tempe needs to continue participating in the local and regional planning processes for transit projects, including:

- MAG High Capacity Transit Plan
- METRO Light Rail Project
- Scottsdale-Tempe N/S Transit Corridor Study
- Planning Activities for the Rio Salado Corridor (potential fixed guideway transit)
- Valley Metro’s Regional Transit System Study

PROJECT LIST

Table 4.5 includes a list of projects for transit projects including buses and high capacity transit for the city of Tempe. This project list includes project to be complete through 2030. The project list categorizes each project by facility type, year, location, and cost estimate. Priority projects are through 2010, while other projects are through 2015, 2020, and 2030.

Table 4.4 - Bus Pullout Priority Sites

Rank	Location	Cross Street	Direction
1	University Drive	Priest Drive	Eastbound
2	Priest Drive	Baseline Road	Northbound
3	Guadalupe Road	Price Road	Westbound
4	Mill Avenue	Washington Street	Southbound
5	Rural Road	Guadalupe Road	Northbound
6	Southern Avenue	48th Street	Eastbound
7	Washington Street	Mill Avenue	Westbound
8	Southern Avenue	Priest Drive	Eastbound
9	Curry Road	Mill Avenue	Eastbound
10	Baseline Road	48th Street	Eastbound
11	Mill Avenue	Washington Street	Northbound
12	University Drive	Hardy Drive	Westbound
13	University Drive	Hardy Drive	Eastbound
14	Kyrene Road	Guadalupe Road	Southbound
15	Mill Avenue	Broadway Road	Southbound
16	Rural Road	Apache Boulevard	Southbound
17	Kyrene Road	Guadalupe Road	Northbound
18	McClintock Drive	Rio Salado Parkway	Northbound
19	University Drive	48th Street	Westbound
20	University Drive	48th Street	Eastbound
21	University Drive	52nd Street	Westbound
22	University Drive	52nd Street	Eastbound
23	Curry Road	Scottsdale Road	Westbound
24	48th Street	Southern Avenue	Northbound
25	Baseline Road	Rural Road	Westbound
26	McClintock Drive	Southern Avenue	Southbound
27	Baseline Road	Mill Avenue	Eastbound
28	Broadway Road	Mill Avenue	Westbound
29	Broadway Road	Hardy Drive	Westbound
30	Guadalupe Road	Rural Road	Eastbound
31	Rural Road	Baseline Road	Southbound
32	Broadway Road	48th Street	Eastbound
33	Baseline Road	Hardy Drive	Eastbound
34	Priest Drive	Elliot Road	Northbound
35	Priest Drive	University Drive	Southbound
36	Rural Road	Elliot Road	Northbound
37	Baseline Road	Rural Road	Eastbound
38	52nd Street	University Drive	Southbound
39	Baseline Road	Kyrene Road	Westbound
40	McClintock Drive	Apache Boulevard	Southbound
41	Priest Drive	University Drive	Northbound
42	Mill Avenue	Southern Avenue	Southbound
43	Guadalupe Road	Kyrene Road	Eastbound
44	Baseline Road	Hardy Drive	Westbound
45	Baseline Road	Mill Avenue	Westbound
46	Rural Road	Guadalupe Road	Southbound
47	Elliot Road	McClintock Drive	Eastbound
48	Rural Road	University Drive	Southbound
49	Priest Drive	Southern Avenue	Southbound
50	Rural Road	Baseline Road	Northbound

Table 4.5 - Transit Project List 2005-2030

LOCATION	TYPE OF WORK	YEAR	COST
HIGH CAPAcity TRANSIT			
Tempe/Phoenix	Central Phoenix East Valley Light	I	$46,098,663
Tempe/Phoenix	Rail Transit / Central Phoenix East Valley Light	I	$87,692,000
Tempe/Phoenix	Rail Transit / Central Phoenix East Valley Light	I	$48,859,000
Tempe/Phoenix	Rail Transit / Central Phoenix East Valley Light	I	$17,788,000
Tempe	Rail Transit / Southern Ave to University Station	II	$144,000,000
Tempe/Scottsdale	Extension / 3rd Street Station to Downtown Scottsdale Streetcar	IV	
Total Cost for High Capacity Transit			**$344,437,663**
LOCAL TRANSIT - BUS			
	Phase 1 Improvements		
Route 65	20 Peak period Service	I	$130,815
Route 66	20 Peak period Service	I	$327,726
Route 61	30 min Sunday	I	$42,075
Route 56	30 min Sunday (entire route)	I	$80,784
Route 56	30 min Sunday (to Autoplex)	I	$76,997
Route 56	30 min Sunday (to AZ Mills)	I	$25,245
Neighborhood Circulator North	Begin NC North Route	I	$1,290,600
Neighborhood Circulator South	Begin NC South Route	I	$1,840,300
Route 45	30 min Sunday	I	$41,654
Route 62	30 min Weekends	I	$183,150
Route 65	30 min Weekends	I	$132,784
Route 56	10 Peak Period Service	I	$272,646
Route 92	30 min Sunday	I	$115,286
Route 81	30 min Weekends	I	$164,835
Route 92	15 min Weekday (peak)	I	$216,304
	Phase 2 Improvements		
Neighborhood Circulator 1	Begin NC Route	I	$2,500,000
Neighborhood Circulator 2	Begin NC Route	I	$2,500,000
Route 81	10 Peak period Service	II	$234,090
Route 45	10 Peak period Service	II	$136,323
Route 30	10 Peak period Service	II	$143,208
	Phase 3 Improvements		
Route 61	10 Peak period Service	III	$137,700
Route 77	10 Peak period Service	III	$125,307
Route 108	10 Peak period Service	IV	$371,790
Total Cost for Local Transit Improvements			**$11,089,619**
TRANSIT FACILITIES			
Tempe-- Rio Salado and 52nd Street	Construct East Valley Bus Operations and Maintenance Facility	I	$41,922,134
Downtown Tempe	Tempe Transportation Center	I	$13,400,000
South Tempe	Transit Center	I	$2,500,000
Arizona Mills	Transit Center	II	$4,000,000
Elliot/Warner	Park & Ride	II	$2,500,000
Total Cost for Transit Facilities			**$64,322,134**

Table 4.5 - Transit Project List 2005-2030, Continued

LOCATION	TYPE OF WORK	YEAR	COST
REGIONAL TRANSIT - BUS			
Regionwide (including Tempe)	Associated capital maintenance -	I	$50,400
Regionwide (including Tempe)	fixed route operations		
	Associated capital maintenance -	I	$60,000
Regionwide (including Tempe)	parts and components		
	Capital cost of contracting	I	$175,000
Regionwide (including Tempe)	72- Scottsdale/Rural	I	$1,612,472
Regionwide (including Tempe)	Associated capital maintenance	I	$111,000
Regionwide (including Tempe)	Associated capital maintenance	I	$110,400
Regionwide (including Tempe)	Associated capital maintenance	I	$110,400
Regionwide (including Tempe)	Purchase bus: standard 40 foot - 15	I	$6,000,000
Regionwide (including Tempe)	replace		
	Associated capital maintenance	I	$110,400
Regionwide (including Tempe)	Purchase bus: commuter 45 foot -	I	$7,650,000
Regionwide (including Tempe)	17 replace		
	Purchase bus: standard 40 foot - 20	I	$8,000,000
101 (Price Fwy) in Tempe	replace		
	Construct regional park-and-ride	I	$2,817,036
Regionwide (including Tempe)	81-Hayden/McClintock	I	$1,116,720
Regionwide (including Tempe)	40/Red-Main Street	I	$342,762
Regionwide (including Tempe)	30-University Drive (to Ellsworth Road)	II	$1,336,738
Regionwide (including Tempe)	108-Elliot Road	III	$1,351,548
Regionwide (including Tempe)	45-Broadway	II	$1,469,424
Regionwide (including Tempe)	Ray Road (New)	II	$231,033
Regionwide (including Tempe)	44-Van Buren (to Litchfield Road)	II	$262,324
Regionwide (including Tempe)	Baseline/Southern/Dobson Ext. (New)	II	$2,830,671
Regionwide (including Tempe)	Ahwatukee Express	II	$149,094
Regionwide (including Tempe)	Superstition Springs Express	I	$392,306
Regionwide (including Tempe)	Red Mountain Express	II	$337,526
Regionwide (including Tempe)	Santan Express	II	$240,336
Regionwide (including Tempe)	Scottsdale/Rural BRT	III	$976,747
Regionwide (including Tempe)	Pima Express (To Airpark P&R)	III	$297,738
Regionwide (including Tempe)	East Loop 101 Connector	III	$314,875
Regionwide (including Tempe)	Red Mountain Fwy Connector	III	$141,884
Regionwide (including Tempe)	Apache Junction Express	III	$307,023
Regionwide (including Tempe)	Ahwatukee Connector	IV	$66,050
Regionwide (including Tempe)	Superstition Fwy Connector	IV	$317,090
Total Cost for Regional Bus Transit			**$39,288,997**
GRAND TOTAL TRANSIT			**$459,138,413**

5 STREETS AND TRAVELWAYS

INTRODUCTION

The travelways element of the Tempe Comprehensive Transportation Plan is summarized in the following material. Travelways includes highways, regional routes, arterials, and local streets. This section includes description of existing conditions, goals, objectives, and strategies, issues and needs, and recommended actions that have been developed for street improvements, overview of current planning and design parameters (including recommended changes to this technical guidance), and proposed physical roadway improvements.

Valley Metro bus traveling along University Drive.

EXISTING CONDITIONS

Tempe's current roadway network is a developed system of north-south and east-west streets. The classification of these roadways varies from arterial to collector and local. Several freeway facilities also traverse the city of Tempe, including the Superstition Freeway (US 60), Red Mountain Freeway (Loop 202), Pima Freeway (Loop 101) and Interstate 10. These freeway facilities provide access to the Tempe community at various interchanges.

Four key corridors are being analyzed in more detail as part of this transportation planning effort. Corridor development reports have been completed for each corridor.

- Rio Salado Parkway
- University Drive
- Apache Boulevard
- Broadway Road

Tempe Traffic Data

A variety of traffic data was collected for the city of Tempe's Comprehensive Transportation Plan project. The data include traffic volumes, roadway geometry, and level of service. These data have been compiled and summarized throughout the study area. Updates have been made to reflect the 2000 base year for the study effort where necessary.

Traffic Volumes

Traffic volume data were collected from the city of Tempe and other sources. These data include daily traffic counts through 2003 and 2005. Data was not available for all roadways during all years. The following statistics were developed based on the data supplied:

- About 86 percent of the roadway segments included in the volume database reflected data collected within the past three years.
- Only 34 percent of the roadway segments counted reflected growth between the earliest count data and the most recent count data. Other roadway segments reflected decreases in traffic between some years and increases in traffic between other years. This is due to the opening of major new roadway facilities in the area, including portions of the Pima Freeway and Red Mountain Freeway. Over a 10 year history, 41 percent of roadway segments reflected traffic growth, and over a five year history, 60 percent of roadway segments reflected traffic growth.
- Annual growth rates (for those roadways with increasing volumes) ranged from less than one percent to 75 percent.

The daily volume data were reviewed and corridor volumes were developed. The corridors with the highest volumes were identified. As can be seen in Table 5.1, the majority of these corridors are east-west roads. They carry traffic from Tempe and adjacent communities to the two north-south freeways within the city, I-10 and the Pima Freeway. They also carry traffic destined for downtown and other major employment centers. McClintock Drive/Hayden Road is the highest volume north-south road, and is about half way between I-10 and the Pima Freeway. Peak hour volume data were not available.

Table 5.1 Daily Traffic Volumes

Roadway	Direction	2000-05 Highest Daily Volume
University Drive	East-west	45,083
McClintock Drive	North-south	44,951
Scottsdale Road/ Rural Road	North-south	43,450
Elliot Road	East-west	42,100
Broadway Road	East-west	41,781
Southern Avenue	East-west	39,400
Baseline Road	East-west	36,800
48th Street	North-south	35,100
Warner Road	East-west	32,100
Apache Boulevard	East-west	31,625

Street and Intersection Configurations

Roadway geometry and traffic signal data were collected from the city of Tempe.

Geometric Data

General geometric characteristics of the high volume corridors are described below.

- University Drive is a four-lane arterial with shoulder bike lanes and a center two-way left turn lane. The center turn lane is replaced by a median in downtown Tempe.
- McClintock Drive is a six lane facility. Most segments are three lanes southbound, a center turn lane and two lanes northbound.
- Scottsdale Road/Rural Road is three lanes per direction with either a center turn lane or a center median. Some segments have two lanes per direction with bike lanes.
- Elliot Road is a six-lane arterial with a center median. Median breaks are provided at regular intervals for business and cross-street access.
- Broadway Road is a six-lane arterial with a center median. The median is replaced by a two-way left turn lane between Priest Drive and Rural Road. Median breaks are provided at regular intervals for business and cross-street access.
- Southern Avenue is an unbalanced six-lane facility. Three lanes are provided westbound, two lanes are provided eastbound, and a two-way left turn lane separates them.
- Baseline Road is a six-lane arterial with a center two-way left turn lane.
- 48th Street provides two lanes southbound, a center turn lane, and either two or three lanes northbound.
- Warner Road is a four-lane arterial with shoulder bike lanes and a center two-way left turn lane.
- Apache Boulevard is a six-lane arterial with a center median. Median breaks are provided at regular intervals for business and cross-street access.

This geometric information was field checked in the fall of 2000. Detailed geometric data have been summarized for each of the four corridors being examined as part of this study.

Traffic Signals

There are 195 traffic signals in the city of Tempe, as shown in Figure 5.1. Of these 165 signals (85 percent) are owned and maintained by the city. Another 16 signals (eight percent) are owned by the Arizona Department of Transportation (ADOT) and maintained by the city of Tempe. The remaining 14 signals are owned and maintained by other agencies, including:

- ADOT – six signals in the I-10 Corridor.
- City of Scottsdale – four signals in northern Tempe.
- City of Phoenix – four signals in the 48th Street and Van Buren Street corridors.

Intelligent Transportation Systems (ITS)

Tempe is also a leader in signalized intersection control. All traffic signals in the city are under closed loop or central control. Further, about 60 percent of signals provide emergency vehicle preemption, and Tempe is working toward increasing this percentage as time and budget permit.

Regional ITS Objectives

The city of Tempe worked with the Maricopa Association of Governments to develop the ITS Strategic Plan for the region in the 1990s. The ITS Strategic plan was updated (again with Tempe's participation) in April of 2001. Elements from that update are described below.

Coordinate signal operations and improve progression

Coordinated signals (particularly across jurisdictional boundaries) allow for improved arterial travel times and reductions in arterial congestion.

Improve incident management

Improved incident management allow for faster reopening of lanes after incidents, reduced rubbernecking (delays due to motorists looking at incidents) and reductions in the number of secondary incidents.

Improve real-time traveler information for the public

Real-time information allows motorists to alter routes before they enter congested roadway segments, thereby reducing the amount and duration of congestion.

Increase the use of Dynamic Message Signs

Dynamic Message Signs (DMS) provide guidance to motorists while they are en route, and away from many mass media outlets.

Improve bus progression using transit signal priority

Many areas have used transit signal priority as a way to provide more reliable travel times for mass transit vehicles. Improved travel time reliability (and the related schedule improvements) promotes mode shifts to transit, reducing reliance on single occupant vehicles.

Increase automated traffic data collection

Additional automated traffic data collection will allow traffic operations centers to detect and respond more quickly to incidents.

Improve communication links

Improved communications links will allow various area municipalities to share data and information so that traffic flow can be better managed.

Tempe Responsibilities under the MAG TIP ITS Projects

The city of Tempe is ahead of other municipalities in certain ITS areas. These areas include the city's bus AVL system and the city's traffic signal interconnect program. However, the MAG ITS Strategic Plan Update outlined additional area for Tempe to improve upon.

Level of Service

Level of Service (LOS) data presented in the Maricopa Association of Governments Regional Congestion Study were reviewed. Key Tempe intersections that were included in this study are described below.

- The Priest Drive/Broadway Road intersection exhibits hour-long AM congestion (LOS F).
- The PM levels of congestion documented the MAG study are higher. Critical intersections (LOS F for one hour) include:
  – Rural Road at Apache Boulevard, University Drive, Broadway Road, and Baseline Road.
  – Mill Avenue at Broadway Road and Southern Avenue.
  – McClintock Drive at Apache Boulevard.
  – Roadways shown as congested during the PM include 48th Street, Priest Drive, McClintock Drive, and Rural Road and freeways and highways.

Freeways and Highways

Tempe is served by several freeway facilities. I-10 provides regional and interstate connectivity along the west side of Tempe and is generally eight lanes. The Pima Freeway is part of the 101 loop around Tempe, and provides north-south regional connectivity along the east side of Tempe. It is generally four lanes wide. US 60 (Superstition Freeway) is an east-west freeway, which cuts through the geographic center of the city and connects to both I-10 and the Pima Freeway. It is generally six lanes wide. The Red Mountain Freeway (202) is eight lanes north of the city.

Key freeway segments with poor LOS were defined in the MAG study. These segments include I-10 westbound in the AM and eastbound in the PM and both directions on US 60 (Superstition Freeway) east of the Pima Freeway.

Railroad Activity

Union Pacific operates the freight railroad tracks in the city of Tempe. There is one main line and several branch lines. These lines are historically owned by the Southern Pacific Railroad, which became part of the Union Pacific Railroad in the mid-1990s. The main line (known as the Phoenix Line) enters Tempe from the north in the area of the Priest Drive / Loop 202 interchange. The line swings south across the Tempe Town Lake just west of the Mill Avenue bridges and continues south just west of Mill Avenue to about 13th Street. At 13th Street, the main line turns east and parallels Apache Boulevard east out of Tempe. Typical train frequency is eight trains per day, including six through trains and a local round trip.

Several industrial tracks also serve Tempe. The Creamery Branch splits from the Phoenix Line just south of the Tempe Town Lake and goes southeast along Third Street, Veterans Way (through the ASU Campus), and Eighth Avenue. This line is currently out of service. This line is abandoned and the right-of-way is planned for use as part of the METRO light rail system. The Tempe Branch splits from the main line near the 13th Street crossing and continues south out of Tempe, paralleling Kyrene Road. There are spurs into businesses at several locations, including the industrial park at Hardy Drive area north of Southern Avenue. The line typically serves one round-trip local per week.

There are 44 grade crossings in Tempe. Of these, 27 are public at-grade crossings, six are grade-separated public crossings, and the remaining are private crossings.

Programmed Projects

As the designated metropolitan planning organization (MPO) for the greater Phoenix area, MAG is responsible for preparing a transportation improvement program (TIP) on an annual basis.

The TIP defines a five-year investment program for preserving, maintaining and expanding transportation systems. MAG prepares the TIP in cooperation with ADOT and the Regional Public Transportation Authority (RPTA). The TIP includes municipal-level transportation improvements projects. The current TIP defines funded projects between fiscal year 2006 and 2010. The Regional Council of MAG approved this program in June of 2000.

The Regional TIP was reviewed to gain an understanding of programmed roadway improvements within the city of Tempe. The TIP document provides a listing of specific city of Tempe projects, as well as ADOT projects that are slated for highway facilities in the Tempe area. Tempe TIP projects are included in Table 5.2. Highway improvement projects that have been designated by ADOT in the current TIP are also included in Table 5.2.

Regional Transportation Plan

In 2003, the Maricopa Association of Governments "Regional Transportation Plan" was completed. This plan is a comprehensive, coordinated regional plan that incorporated planning efforts through 2026. The report indicates that projected growth throughout the region will significantly increase traffic congestion on the regional freeway system and the regional arterial grid network. Below are the plans recommended projects and programs for the next twenty years.

Freeways and Highways

Funding for new freeway and highway corridors in the plan totals $3.7 billion. Proposed new corridors will provide approximately 490 additional new lane miles to the network. Funding for widening and other improvements to the existing regional freeway/highway network totals an additional $4.4 billion. These improvements include an additional 530 lane-miles of general purpose lanes and 300 lane-miles of high occupancy vehicle (HOV) lanes, covering essentially the entire existing system. In addition to new travel lanes, a series of new interchanges with arterial streets on existing freeways is included in the plan. Improvements at freeway-to-freeway interchanges to provide direct connections between HOV lanes have also been included. Together, these improvements total $396 million.

Improvements in Tempe include adding new general purpose lanes to both US 60 and Loop 202 and adding HOV lanes to Loop 101. Total lanes for Loop 202 will be ten lanes and total lanes for US 60 and Loop 101 will be eight lanes each.

Streets

The plan includes a future arterial network that extends the current regional mile arterial grid system concurrent with new development, and also closes gaps and improves connectivity in both developed and developing areas. Other arterials will receive major capacity improvements. It is anticipated that the overall arterial street network will expand by a combination of new roadway construction, on the mile grid system, where feasible and widening existing arterial streets. Throughout Tempe, the future arterial network includes mostly six lane arterial streets. Some streets will be four lane arterials including University Drive, Broadway Road, Guadalupe Road, and Elliot Road.

A total of $1.5 billion from regional revenue sources is allocated to the arterial network in the plan for the following categories:

- Major capacity improvements and new connections
- New/widened arterials
- Intersection improvements
- Intelligent Transportation System (ITS)

NEEDS/ISSUES

There are no plans in Tempe's future to widen arterial or collector streets to add capacity. Tempe is committed to making its streets more multi-modal-friendly. To accomplish this, streets need to be designed for all users including pedestrian, bicyclists, transit users, and autos. The issues include redesign and redevelopment of Tempe's arterial streets to accommodate the multi-modal transportation. The Recommended Action in the plan will address this issue and need.

GOAL/OBJECTIVES/STRATEGIES

The goal of the Travelways Element is to encourage the development of a street and rail network in Tempe that balances the needs of various types of travelers and more fully serves all modes of transportation.

Objectives

- Retain existing automobile traffic capacity while reducing reliance on the SOV.
- Create a compatible relationship with adjacent land uses.
- Maintain traffic speeds appropriate to adjacent land uses.
- Mitigate heat and climate conditions along streets, where appropriate.
- Provide safe pedestrian and bicycle environments along streets.
- Avoid widening streets as a solution to traffic congestion.
- Encourage and plan for rail uses.

ITS Strategies

- Utilize a travel demand model as one tool to measure street and travelway performance.
- Continue to proactively repair and maintain the city's street system.
- Develop and implement projects that offer and promote alternative transportation choices (such as walking, bicycling, transit) within the street network of Tempe.
- Enhance the strong visual identity and aesthetic of Tempe, its gateway entrances, and its neighborhoods.
- Utilize Tempe General Plan 2030 Adopted December 4, 2003.
- Work with neighborhoods to minimize negative impacts of transportation projects.
- Consider noise mitigation strategies for freight activities.
- Implement design guidelines for arterial and collector streets to calm traffic and meet the needs of each mode of travel.
- Consider lowered speed limits (e.g., 35 mph on arterials) to promote efficiency and safety.
- Increase street tree plantings and landscaping in medians and along arterials.

- Encourage planning and development that is consistent with the street classification system, including the designation of Transit Streets and Green Streets.
- Separate pedestrians and other modes of transportation where possible.
- Implement the provisions of the proposed pedestrian overlay district.
- Continually investigate new and emerging transportation technologies for use in the design and operation of streets and transit.
- Coordinate with emergency services to ensure that proposed transportation projects maintain a high level of emergency response.
- Integrate Intelligent Transportation System (ITS) technologies into the street network and traffic flow control system where appropriate.
- Evaluate all other alternatives (HOV lanes, high capacity transit service, etc.) when considering freeway widening proposals.
- Require that any proposal to widen or otherwise expand a freeway include, as part of the planning and design process, provisions for noise abatement, avoidance of impacts on air quality and neighborhoods, and consideration of aesthetics, landscaping, and public art.

RECOMMENDED ACTIONS

The following information summarizes the recommendations for the streets element of the overall plan. These recommendations are consistent with the policy basis that was developed during the early phases of this project. The content of these suggestions was the result of the ongoing planning process that has been conducted, including research, analysis, agency coordination, and community input.

Functional Classifications

The determination of roadway functional classification is a multi-agency effort involving the city of Tempe, MAG and ADOT. These roadway classifications provide a framework for planning, design and funding activities related to transportation improvements in the greater Phoenix area. The roadway categories recognized by the process include local streets, minor collectors, major collectors, minor arterials, major arterials, and freeways.

As part of the Tempe Comprehensive Transportation Plan, current functional classifications were reevaluated to determine where changes in designation were appropriate. This reevaluation concluded that two new classifications should be added to the current list, Green Streets and Transit Streets.

Green Streets

Green Streets typically include collector streets that already serve as high volume bicycle and pedestrian corridors. Green Streets serve as priority routes for bicyclists and pedestrians and function as connectors between off-street multi-use paths. Green Streets may be located both inside and outside pedestrian overlay districts and are particularly important in providing pedestrian and bicycle access to parks, shopping, schools, civic places, and other community destinations.

With further enhancements and improvements, Tempe citizens will be able to immediately recognize these streets as pedestrian- and bicycle-friendly. Figure 5.2 shows streets in Tempe classified as Green Streets. Typical characteristics of Green Streets can be found in Tempe's Design Toolbox.

Transit Streets

Transit Streets include street corridors (typically arterials) that serve important functions as transit routes. Bus routes with 15-minute (or less) service frequency during the peak, and streets that share space with the light rail corridor are examples. Transit Streets may include arterials that are inside and outside transportation overlay districts, and these streets will be improved for accessibility to transit by pedestrians and bicyclists. Figure 5.2 shows streets in Tempe classified as Transit Streets. Typical characteristics of Transit Streets can be found in Tempe's Design Toolbox.

Ongoing Activities

A number of actions have already occurred for street improvements. Below is a list of recommended activities that should continue on an ongoing basis.

- Ongoing agency coordination activities, locally and regionally, to address transportation issues and implement highway/roadway projects. This coordination should include working with ADOT on the freeway system and interacting with

neighboring municipalities as necessary to deal with any issues that arise on arterial and collector roadways.
- Continue implementing the projects that are locally programmed. These projects include improvements such as lighting, sidewalks, multi-use paths, bicycle lanes, traffic calming, and curb and gutter.
- Work closely with ADOT on freeway improvements that are programmed over the next five years. These programmed projects primarily include the development of HOV lanes along freeways in the Tempe area.

PROJECT LIST

Table 5.2 includes a list of projects for streets and travelway projects including streetscape improvements, traffic signals, and freeway projects in the city of Tempe. This project list includes project to be complete through 2030. The project list categorizes each project by facility type and then year and also includes location and cost estimate. Street and Travelway projects are shown in Figure 5.3. The proposed Street Classification Map for 2030 is shown in Figure 5.4.

Table 5.2 - Project List for Streets and Travelways

LOCATION	TYPE OF WORK	PHASE	COST
Apache: Mill to city Limits Traffic Signals	Streets Improvements	I	$575,000
LRT Traffic Signals	Install/upgrade signals	I	$2,975,000
101L - Santan to US 60	Install/upgrade signals for LRT	I	$4,900,000
I-10 to SR 51	General Purpose Lanes	I	$410,000,000
Loop 101	Collector Distributor Roads	II	$53,000,000
Broadway: 48th St. to Tempe Canal	HOV Lanes	I	$20,000,000
Southern: 48th St. to Tempe Canal	Streets Improvements	III	$20,000,000
Broadway: Rural to Mill	Streets Improvements	III	$5,143,560
I-10 at Baseline to Santan Freeway	Streets Improvements	I	$9,000,000
US 60 - I-10 to 101L	General Purpose Lanes	II	$53,000,000
202L Red Mountain Freeway	General Purpose Lanes	II	$55,000,000
Rural: Rio Salado to Ray	Streets Improvements	I	$10,000,000
Alameda: 48th St. to Tempe Canal	Streets Improvements	IV	$10,000,000
Rural Road/US 60	HOV Ramps	III	$20,000,000
Priest Road/Loop 202	HOV Ramps	III	$20,000,000
Mill: University to Baseline	Streets Improvements	IV	$10,000,000
Scottsdale: Rio Salado to Continental	Streets Improvements	IV	$5,000,000
McClintock: Rio Salado to Guadalupe	Streets Improvements	IV	$10,000,000
Baseline: 48th St. to SR 101	Streets Improvements	IV	$20,000,000
College Avenue: US 60 to Apache	Streets Improvements	IV	$6,000,000
Elliot: I-10 to SR 101	Streets Improvements	IV	$20,000,000
Warner/Elliot	HOV Ramps	IV	$20,000,000
TOTAL STREET AND TRAVELWAY			**$484,593,560**

Figure 5.1 - City of Tempe Traffic Signals

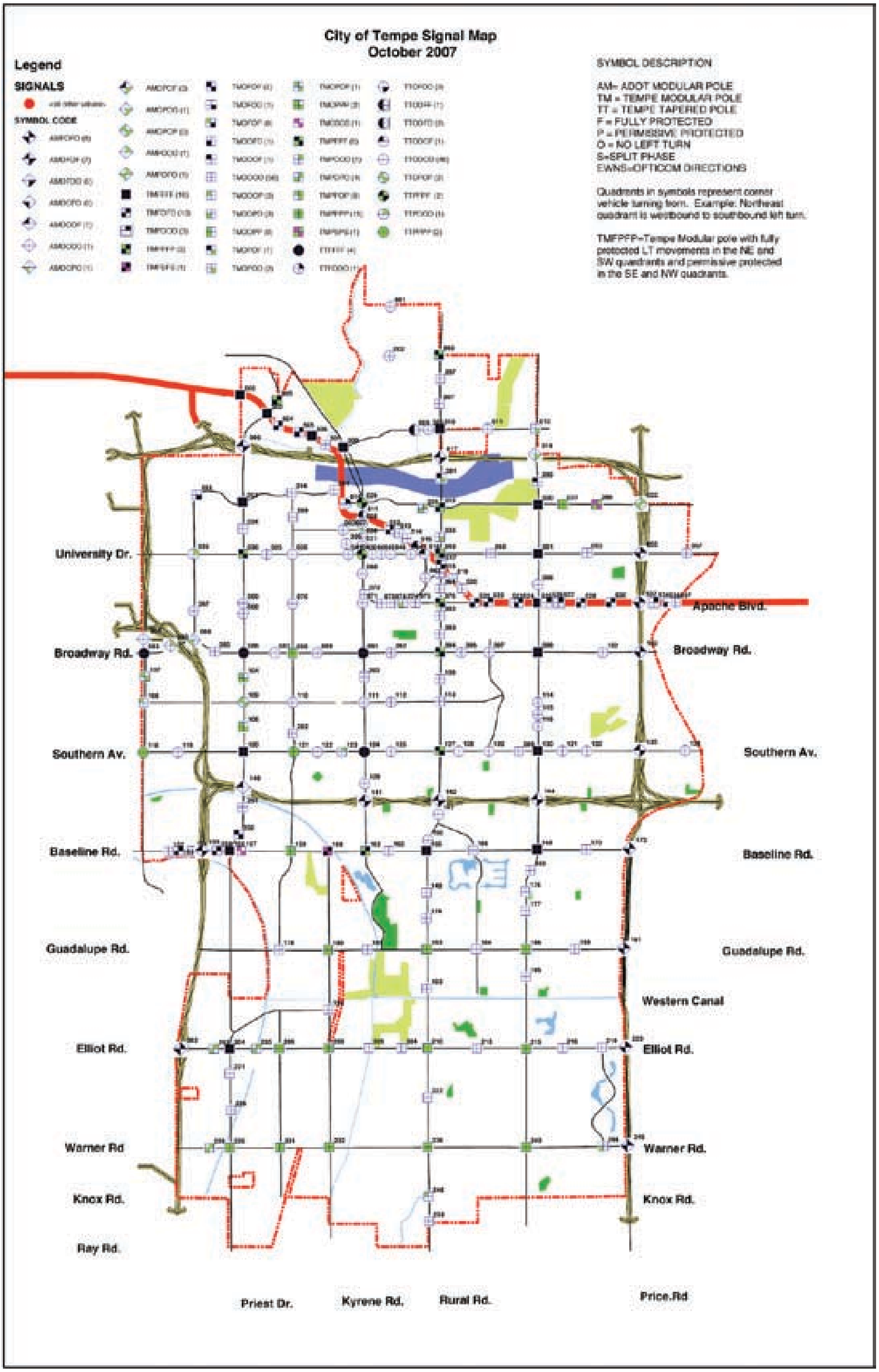


Figure 5.2 Tempe's Transit Streets and Green Streets

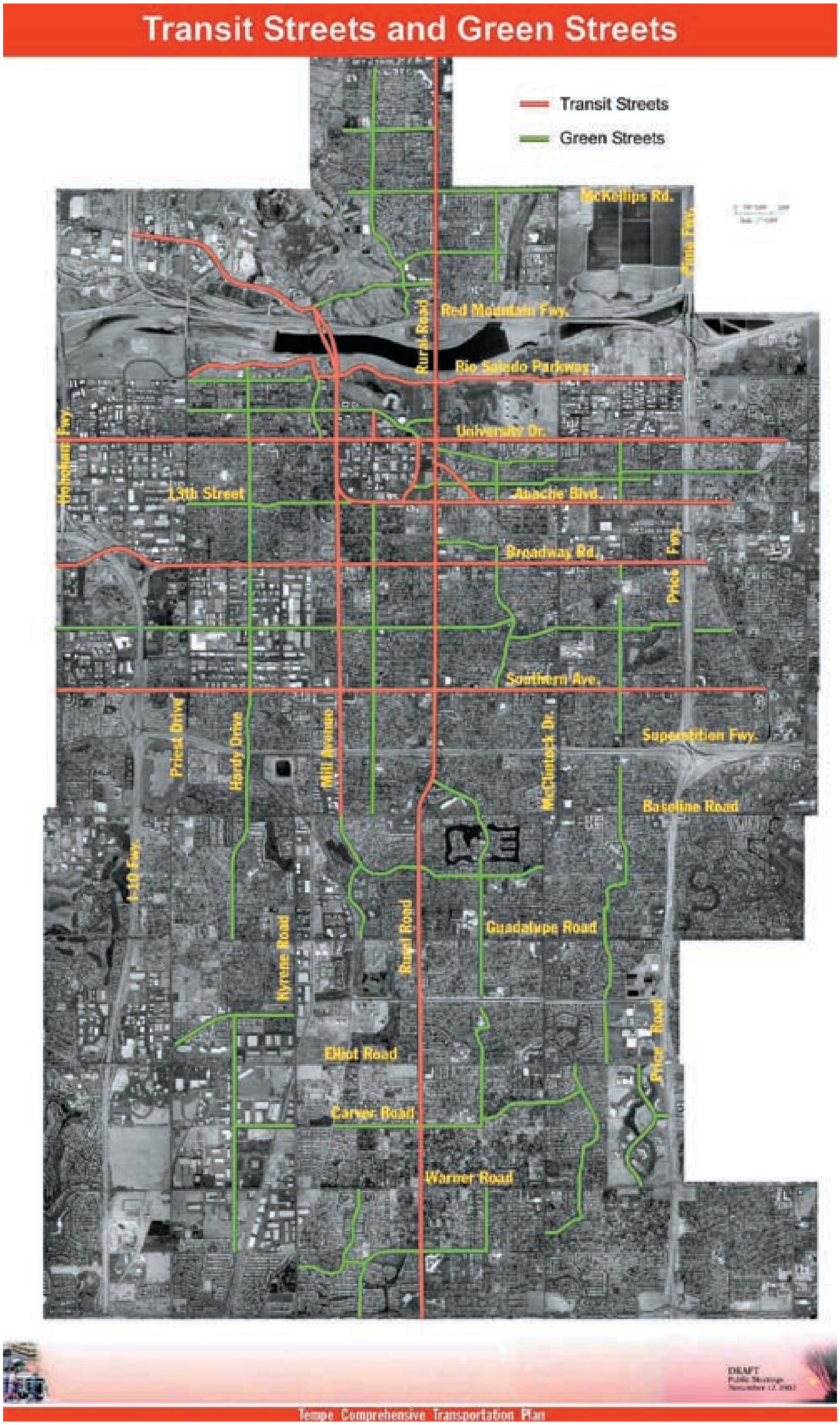
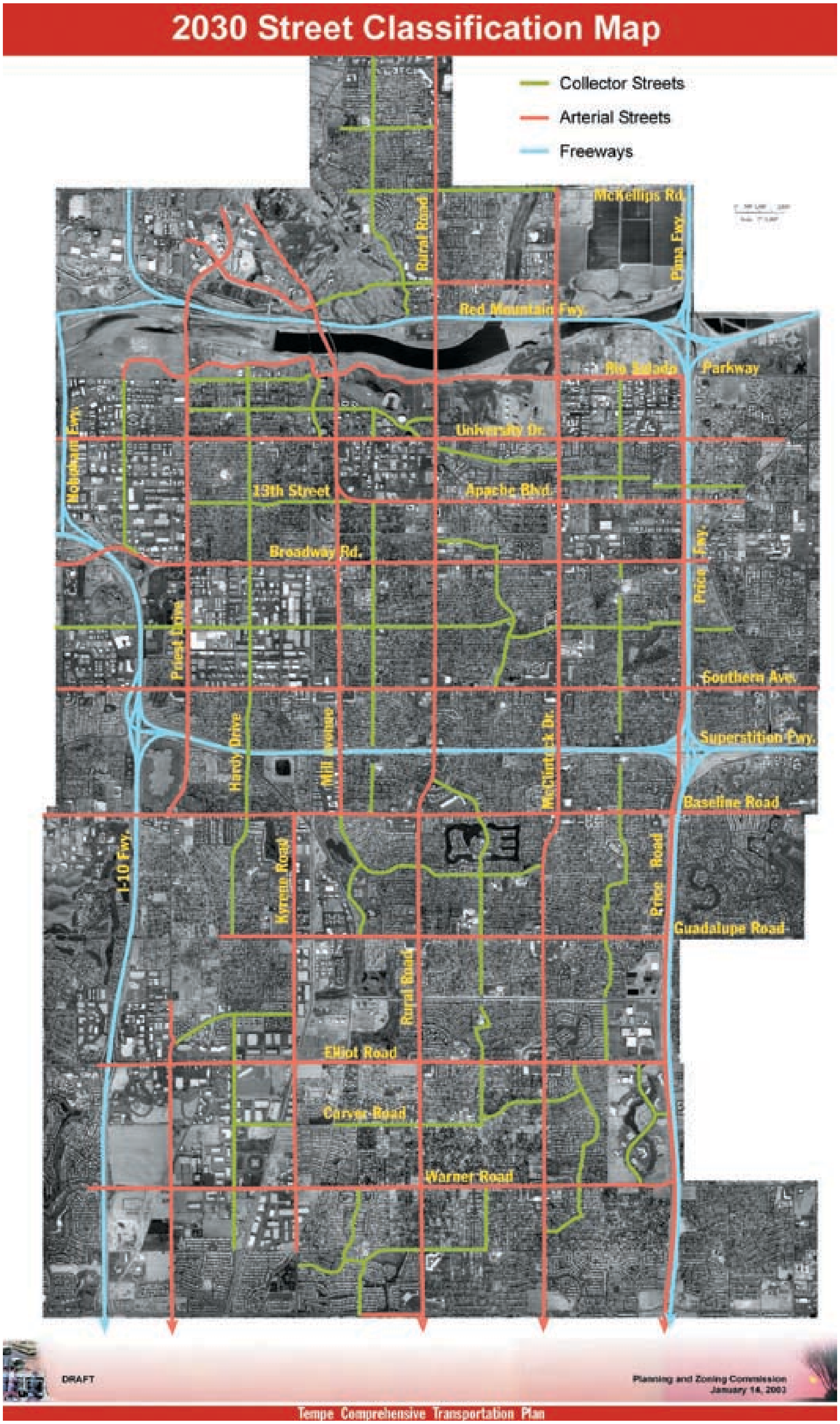


Figure 5.3 - Streets and Travelway Projects

Figure 5.4 - 2030 Street Classification Map



Transportation Toolbox

Artwork by John Nelson,
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A Guide for Planning and Design of Friendly Streets and Sidewalks

City of Tempe

Match 2008

TABLE OF CONTENTS

HOW TO USE THIS TOOLBOX

SECTION 1 - INTRODUCTION

SECTION 2 - ACCESSIBILITY

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION 5 - TRAFFIC CALMING

SECTION 6 – INTERSECTIONS AND CROSSINGS

SECTION 7 – MULTI-USE PATHS

TABLE OF CONTENTS

SECTION 8 – CHILDREN AND SCHOOL ZONES

SECTION 9 - SITE DESIGN

TABLE OF CONTENTS

HOW TO USE THIS TOOLBOX

How Should the Information in This Toolbox Be Used?

The information presented in this toolbox should not be interpreted as standards, specifications, requirements, or regulations, but rather as **guidelines**.

The guidelines included in this toolbox apply to normal situations encountered during project development. Unique design problems sometimes require flexibility in design solutions. Other available design information and all applicable federal, state, and local requirements should be reviewed as part of the project design. Some elements of the guide may not be appropriate for major highways and arterial routes or may not be possible on existing right-of-way, but some parts of the guide should always be considered and implemented wherever feasible.

Fifth Street sidewalk in Tempe

The information presented in this guide may not solve all problems associated with pedestrian travel, but it provides a "first step" in establishing a consistent set of citywide guidelines for design of pedestrian facilities. The guide can also be used as a tool to build consensus on sometimes differing approaches to design.

The guidelines in this toolbox are often presented in terms of "desirable" and "minimum" dimensions or recommendations. These recommendations should be applied with professional judgement to achieve design solutions that are specifically tailored to the circumstances encountered. For example, if a sidewalk receives a high amount of use, the project designer or local design reviewer may elect to apply the "desirable" dimension over the "minimum" for the sidewalk width.

Relationship to Other Guidelines and Standards

Cities and counties may already have adopted standards related to design of pedestrian facilities. In that case, the guidelines can be referenced as a supplement to local standards. When no standards have been adopted by federal, state, or local agencies, these guidelines and other documents can provide useful direction to design practitioners. Eventually, local agencies may amend their current design standards to incorporate all or portions of these guidelines.

Transportation facilities should be designed and built in accordance with existing federal, state, and local standards as applicable. In some situations, the current standard may not be achievable due to geometric, environmental, or other constraints. In these circumstances, variances from the standard may be acceptable; however, a facility should not typically be built to less than the minimum standards described. Deviations from standards should be documented and justified through special studies. Table HT-1 lists several documents that include other design standards and guidelines related to transportation design.

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Crosswalk at ASU in Tempe

Table HT-1

Other Documents to Review for This Toolbox

- Local design standards, zoning codes and development codes
- *Americans with Disabilities Act* (ADA) Federal Requirements
- *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, USDOT
- *A Policy on Geometric Design of Highways and Streets,* American Association of State Highway and Transportation Officials (AASHTO)
- *Uniform Building Code* (UBC), International Conference of Building Officials, and/or locally adopted building code
- *Design and Safety of Pedestrian Facilities*, ITE
- *Guide for Planning, Design, and Operation of Pedestrian Facilities, AASHTO*
- *Guide for the Development of Bicycle Facilities,* AASHTO

Note: This is only a partial list and does not include all available resources.

Transportation Design Toolbox Topics

This Transportation Toolbox provides recommendations under 11 topics. A directory of the toolbox topics is provided in the Table of Contents of the Toolbox for easy reference. Toolbox Section 1, Introduction, provides a general overview of design considerations related to transportation facilities including pedestrians, bicycles, and transit. Toolbox Section 2, Accessibility, provides recommendations and guidelines related to accessible design and compliance with the Americans with Disabilities Act (ADA). The remaining toolbox sections focus on more specific areas of transportation facility design including accessing transit, multi-use path design, traffic calming guidelines, site design recommendations, desert vegetation, and safety in construction zones.

Look for the Boxes

Important and helpful information is highlighted in boxes, tables, and figures like this one, throughout the toolbox.

This Section Addresses:

- *The Purpose and Focus of These Design Guidelines*
- *The Importance of Good Design*
- *Land Use Planning for Pedestrian-Friendly Communities*
- *Creating a Continuous and Effective System*
- *Friendly Streets/Friendly Sidewalks*
- *Special Pedestrian-Oriented Districts*
- *Other Sources of Information*

This section provides a brief overview of the importance of good design for transportation facilities, followed by a discussion of general planning and design guidelines that can be applied on a community-wide basis. The design information presented in this section offers important basic guidance for improving overall conditions for citizens in Tempe, thereby encouraging a broader range of transportation options to enhance the quality of life.

Tempe is committed to providing options for all modes of transportation.

The Purpose and Focus of This Toolbox

The focus of this “toolbox” is to encourage good design of transportation facilities, including streets that serve all modes of travel - pedestrians, bicyclists, transit, and motor vehicles. Conscientious planning, effective education programs, and consistent safety and law enforcement also contribute to improving the way people travel in our communities. The information presented throughout this toolbox is based on nationally accepted standards, guidelines, and best practices, as well as regional (Maricopa Association of Governments — MAG) and local standards and guidelines. Many of the guidelines in this toolbox relate directly to the design of pedestrian facilities. Design recommendations for bicycle facilities are located in Section 3, Friendly Streets and Sidewalks. Transit users are also pedestrians, therefore Section 4, Access to Transit addresses design of transit facilities. Table 1.1, on the following page, lists some of the elements addressed in this toolbox.

The Importance of Good Design

Pedestrians, bicyclists, and transit users are an integral part of Tempe’s transportation system. Good design practices will ensure that these modes are adequately served throughout Tempe. The importance of good design not only applies to development of new facilities, but also to improvement and retrofitting of existing facilities for use by all. When access is

Table 1.1

Some of the Elements Addressed in This Toolbox
• *Sidewalks and on-street facilities*
• *Walkways and trails*
• *Curb ramps*
• *Traffic calming and control measures*
• *Crosswalks*
• *Grade separations (such as underpasses and overpasses)*
• *High capacity transit features*
• *Bus stops*
• *Transit-oriented development concepts*
• *Bicycle lanes*
• *Bicycle parking*
• *Furnishings that create a pedestrian friendly atmosphere (such as benches and landscaping)*
• *Other technology, design features, and strategies intended to encourage non-motorized travel including traffic circles, plating strips, shelters, public art and lighting*

expanded and existing conditions are improved, higher numbers of nonmotorized travelers can be expected to use the system. Research has shown that well designed and maintained facilities encourage walking, bicycling, and transit use and promote higher levels of alternative mode travel.

Travelers want facilities that are safe, attractive, convenient, and easy to use. Good details attract more pedestrians, thus making neighborhoods feel safer and helping commercial areas succeed. If designed properly, the best public facilities can also be the most durable and the easiest to maintain. Poor design can lead to perpetual problems and actually discourage use where pedestrians are made to feel unsafe, unprotected, or uncomfortable. Unattractive, inadequate, and poorly designed and maintained facilities can be an unfortunate waste of money and resources, and a hindrance to community vitality. Figure 1.1 shows a pedestrian-friendly streetscape.

Consider All Transportation System Users at the Start of Projects

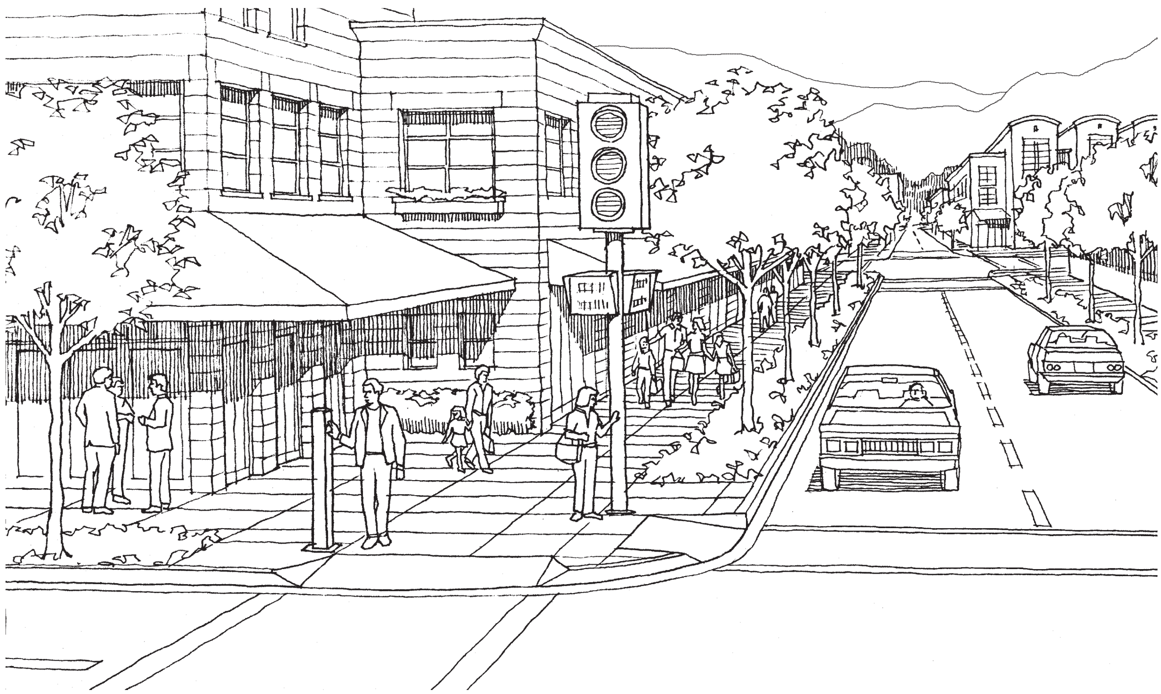
Planners and designers need to consider all travelers at the inception of public and private projects, including those of pedestrians, bicyclists, transit users, and motorists. All users' needs need to be addressed as part of the total design solution. Consider the character and setting of the area, nearby land use designations, origins and destinations, and the level of pedestrian use, including the increase in use that may occur when pedestrian improvements are installed.

Often, decisions not to install pedestrian, bicycle, and transit facilities during project planning and design are short sighted, based on the perception that an area with low pedestrian use does not need improvement. In reality, alternative mode users are probably not using the system because it is not adequately meeting their needs under existing conditions. Sometimes land use designations and facilities need to be upgraded to serve more intensive pedestrian, bicycle, and transit use. After conditions are improved pedestrian, bicycle, and transit use can be expected to increase, based on recent research findings. See Tempe's Pedestrian Plan Element for more information.

Design is Only Part of the Solution

Good design is an important factor in incorporating pedestrians, bicyclists,

Figure 1.1



Pedestrian-friendly streetscape

transit users, and other travelers into Tempe's transportation system, but it can not be expected to solve all problems. Education and enforcement are other important tools that heighten awareness of pedestrians and encourage a safer and more balanced transportation system overall. Proactive policy development typically sets the stage for establishing a stronger focus on pedestrian issues. Refer to the Comprehensive Transportation Plan elements for goals and policies related to pedestrians, bicyclists, transit, streets, and other transportation facilities.

Land Use Planning for Pedestrian-friendly Communities

Planning for pedestrians should be an integral part of any planning or design process. Destinations, whether grocery stores, parks, schools, or bus stops, should be close in proximity to neighborhoods and housing. In established neighborhoods, strategies can be used to encourage pedestrian-scale design and increase pedestrian travel. Techniques such as infill development, zoning changes, and pedestrian connections to transit help create pedestrian-friendly communities.

Some common characteristics of pedestrian-friendly communities are listed in Table 1.2. There are also many good sources of information about how to plan and design pedestrian-friendly communities listed at the end of this section.

Creating a Continuous and Effective System

Coordination between Tempe agencies, other local, regional, and state governments, and private entities is critical to the success of a regional pedestrian system. School districts, utility companies, private corporations, adjacent cities, and the City of Tempe need to work together at the onset of planning and development projects to reach the best solutions for all interests involved. Consider the needs of all travelers, including pedestrians, throughout project planning, design, and development processes, with particular interest toward increasing pedestrian safety and mobility and improving the pedestrian network overall.

Pedestrian systems and facilities need to be functional to be effectively used by pedestrians. The *National Bicycle and Walking Study* conducted by the US Department of Transportation in 1992 provides guidance for making a pedestrian system effective. The study states:

"Pedestrian facilities both encourage people to walk and improve pedestrian safety along certain routes. The facilities must be well designed and maintained to be effective, and must include the following features:

- *sidewalks, paths or walkways that are wide, relatively clear of obstructions and separated from traffic lanes;*
- *grade separated pedestrian crossings, that are clearly justified, since such facilities go unused or create illegal street crossing behavior by pedestrians if not properly planned, designed and located;*
- *proper design and operation of traffic and pedestrian signals, including pedestrian push buttons, where appropriate;*
- *barriers that physically separate pedestrians from motor vehicle traffic at selected locations;*
- *facilities for people with mobility and visual impairments, including curb ramps, audible pedestrian signals, lighting, and longer intervals for crossings;*
- *signing and marking, including pavement edgelines and pedestrian warning signs where needed; and*

Table 1.2

Coordination Between Jurisdictions	Putting pedestrian facilities in place to meet current and future needs requires close coordination between jurisdictions and other modes of transportation.
Linkages to a Variety of Land Uses/Regional Connectivity	Pedestrian circulation and access is provided to shopping malls, transit, downtown, schools, parks, offices, mixed-use developments, and other community origins and destinations.
Continuous Systems/ Connectivity	A complete system of interconnected streets, pedestrian walkways, and other pedestrian facilities will increase pedestrian travel.
Shortened-Trips and Convenient Access	Connections are provided between popular origins and destinations, between dead-end streets or cul-de-sacs, or as shortcuts through open spaces.
Continuous Separation from Traffic	Minimized or eliminated street and driveway crossings are provided and well defined. Buffers from motor vehicles and separation of uses are provided.

Table 1.2 (continued)

Pedestrian Supportive Land Use Patterns	Land use patterns, such as a grid layout or short blocks in business districts and downtowns enhance pedestrian mobility.
Well-Functioning Facilities	Adequate width and sight distance, accessible grades, and alignment to avoid blind corners are provided. Common problems, such as poor drainage, are avoided.
Designated Space	Pedestrian facilities should be well delineated, signed, and marked.
Security and Visibility	Design to ensure a secure environment for pedestrians is important. Lighting, increased visibility, open sight-lines, and access to police and emergency vehicles, and locating pedestrian facilities adjacent to neighborhoods and businesses can increase safety.
Automobile is not the Only Consideration	Streets are designed for all modes of transportation. Parking supply is reduced or managed using methods that encourage walking.
Neighborhood Traffic Calming	Narrowed streets lined with trees, traffic circles, curb bulbs, neck-downs, and other techniques can lower vehicle speeds and create safer conditions for pedestrians.
Accessible and Appropriately Located Transit	Siting of transit facilities adjacent to work, residential areas, shopping, and recreational facilities encourages pedestrian trips. Transit stops and centers should typically be located in areas of supporting densities (4 to 7 units per acre minimum). Development of adequate pedestrian facilities to access transit is essential to the success of pedestrian travel as an alternative mode.
Lively Public Spaces	Secure, attractive, and active spaces provide focal points in the community where people can gather and interact. Pedestrian pocket parks and plazas are examples.
Character	Preservation of important cultural, historic, and architectural resources strengthens community heritage and character.
Scenic Opportunities	Attractive environments and scenic views encourage pedestrian use, particularly when facilities are oriented toward them.
Pedestrian Furnishings	Providing amenities, such as benches, restrooms, drinking fountains, artwork and other elements, creates a more attractive and functional environment for pedestrians.
Street Trees and Landscaping	Street trees bring human scale to the street environment. Landscaping and flowers in planting strips, containers, and other areas soften surrounding hard edges of buildings and parking lots and add life, color, and texture to the pedestrian's field of vision.
Design Requirements	Guidelines and adopted standards are followed and, if deviated from, justified and documented.
Proper Maintenance	Frequent cleanup and repair on a regular basis ensures ongoing, consistent use.

- *pedestrian malls, well-planned with respect to commercial development, traffic circulation and visual appeal."*

Figure 1.2 illustrates an example of how to design effective pedestrian facilities within an area, including some of the features recommended by the *National Bicycling and Walking Study*. (See Section 9, Site Design).

Friendly Streets/Friendly Sidewalks

Design of pedestrian and bicycle friendly streets and sidewalks is strongly encouraged in Tempe. Design guidelines for achieving friendly streets are provided throughout the various sections of this toolbox. The intent is for street design to incorporate elements that enhance safety, security, comfort, and mobility for all users. Table 1.3, on page 1-8 lists some common characteristics of streets that are "friendly" for all users.

Tempe's streets should be planned and designed to serve all users.

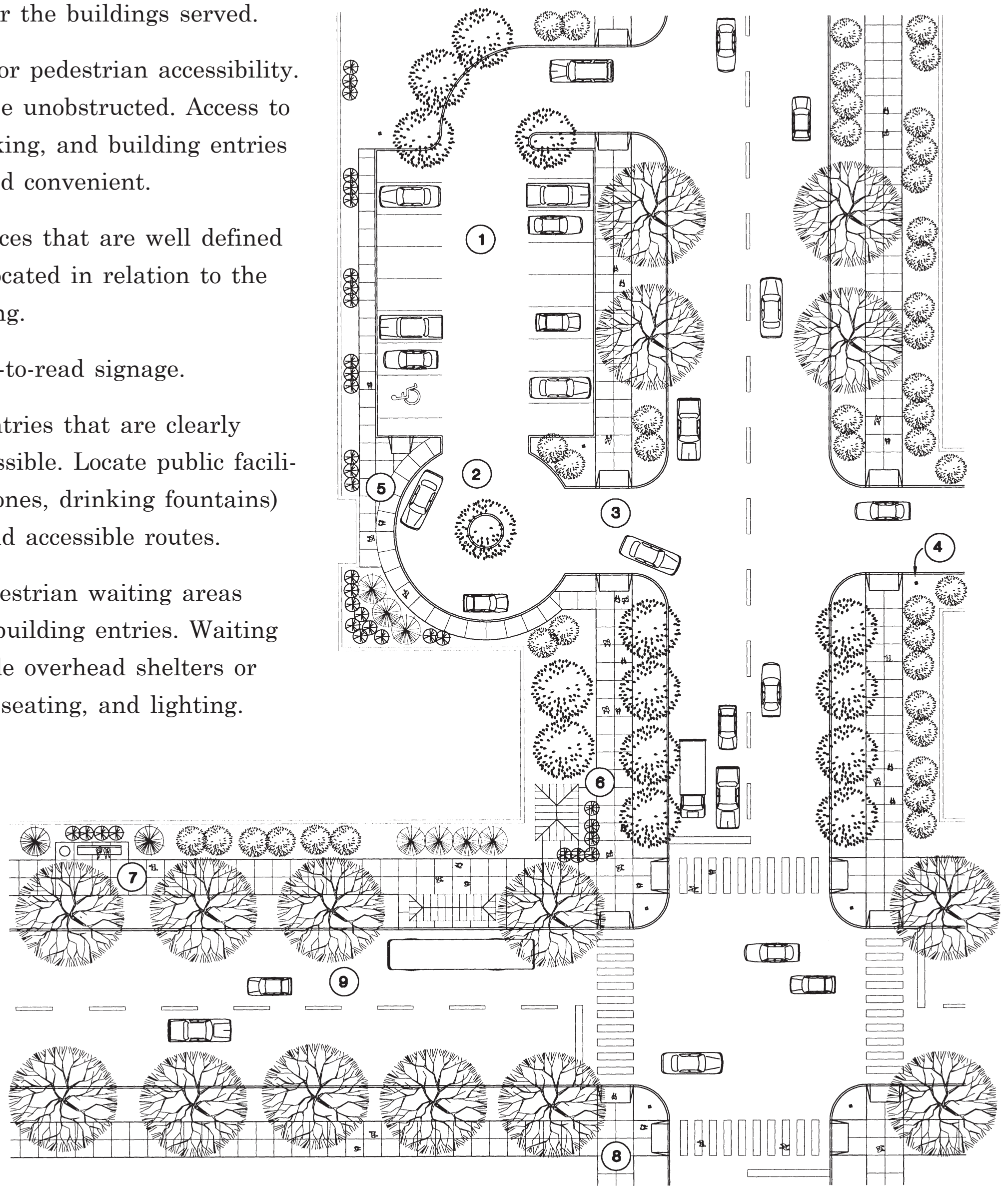
Special Pedestrian-Oriented Districts

The City of Tempe could create new pedestrian overlay districts that strongly encourage pedestrian-friendly design practices, supporting the use of street trees, reduced parking requirements, and building facades oriented to the sidewalk. New development that occurs in pedestrian districts should follow guidelines and criteria that make the environment more conducive to pedestrian travel. The objectives for establishing pedestrian overlay districts in Tempe would be to:

- recognize, preserve, and enhance the unique character of the pedestrian districts in Tempe and the attractiveness of alternative modes of transportation;
- allow for expansion of this character into the rest of the overlay district with emphasis on mixed-use development patterns that encourage walking, bicycling, and transit use as modes of transportation;
- encourage development patterns surrounding the new light rail transit line that will maximize ridership and support the benefits of the line; and
- provide flexibility in the siting and design of new development to protect neighborhood character and anticipate change.

Figure 1.2

Creating an Effective Pedestrian System



1 Locate parking near the buildings served.

2 Provide curb cuts for pedestrian accessibility. Walkways should be unobstructed. Access to drop-off areas, parking, and building entries should be direct and convenient.

3 Provide site entrances that are well defined and conveniently located in relation to the site and the building.

4 Use clear and easy-to-read signage.

5 Provide building entries that are clearly identified and accessible. Locate public facilities (restrooms, phones, drinking fountains) near entry-ways and accessible routes.

6 Locate exterior pedestrian waiting areas within 300 feet of building entries. Waiting areas should include overhead shelters or awnings, adequate seating, and lighting.

7 Provide resting areas where pedestrians must walk long distances. Benches and other furnishings should not encroach on walkways.

8 Provide firm and level walkways along clear and direct routes throughout the site. Curb cuts and ramps should be provided where necessary. Accessible walkways should be continuous (not dead-ends).

9 Locate transit stops in highly visible and convenient areas. Provide shade and shelter.

Source: Time-Saver Standards for Landscape Architecture, adapted with revisions for this toolbox

Table 1.3

Elements of Friendly Streets

- *Streets that are interconnected and small block patterns and provide good opportunities for pedestrian access and mobility*
- *Narrower streets, scaled down for pedestrians and less conducive to high vehicle speeds (note: street trees create the perception of a narrower roadway)*
- *Traffic calming devices to slow traffic (See Section 8) or, if appropriate, reduced speed limits*
- *Median refuge islands to provide a safe area for crossing pedestrians*
- *Public spaces and pedestrian "pockets" adjacent to the main pedestrian travel way that provide a place to rest and interact (sidewalk cafes, benches, etc.)*
- *Awnings and covered building entrances that shelter pedestrians from weather and the heat of summer sun*
- *Planting buffers containing landscaping and street trees that provide shelter and shade without impeding safe traffic movement and help to soften the surrounding buildings and hard surfaces*
- *Street lighting designed to pedestrian scale: shorter light poles with attractive fixtures that are effective in illuminating the pedestrian travel way*
- *Wide and continuous sidewalks or separated walkways that are fully accessible*
- *Clear delineation and direction for the pedestrian (special paving on sidewalk or edge of pedestrian travel area, easy-to-reach signal actuators, etc.)*
- *Lively buildings with architectural relief, windows, and attractive surfacing*
- *Street furnishings, such as benches, garbage receptacles, drinking fountains, and newspaper stands placed outside of the route of travel*
- *Public art, murals, banners, sculpture pieces and water features*
- *Signs, information kiosks, maps and other elements to help pedestrians find their way*

Other Sources of Information

The following sources of information are recommended for general design of pedestrian facilities and balancing the needs of multi-modal travelers. Please see the Resource Guide included at the end of this guidebook for complete bibliography information.

Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling, Richard K. Untermann

A Guide to Land Use and Public Transportation, The Snohomish County Transportation Authority

City Comforts, How to Build an Urban Village, David Sucher

City, Rediscovering the Center, William H. Whyte

Creating Bicycle-Friendly and Walkable Communities, Pro Bike Pro Walk 96 Resource Book, Bicycle Federation of America, Pedestrian Federation of America

Creating Transportation Choices Through Zoning, A Guide for Snohomish County Communities, The Snohomish County Transportation Authority

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Handbook of Landscape Architectural Construction, Volume Two, Site Works, Maurice Nelischer

Making Streets That Work
City of Seattle

Municipal Strategies to Increase Pedestrian Travel, Washington State Energy Office

National Bicycling and Walking Study, Case Study No. 4, Measures to Overcome Impediments to Bicycling and Walking, US Department of Transportation

Pedestrian Malls, Streetscapes, and Urban Spaces, Harvey M. Rubenstein

Pedestrian Planning and Design, John J. Fruin, PhD

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas Research Report 294A, Transportation Research Board

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas State-of-the-Art Report 294B, Transportation Research Board

Planning Design and Maintenance of Pedestrian Facilities, Goodell-Grivas, Inc.

Site Planning and Community Design for Great Neighborhoods, Frederick D. Jarvis

The Car and the City, 24 Steps to Safe Streets and Healthy Communities, Alan Thein Durning

Time-Saver Standards for Landscape Architecture, Design and Construction Data, Charles W. Harris, Nicholas T. Dines

Walk Tall, A Citizen's Guide to Walkable Communities, Version 1.0, Pedestrian Federation of America

Handbook for Walkable Communities and Washington State Pedestrian Facilities Planning and Design Courses, Dan Burden and Michael Wallwork, PE

This Toolbox Section Addresses:

- *Spatial Needs for People with Disabilities and Older Adults*
- *Understanding the Americans with Disabilities Act (ADA)*
- *Designing for People with Disabilities*
- *Designing for Older Adults*
- *Pedestrian Access Routes*
- *Accessible Route of Travel*
- *Eliminating Barriers and Obstacles*
- *Widths and Clearances*
- *Passing and Resting Areas*
- *Longitudinal Grades*
- *Cross Slopes*
- *Sidewalk Curb Ramps*
- *Ramps*
- *Handrails*
- *Accessibility Across Driveways*
- *Surfacing*
- *Textural and Visual Cues*
- *Accessible Pedestrian Signals*
- *Crosswalks*
- *Medians and Pedestrian Refuge Islands*
- *Signing and Other Communication Aids*
- *Site Connections*
- *Lighting*
- *Other Sources of Information*

Everyone has an inherent right to accessibility. The overall intent of this toolbox section is to encourage design that provides accessibility to all pedestrians, including people with disabilities and older adults. People with physical impairments and older adults have a wide range of abilities and needs and often rely on pedestrian travel and transit as their primary modes of transportation. Just as we design roadways for use by a wide range of vehicles, so should we design sidewalks, transit stops, walkways, crossings, signals and other types of facilities for use by a wide range of pedestrians.

Everyone has an inherent right to accessibility.

Spatial Needs for People with Disabilities and Older Adults

People with disabilities, including those using special walking aids or wheelchairs, need carefully designed facilities that eliminate barriers.

The needs of pedestrians with disabilities can vary widely depending on the type of disability and level of impairment. Elements that are helpful to people with disabilities are listed in Table 2.1.

Table 2.1

Aids to Pedestrians With Disabilities
• *Curb cuts and ramps*
• *Tactile warnings*
• *Easy-to-reach activation buttons*
• *Audible warnings and message systems*
• *Raised and Braille letters for communication*
• *Signal timing at lower than average walking speed*
• *Maximum grade of 1:20 and cross slope of 1:50 (ramps can be 1:12)*
• *Roadway crossing refuges*
• *Reduced roadway crossing distances (bulb-outs and curb extensions)*
• *Traffic calming*
• *Handrails*
• *Smooth surfaces and unobstructed travel ways*

Space requirements for pedestrians with disabilities vary considerably depending on their physical abilities and the assistive devices they use. Spaces designed to accommodate wheelchair users are generally considered to be functional and advantageous for most people. Figure 2.1, on the following page, illustrates the spatial dimensions of a wheelchair user, a person on crutches, and a sight-impaired person.

Older adults have a variety of needs as pedestrians. Research shows that people over 60 walk more, yet in some cases may have impaired mobility. Table 2.2 lists some examples of elements that aid older adults in their travel as pedestrians.

Table 2.2

Aids to Older Pedestrians
• *Reduced roadway crossing distances (bulb-outs and curb extensions)*
• *Signal timing at lower than average walking speed*
• *Signals within 60 feet of viewing distance; easy-to-read signs*
• *Refuge areas in roadway crossings*
• *Traffic calming*
• *Shelter and shade*
• *Handrails*
• *Smooth surface and unobstructed travel ways*

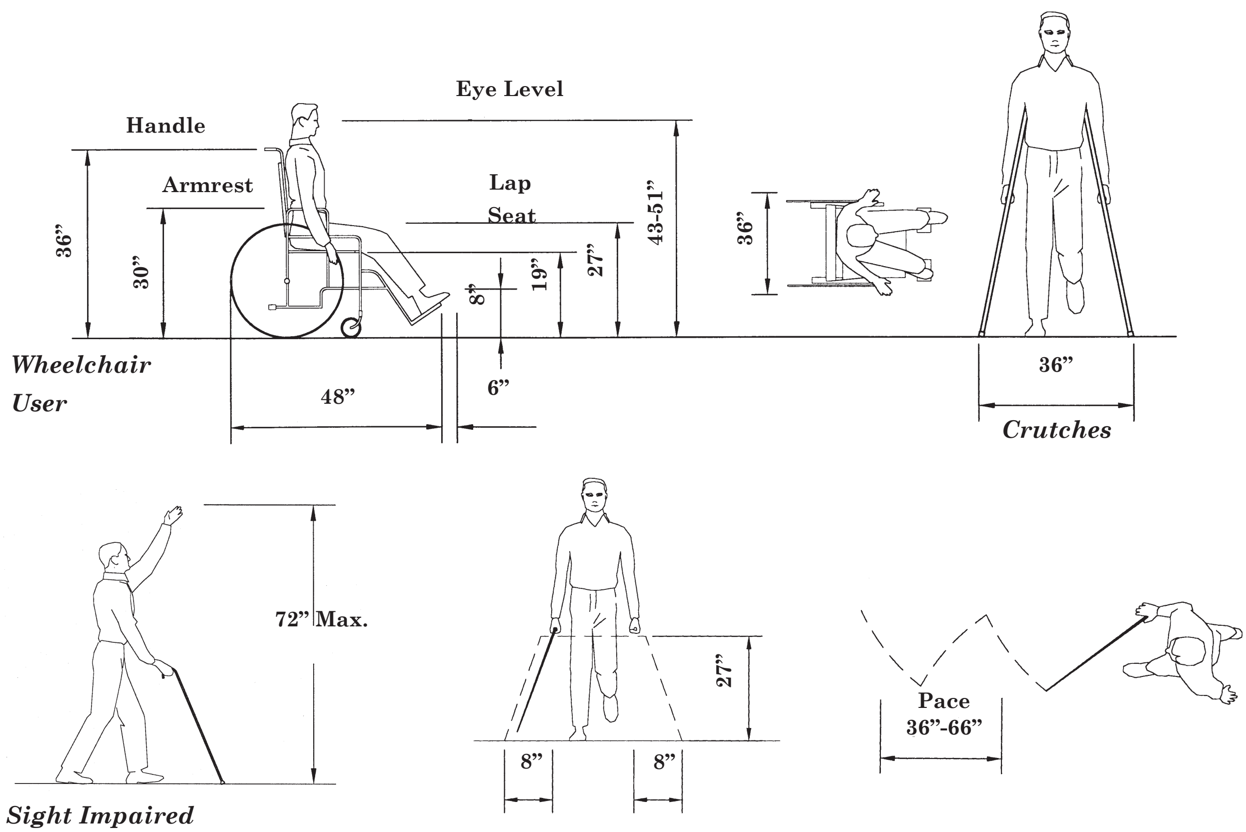
Understanding the Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal law enacted in 1990 for the purpose of ensuring that all Americans have the same basic rights of access to services and facilities. The ADA prohibits discrimination on the basis of disability. To effect this prohibition, the statute requires certain designated federal agencies to develop implementing regulations. The ADA Accessibility Guidelines (ADAAG) prepared by the Architectural and Transportation Barriers Compliance Board (also called the US Access Board) are a result of this rule-making process. The ADAAG contain a wide range of administrative and procedural requirements, including compliance with design and construction standards.

The guidelines and standards contained within the ADAAG are continually being updated and refined, and current versions should be reviewed as part of the design process for every project. The ADAAG

Figure 2.1

Spatial Dimensions for People with Disabilities



Source: Accessibility Design for All

applies only to new construction and alterations, but other legal requirements of the ADA cover improvements of existing facilities, including removal of barriers in places of public accommodation.

In recent years, much information has been developed to respond to the perceptions planners and designers have about what the ADAAG requires. Some of this information can be confusing and conflicting. This section explains the regulations of the ADA as described in the ADAAG.

In 1999, the US Access Board formed the Public Rights-of-Way Access Advisory Committee (PROWAAC) to develop guidelines for accessibility in the public right-of-way. PROWAAC published a report in January 2001 called *Building a True Community* that set forth the committee's recommendations. The report is currently in the Federal rule making process; thus the committee recommendations cannot be considered law at this point. Recommendations in PROWAAC guidelines should be considered as best practices. These recently developed guidelines have been integrated into this toolbox.

Designing for People With Disabilities

Disabilities include a wide range of conditions (hearing and sight impairments, mobility limitations, etc.). Approximately 70 percent of all Americans will have a disability at some point in their lifetime, either temporarily or permanently (Accessibility Design for All, An Illustrated Handbook). Disabilities can affect people differently and limit abilities to greater or lesser degrees. For this reason, some design approaches that accommodate one person may be a barrier to others.

Working closely with people who have disabilities throughout the project design process can be an effective way to ensure that their needs are recognized and accommodated. The best guidance design professionals have for accommodating the needs of people with disabilities are the regulations and standards issued under the ADA. The Easter Seal Society provides design review and comment upon request. (There may be a fee associated with reviews by the Easter Seal Society or other groups.)

Designing for Older Adults

Older adults are often avid pedestrians. If retired, senior citizens may have more time to enjoy walking for exercise and recreation. Older adults often rely on walking and transit service to do their daily errands. They sometimes use wheelchairs or motorized carts to travel along pedestrian routes. When walking, they may travel at slower rates and have less mobility, or they may have disabilities such as sight or hearing impairments. Many of the same design recommendations for people with disabilities can be applied to accommodate older adults with these special needs.

Pedestrian Access Routes (PAR)

The "pedestrian access route (PAR)" is the key element of accessibility. A PAR is a continuous corridor of accessible travel, threading its way along sidewalks and across driveways and roadways, free of abrupt changes in level, with a clear width of at least sixty inches and a clear height of at least eighty inches. It assures access for all sidewalk travelers, from those who use wheelchairs or push strollers to those who find their way with a cane.

Accessible Route of Travel

ADAAG requires that every site have at least one accessible route of travel that provides a connection between exterior accessible site elements (parking, waiting and drop-off zones, sidewalks and walkways, bus stops, etc.) and an accessible building entrance. In a park or open space, public facilities and points of interest should be connected by an accessible route.

Older adults often rely on walking and transit service to do their daily errands.

Figure 2.2 illustrates a site with alternative routes of travel connecting the building entrance.

Recreational facilities and trails should provide accessible experiences as well. If terrain or other unusual conditions do not allow for the trail to serve as an accessible route of travel, alternate connections can be created that provide a similar recreation experience.

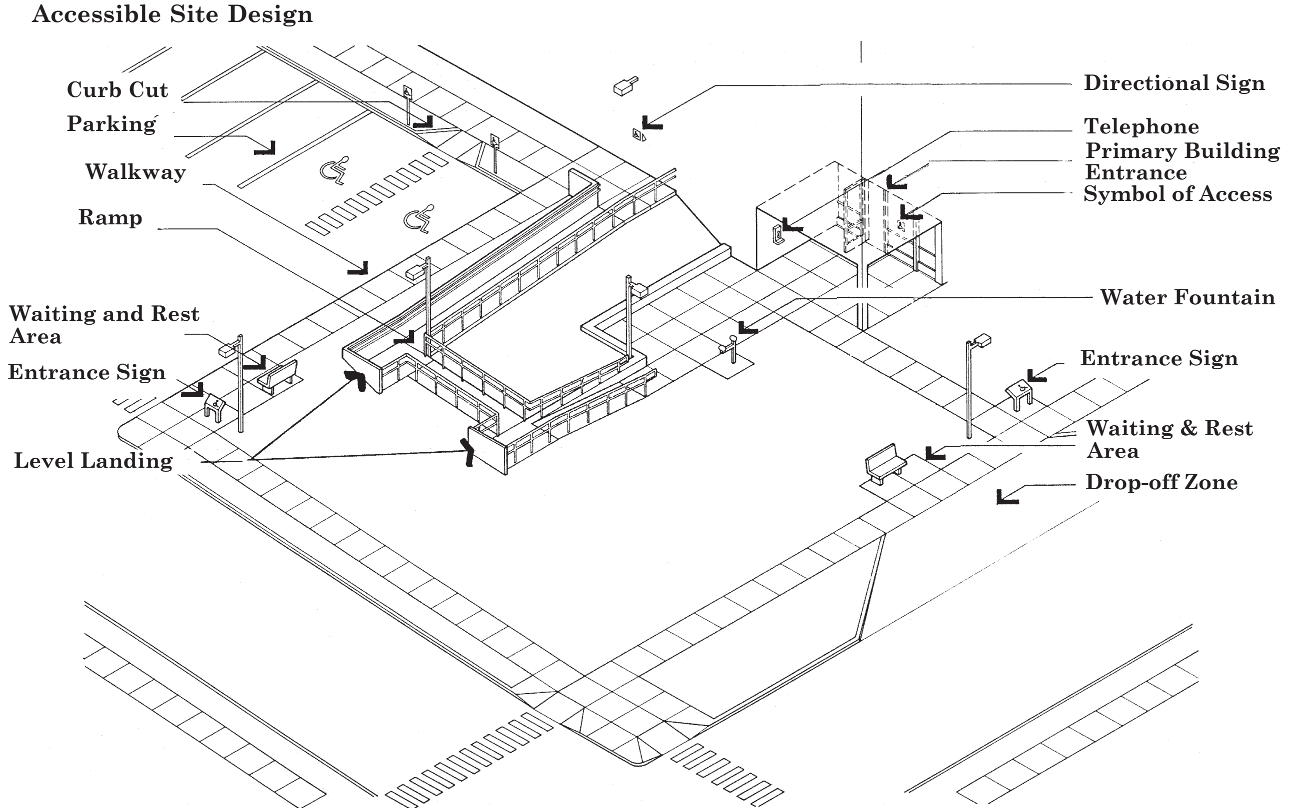
Eliminating Barriers and Obstacles

Access routes need to be continuous and unobstructed. Obstacles and abrupt changes in elevations create barriers for all pedestrians. Curbs, steps, and stairways create barriers for wheelchair users and people pushing strollers or carts. Curb ramps allow access for wheeled devices to areas raised and separated by curbs. Where it is not possible or practical to avoid the installation of steps and stairways, ramps or elevators should be provided to facilitate full access. Design guidelines for curb ramps and long ramps are presented on page 2-8. Design guidelines for steps and stairways are provided in Section 9, Site Design.

Building a True Community recommends that the pedestrian access route include a "reduced vibration zone" that provides a smooth, stable, and slip resistant surface within the route of travel. This "path within a path" is described on page 2-15.

Coordination between the city, private vendors, utility companies and others is necessary to avoid placement of obstacles

Figure 2.2



Source: Accessibility Design for All - An Illustrated Handbook, 1995 Washington State Regulations within the pedestrian travel way. Another solution to reducing obstacles is achieved by consolidating elements (placing multiple signs on one post, placing signs on light standard posts and providing a "corral" for trash receptacles, newspaper stands, and other street furniture).

Sidewalk cafes and displays along an accessible route can become hazards for sight impaired pedestrians and wheelchair and stroller users. Enclose these areas with covered railing or fencing that is at least 27 inches in height and detectable by canes. Provide a clear path of travel around the outside of these areas.

Widths and Clearances

A clear width of passage, without obstacles such as signs, newspaper stands, and trash receptacles needs to be provided for accessible routes of travel. ADAAG requires a minimum 3-foot wide path of travel to accommodate wheelchairs. PROWAAC recommends a minimum 5-foot-wide path of travel, and a 4-foot-wide "reduced vibration zone." The purpose of the reduced vibration zone is to provide a smooth surface for wheelchairs to reduce pain and discomfort for those using them. This surface needs to be free of utility covers, wide joints, and rough or bumpy surfaces. It is best to provide direct routes of travel as well, so that pedestrians do not have to change their course of travel to avoid obstacles.

Vertical clearance is also important to accommodate people with visual impairments. Accessible routes of travel are required to have a minimum clear height of 80 inches. Local requirements may vary. Where the vertical clearance of an area adjacent to an accessible route of travel is impacted by lateral obstructions, a continuous permanent barrier around or at the base of the obstruction is required.

Passing and Resting Areas

It is necessary to provide sufficient passing areas for two wheelchairs. When an accessible route of travel is less than 5 feet wide, passing areas measuring 5 feet by 5 feet every 200 feet are necessary (Figure 2.3). Passing areas may already be available at building entrances, plazas, and sidewalk intersections. It may be more cost effective, practical, and desirable to create a continuous 5-foot-wide path than to create special passing areas.

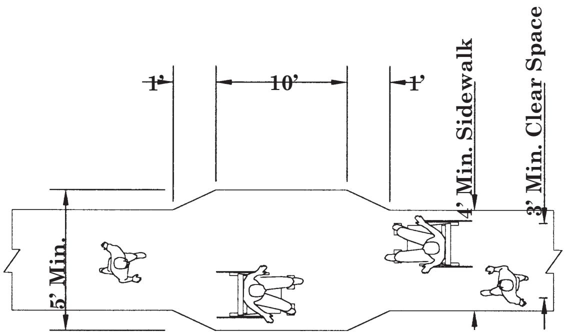
Avoid long distances between resting areas for people with lower stamina or health impairments. Strategically and frequently located benches, seating walls, resting posts, railings, restrooms, and drinking fountains are examples of elements that can make pedestrian travel more convenient and enjoyable, particularly for those with mobility impairments.

Longitudinal Grades

Accessible routes of travel should not exceed a maximum longitudinal grade of 1:20 or 5 percent. If the grade exceeds 5 percent, a ramp should be constructed. Accessible routes of travel may not exceed a maximum ramp grade of 1:12 or 8.33 percent. Sidewalks and walkways located along roadways within the right-of-way may follow the grade of the roadway, which may exceed the maximum gradients of 5 percent (1:20) for normal conditions and 8.33 percent (1:12) for ramps. When an accessible route is greater than 1:20, it is considered a ramp (except for sidewalks along roadways) and must have handrails and landings.

Figure 2.3

Accessible Passing Area



Note: Dimensions of passing area shown are desirable. 5 feet by 5 feet is the minimum dimension.

Landings are required at every point in the run of ramped accessible walkways with a grade exceeding 1:20 (5 percent). If a ramp has a 1:12 (8.33 percent) grade, landings are required at every 2.5 vertical feet in drop and where there is a change in direction. These requirements do not apply to pedestrian facilities within public rights-of-way that follow the street grade, although the sidewalk grade may not exceed the grade of the adjacent street. Landings are required to be level (i.e., not exceeding 2 percent cross slope) and a minimum of 5 feet in length and width, and should be consistent lengths along the route of travel.

In some cases it may be more practical to design a pathway at a lower gradient to minimize the number of landings required (Figure 2.4.) On multi-use pathways that follow the natural terrain, landings are typically not required by the ADA. Where possible, multi-use pathways should be accessible, but this is not always practical due to topographic conditions and other physical constraints. Landings on these steeper multi-use trails create a choppy effect, are difficult to construct, and are a hindrance to bicycle travel. However, if a pathway is designated as an accessible route of travel, landings and handrails on both sides must be provided where adjacent grades are lower than the surface of the path.

Cross Slopes

Cross slopes on sidewalks and walkways should not exceed 2 percent and should facilitate positive drainage, avoiding water accumulating on the surface. It is difficult to operate a wheelchair along a walkway with a cross slope greater than 2 percent because the wheelchair tends to turn toward the direction of the cross slope. As the cross slope of the sidewalk increases, the user is essentially required to steer with one arm and push the wheel with the other arm. This exponentially increases the amount of work required to move the wheelchair.

Slopes across intersections and crossings should not exceed 2 percent, to facilitate crossing by wheelchair users and others.

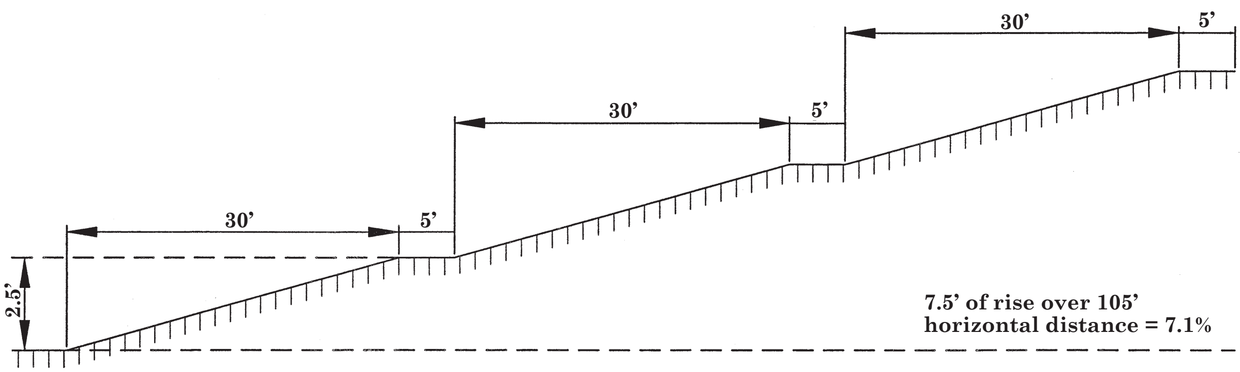
Sidewalk Curb Ramps

Design of Sidewalk Curb Ramps

Sidewalk curb ramps provide accessibility at intersections, building entrances and other areas where elevated walkways are edged with curbing.

Figure 2.5 shows two methods for curb ramp design in detail. Figure 2.6 illustrates accessible curb ramp design options.

Figure 2.4



Note: If designing an accessible route of travel, handrails are required on both sides of ramps.
Source: Adapted from Oregon Bicycle and Pedestrian Plan

Locations of Sidewalk Curb Ramps at Intersections

Curb ramps are important devices at intersections, not only because they facilitate crossing for wheelchair users, people pushing strollers, bicyclists, and others, but also because they help the sight impaired pedestrian identify the street crossing location. Two curb ramps per corner are recommended for new intersections, one in the direction of each crosswalk (see Figure 2.6).

The use of only one curb cut at each corner point presents a hazard as it may direct pedestrians out into the center of the intersection and into an opposing traffic lane, rather than toward the crosswalk. Corner curb cuts introduce a pedestrian at a point where drivers are not anticipating a pedestrian, especially when turning. Table 2.3 lists important criteria for the design of curb cuts at intersections.

Ramps

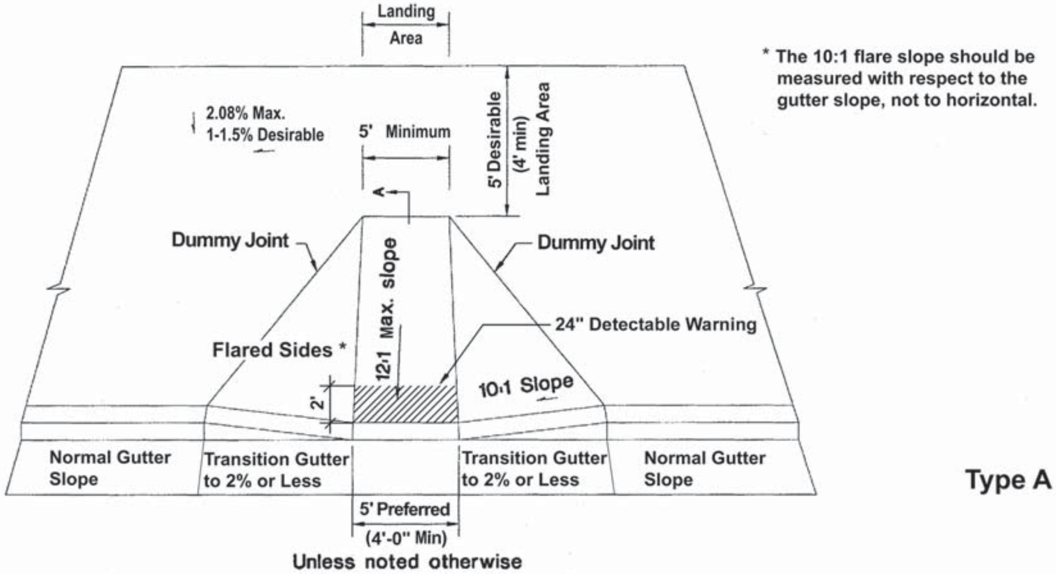
Providing accessibility along walkways and across sites with significant changes in elevation is sometimes challenging. Ramps allow accessibility where grades exceed 1:20 or 5 percent.

In general, ramp design should incorporate the following:

- maximum longitudinal grade of 1:12 or 8.33 percent;
- minimum width of 44 inches (60 inches desirable) for exterior ramps, with a minimum clear space of 36 inches between handrails;
- level landings at the top and bottom of the ramp and at changes in direction;
- intermediate landings for every 30 inches of vertical elevation change; every 30 feet of an 8.33 percent run;
- handrails for walkways and pathways steeper than 1:20 (see design guidelines later in this section);
- maximum cross slope of 2 percent and sufficient to provide positive drainage; and

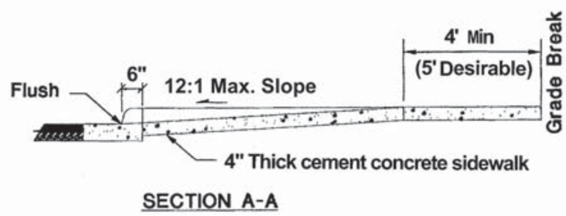
Figure 2.5

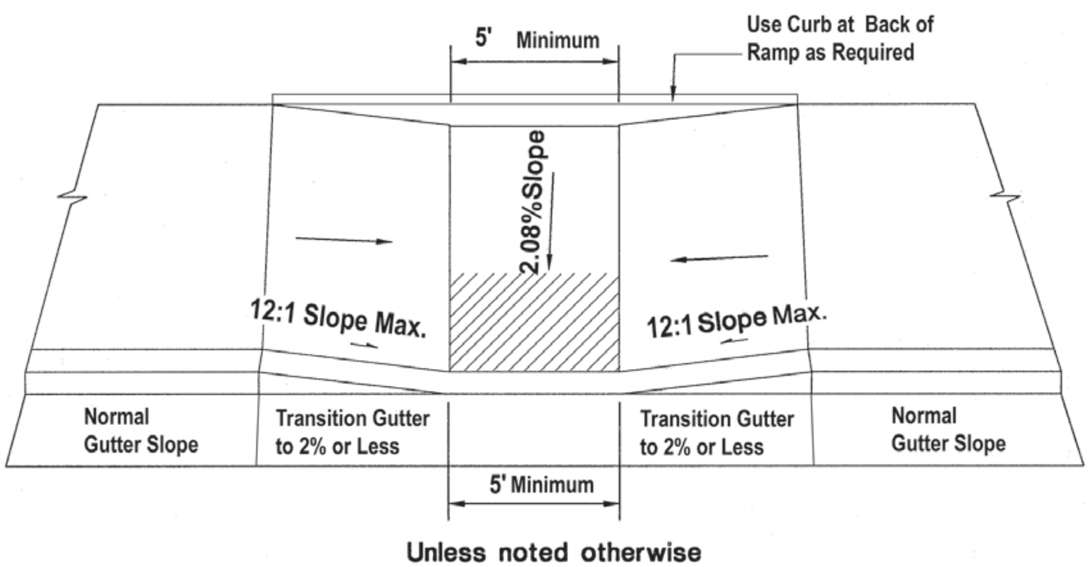
Accessible Curb Ramp Design Details



NOTES:

1. Ramp and approaches shall be clear of obstacles incl. hydrants, poles, and inlets.
2. Provide detectable warning structure at bottom 2 feet of ramp, measured from the back of the curb.
3. Ramp center line shall be perpendicular to or radical to curb returns unless otherwise approved by engineer.



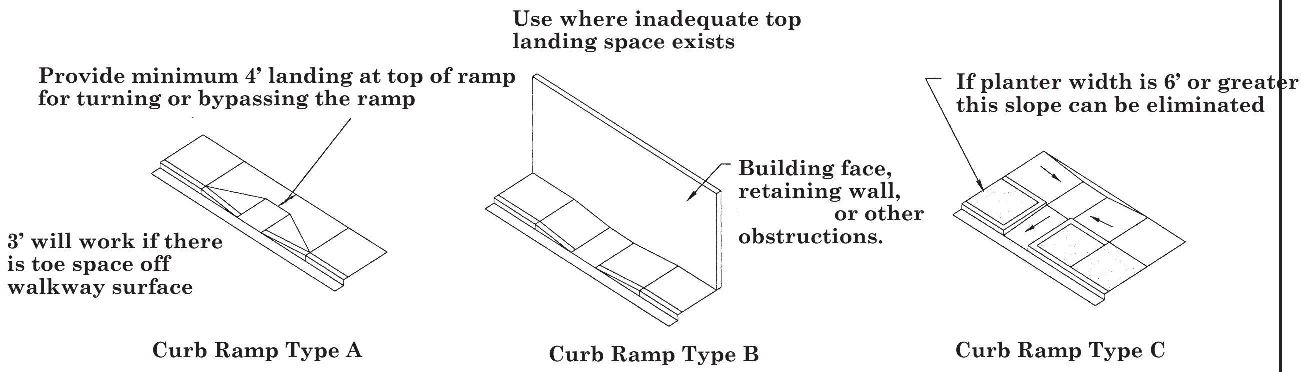


NOTES:

1. Ramp and approaches shall be clear of obstacles incl. hydrants, poles, and inlets.
2. Ramp center line perpendicular to or radial to curb unless otherwise approved by engineer.
3. Where street grads are steep ramp slope length can be limited to 15 feet.

Figure 2.6

Accessible Sidewalk Curb Ramp Designs



Sidewalk Curb Ramps at Intersections

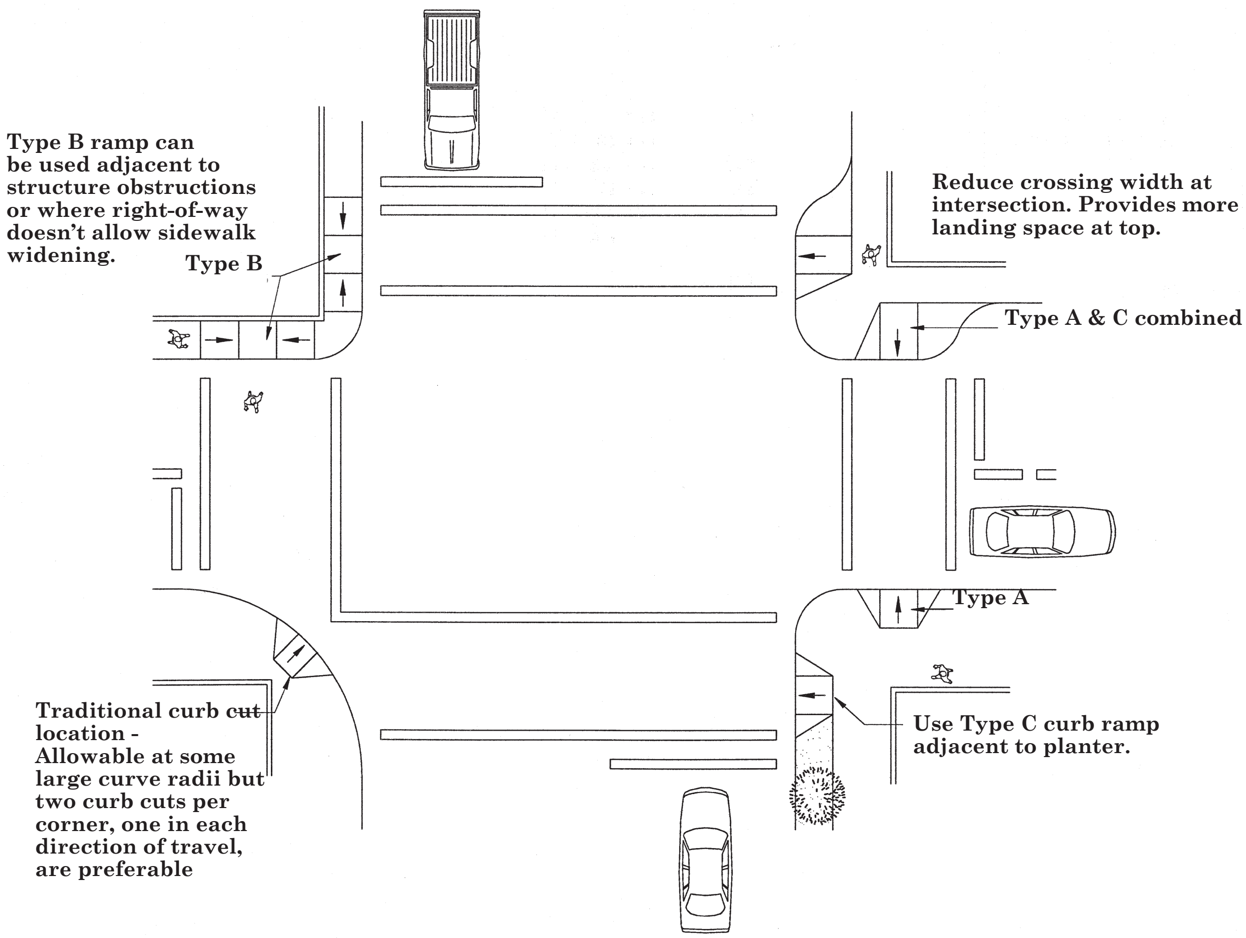


Table 2.3

Important Things to Remember About Curb Cuts at Intersections
• *Curb cuts should align in the direction of crosswalks, with two per corner at each intersection.*
• *Curb cuts function best when located in the center of the crosswalk; or as an alternative, can be constructed to be as wide as the approaching walkway.*
• *The low end of the curb cut should meet the grade of the street with a smooth transition, and no lip.*
• *Curb cuts should also be provided at channelization islands at intersections and median refuge islands, unless full cut-through openings are provided at grade with the street.*
• *Good drainage at intersection corners is important so that standing water does not accumulate within the crossing area. Storm drainage inlets should be placed on the uphill side of crosswalks and outside of the crosswalk area.*

- edge protection for ramps steeper than 1:20 or landings more than ½-inch above the adjacent grade. Edge protection may include low walls or curbs not less than 2 inches high, and guardrails when necessary.

Landings on Ramps

Where a ramp changes direction, landings need to be 5 feet wide by 5 feet long minimum. Landings always need to be at least as wide as the width of the ramp.

Exceptions to Maximum Grades of Ramps

Curb ramps and other short ramps constructed on existing developed sites may have slopes and rises greater than those allowed by the ADA where space limitations preclude the retrofit of 1:12 slopes or less, provided that:

- a slope not greater than 1:10 (10 percent) is allowed for a maximum rise of 6 inches;
- a slope not greater than 1:8 (12.5 percent) is allowed for a maximum rise of 3 inches; and
- keep in mind that grades steeper than 1:8 (12.5 percent) are difficult to maneuver.

Handrails

Sidewalks within public rights-of-way should not be considered to be ramps, and are not required to comply with the same criteria that ADAAG specifies for site and building conditions. Thus, handrails would not normally be required within public rights-of-way, although there may be situations where the designer would elect to include them.

If handrails project into a pedestrian access route in street right-of-way more than four inches (4"), they must include an extension to improve cane detectability for sight impaired pedestrians.

Accessible routes having grades steeper than 1:20 (5 percent) must have handrails on both sides. Handrails shall extend at least 12 inches beyond the top and bottom of any ramp run (see Figure 2.7.) The top of the handrail is required to be 34 to 38 inches above the grade of the walkway or ramp. An intermediate handrail may be mounted at a height of 17 to 19 inches or a handrail with vertical rail members spaced not more than four inches apart to aid those in wheelchairs.

Handrails are required to be continuous unless there is a point of access along the ramp that requires a break in the handrail.

Handrails should be continuous through the landings for the entire length of the ramp system.

Handrails are not required for sidewalk curb ramps, and are generally not recommended alongside multi-use pathways since they could become a hazard to bicyclists (unless the pathway is specifically designated as an accessible route of travel).

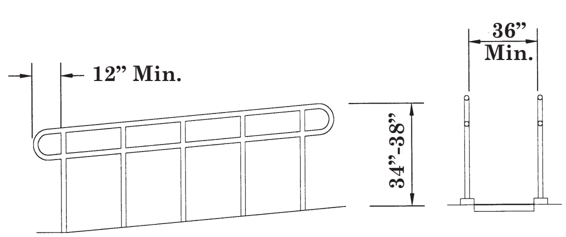
Accessibility Across Driveways

As a general rule, it is best to minimize the number of driveways a pedestrian must cross. When the sidewalk across the driveway is an accessible route, special design detailing is required.

The traditional approach to accommodating driveway cuts in sidewalks has changed due to accessibility requirements. The past method of driveway installation across sidewalks resulted in a 10 percent cross slope for a 5-foot wide sidewalk (see Figure 2.8). This resulted in difficult-to-maneuver driveway aprons in the path of travel, creating a major impediment to sidewalk usability, and violating the requirement for maximum cross slope of 2 percent.

Figure 2.7

Handrail Detail



Sources: ADAAG; Accessibility Design for All

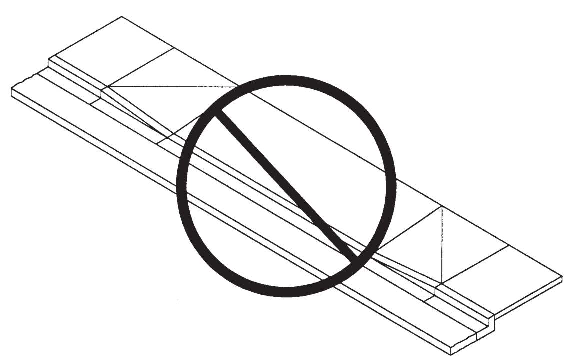
There are four basic approaches to designing driveway cuts that fulfill accessibility needs. These are illustrated in Figures 2.9 through 2.12, on the previous page. The important common element of these solutions is that they provide a continuous accessible route that is a minimum 4 feet in width (5 feet desirable) with a cross slope not exceeding 2 percent.

Where a planting strip or wider sidewalk in unfeasible, the sidewalk can be wrapped around the upper end of the driveway cut. (Note: this method may be difficult for sight-impaired who follow the curb line for guidance, but this can be helped by providing a substantial lip at the edge of the driveway along the road edge.)

This approach dips the sidewalk in the direction of travel, keeping the cross slope at a constant grade. The problems with this approach are that pedestrians must maneuver up and down the sidewalk grade change and drainage may accumulate in the sidewalk area. A prominent lip at the edge of the driveway can help to resolve the drainage problem.

Figure 2.8

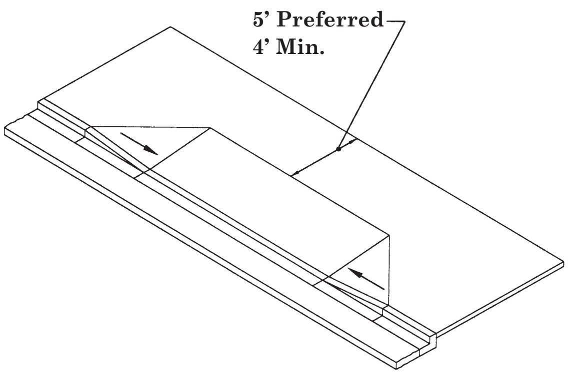
Traditional Driveway Design (Not Acceptable)



Driveway aprons are difficult to maneuver across due to excessive cross slopes.

Figure 2.9

Driveway with Wide Sidewalks



Wide sidewalks allow a 5-foot-wide preferred and 4-foor-wide minimum path of travel behind the driveway cut.

Figure 2.10

Driveway with Sidewalk Behind

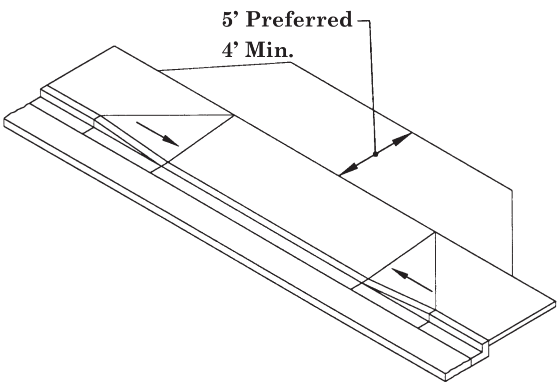
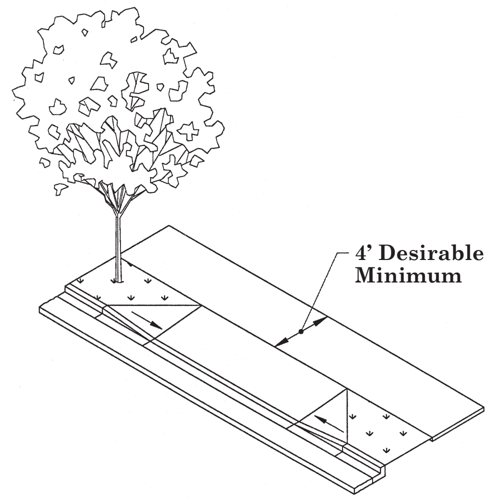


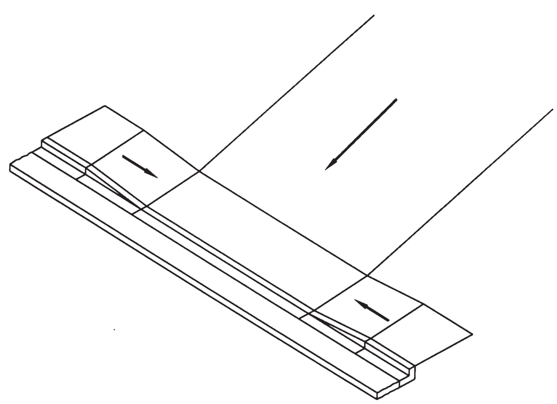
Figure 2.11



Planting strips allow the sidewalk to remain level and in a continuous direction.

Figure 2.12

Driveway with Dipped Sidewalk



Surfacing

The surface of a walkway must be firm and stable enough to support the higher point loads of wheelchair wheels, crutch tips, and other mobility aids. Pavement is typically the most practical means of meeting this requirement. Smooth surfaces are the most desirable, such as concrete or asphaltic concrete. Unit pavers can also provide a stable surface, particularly if the pavers are joined end to end without joints and are smooth and level. Also, the supporting surface should be designed to provide permanent support that eliminates the possibility of settling.

Sometimes, scoring and unit paving patterns can create irregular surfaces that compromise wheelchair stability and control, or that create barriers for ambulatory pedestrians who have gait impairments. Architectural style and appearance should always be balanced with the importance of accessibility. Keep in mind that the requirement for a smooth, stable, and slip resistant surface does not limit the entire paved walkway to unjointed, plain pavement.

However, this type of surfacing may be a suitable solution in more primitive or rural outdoor recreation areas, to make walkways and trails more accessible. Compacted crushed rock surfaces and consolidated soils such as decomposed granite may not be acceptable for accessible routes without extensive maintenance to ensure rollability and maneuverability. However, in some cases, this type of surfacing may be a suitable solution in outdoor recreation areas, to make walkways and trails more accessible to all. (See Section 7, Multi-Use Paths, which addresses accessibility considerations for recreational trails.) Crushed rock surfaces should be compacted into a smooth condition without loose rocks, bumps or grooves. Loose gravel, such as pea gravel and most types of wood chip surfacing, are generally not acceptable as accessible surfaces. The use of a binding agent with the crushed rock to create stabilized decomposed granite paths can improve surface stability and longevity.

Textural and Visual Cues

People with sight impairments need cues as they travel through a pedestrian system to detect changes in slopes and to identify traffic areas. Detectable warning surfaces can provide this cue. If their meaning is understood, textural changes in the surface of the walkway can serve as a tactile cue for persons who have low vision or are blind (Figure 2.13-2.15).

The detectable warning is a unique and standardized surface intended to function much like a stop sign to alert pedestrians who are blind or visually impaired to the presence of hazards in the line of travel and should only be used for this purpose. The truncated dome surface should not be used for wayfinding or directional information. The locations above were identified by the PROWAAC committee as being appropriate for the installation of detectable warnings. Detectable warnings are not required at unsignalized driveways because installation at driveways would make it harder to truly identify the streets.

Where islands or medians are less than 4 feet wide, the detectable warning strip should extend across the full length of the cut through the island or median.

Detectable Warning Surface Specifications:

(A) Size: Detectable warnings should be placed for a width of 24 inches in the direction of travel and extend the full width of the curb ramp or flush surface.

(B) Location: The detectable warning should be located so that it is 6 to 8 inches from the curb line or other potential hazard, such as a reflecting pool edge or the dynamic envelope of rail operations. This gives some latitude in placement of the detectable warning. Where curbing is embedded at the sidewalk/street junction, it will not need to be replaced. In addition, allowing 6 to 8 inches of ramp (or curb) surface beyond the detectable warning will give pedestrians who are blind an additional stopping distance before they step into the street. It will also enable some persons with mobility impairments to make a smoother transition between the street and the curb ramp.

(C) Dome size and spacing: Truncated domes should have a diameter of 0.9 of an inch at the bottom, a diameter of 0.4 of an inch at the top, a height of 0.2 of an inch and a center-to-center spacing of 2.35 inches along one side of a square arrangement. Refer to Figures 2.13 and 2.15. The size and spacing of the domes affect detectability by pedestrians who are blind. This specification is much more detailed than that in the current ADAAG, and offers much less latitude in dimensions and spacing. It ensures that the dome spacing is the maximum currently known to be consistent with high detectability.

(D) Dome alignment: Domes should be aligned on a square grid in the predominant direction of travel to permit wheels to roll between domes. This specification ensures the greatest degree of safety and negotiability for persons with mobility impairments.

Figure 2.13

Dome Spacing (in inches)

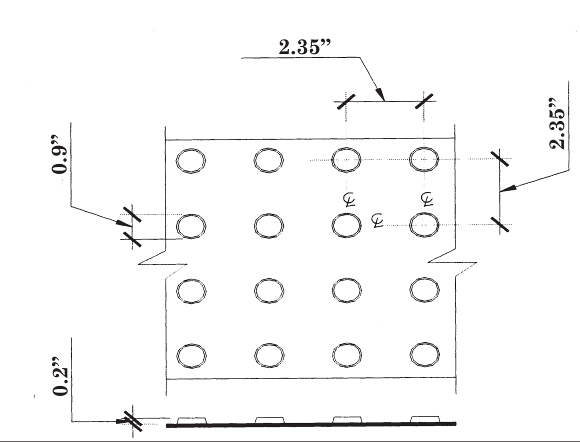


Figure 2.14

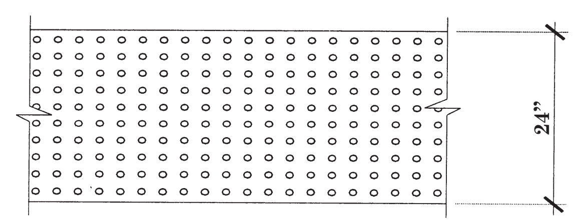
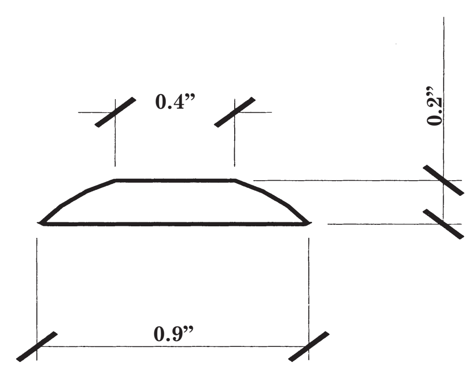


Figure 2.15



It requires square alignment, to give persons using wheeled mobility aids the greatest chance of being able to avoid the truncated domes. Refer to Figure 2.14.

(E) Visual Contrast: There should be a minimum of 70 percent contrast in light reflectance between the detectable warning and an adjoining surface, or the detectable warning should be "safety yellow." The material used to provide visual contrast should be an integral part of the surface. Both domes and the underlying surface should meet the contrast recommendation. Visual contrast can be measured in accordance with existing ADAAG, A.2.9.2, appendix.

Other elements can be strategically placed along accessible routes to identify ramps, building entrances, pathway intersections, etc. Such elements include lighting, change in landscaping, signs, and changes in pavement patterns or colors.

Curbs are also important detection devices for sight impaired people and should be kept along street edges and intersections. Curbs help cane users clearly detect curb ramps and driveways because they can follow the curb line and note where it recesses. The removal of curbs, such as at a recessed intersection, has caused difficulty for those who are blind or visually impaired because they then have trouble detecting the edge of the street.

Accessible Pedestrian Signals

Accessible pedestrian signals (APS) vary greatly in their current technology and use. PROWAAC in *Building a True Community*, recommended a number of measures to provide consistency in the use of APS. Essentially, they suggest that signals providing any pedestrian information must also provide an accessible format.

Specific direction is provided in the PROWAAC report for location of push buttons, push button size, push button force requirements, locator tones, visual contrast, acknowledgment indications and signage. Generally, APS should comply with the following requirements:

(A) Push buttons should be a minimum of 2 inches in at least one dimension.

(B) A locator tone should be provided for each push button. If two buttons are on one pole (in an alteration application) only one locator tone source is required.

(C) The force required to activate push buttons should be no greater than 3.5 lbf.

(D) Push buttons should be operable with a closed fist.

(E) Push buttons should have a minimum 70 percent visual contrast with the body background.

(F) There should be a visible and audible indicator that the button press has occurred (acknowledgment indication).

Note: A long button press (e.g., 3 seconds) may bring up the accessibility features of the individual device. An additional button should not be used to bring up additional accessibility features. All accessible features available are to be actuated in the same way. Thus, for a given signal, a long button press could request more than one additional feature.

Possible additional features include: 1) sound beaconing by increasing the volume of the WALK tone and the associated locator tone for one signal cycle, so a blind pedestrian might be able to use the sound from the opposite side of the street to provide alignment information, 2) sound beaconing by alternating the audible WALK signal back and forth from one end of the crosswalk to the other, 3) extended crossing time, and 4) a voice message with the street names at the intersection.

(G) Signage accompanying push buttons should comply with the Street Identifications and Other Pedestrian Signage section that follows.

Push Button Location

The location of the push button should be in accordance with the following minimum requirements.

(A) It should be placed adjacent to a clear level landing on the pedestrian access route leading to the crosswalk. A clear level (no greater than 1:48 cross slope in any direction) ground space should be provided with a stable, firm, slip resistant surface. The minimum clear ground space area should be 32 inches by 54 inches.

(B) Where a parallel approach is provided, controls should be within 10 inches of the clear ground space, measured horizontally, and centered on it. Where a forward approach is provided, controls should abut and center on the clear ground space.

(C) The control face of the button should be parallel to the direction of the marked crosswalk controlled by the push button, and no closer than 30 inches to the curb.

(D) Mounting height should be 42 inches to the center line of the push button above the clear approach area.

(E) The push button should be no further than 5 feet from the crosswalk lines extended and within 10 feet of the curb, unless the curb ramp is longer than 10 feet.

(F) When at a curb ramp, the push button should be within 24 inches of the top corner of the ramp, on the side furthest from the center of the intersection of the roadway. At a transition ramp, the push button should be adjacent to the lower landing.

(G) Where there are two APS in separate pedestrian push button housings on the same corner, the push buttons should be mounted on poles separated by at least 10 feet.

Push button at signal

If the requirement for separation cannot be met due to location requirements A-F above, two APS-related push buttons may be installed on a single pole. If installed on the same pole, the APS should be equipped to provide speech transmitted data or other technology that delivers an unambiguous message about which crosswalk has the walk signal indication.

Signals providing information only in vibrotactile format are not recommended. For information in vibrotactile format to be usable, the pole must be located so the user is able to keep a hand on the button while positioned at the top of the curb ramp or at the crosswalk.

The discussion above is intended to standardize some elements of pedestrian push button location to enhance accessibility. Locating the pedestrian push buttons away from the crosswalk, which is common now, makes it difficult for a pedestrian, particularly a sight impaired pedestrian, to push the button and return to the crosswalk location in time for the walk phase. A wheelchair user needs to be able to push the button from a level surface. The control face of the push button or the push button housing should include a tactile arrow to inform the pedestrian who is blind about the direction of the crosswalk. The location and direction of the control must be aligned with the crosswalk.

Since the APS will provide an audible indication of the WALK interval from the pedestrian push button, the blind pedestrian must be able to discern which signal is sounding at each phase. This is not possible if both APS are on the same pole. Use of different tones is not an acceptable method to identify different crossings. The separation is intended to allow the blind pedestrian to determine which APS is sounding through sound localization while standing at the curb preparing to cross the street. While the separation is not required for call buttons that are not associated with an APS or locator tone, routinely separating the call buttons will result in a more uniform and predictable location, and will facilitate consistent future APS and/or locator tone installation. See Figures 2.16 through 2.18.

Push Button Signage

(A) **Tactile arrow.** Where there is a push button, there should be a tactile arrow pointing in the direction of pedestrian travel. See Figure 2.19.

The arrow should be raised at least 1/32 of an inch, 1.5 inches in length. Stroke width should be between 10 percent minimum and 15 percent of maximum of the length of the arrow. The arrowhead should be open and at 45 degrees to the shaft. The arrowhead should be no more than 33 percent of the length of the arrow shaft.

(B) **Universal Symbol.** Controls are to include a universal tactile and visual symbol (if established by the US Access Board) that will go on or at the push button indicating the presence or absence of an Accessible Pedestrian Signal (APS) at a crossing. See Figure 2.20.

(C) **Street Name.** Street name information should be provided at pedestrian push buttons, where the push button is equipped with an APS and a locator tone. The accessible street name information should include the street name (or a reasonable abbreviation) in grade 2 Braille and in tactile raised letters complying with “Street Identification and Other Pedestrian Signage.” The sign should be located immediately above the push button mechanism and parallel to the crosswalk controlled by the button. The street name should be the name of the street where the crossing is controlled by the push button.

Street name information, for individuals with visual impairments, should be provided at pedestrian push buttons equipped with an APS and a locator tone. Therefore the push button (or its housing) would also be equipped

Figure 2.16

Curb Ramp APS Zones

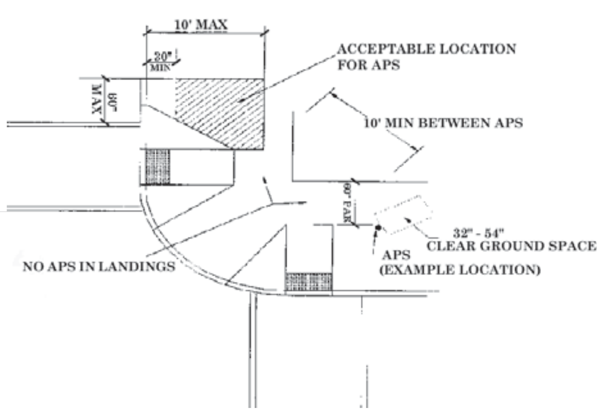


Figure 2.17

Shared Curb Ramp APS Zones

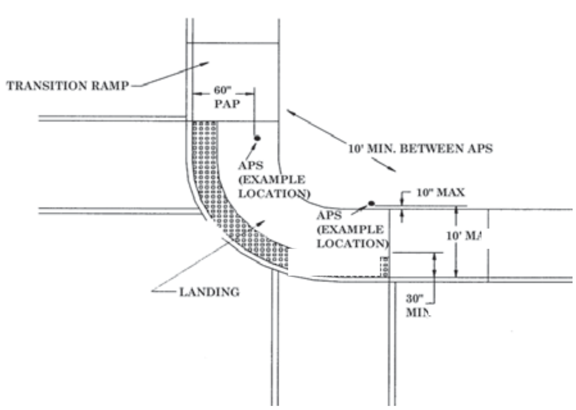
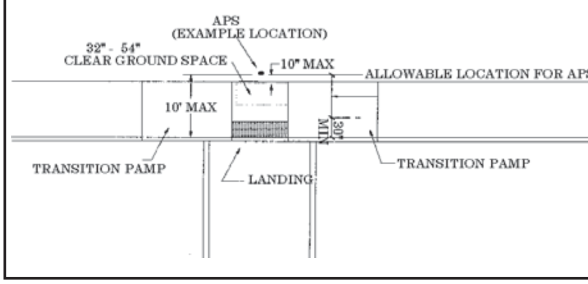


Figure 2.18

Transition Ramp APS Zones



with a tactile arrow indicating which street is controlled by the pedestrian crossing. It is logical to name that street. While this is in contrast to the convention in visual street naming, where the street name is parallel to the street itself in order to be visible to drivers and pedestrians, it is NOT in contrast to visual signs adjacent to pedestrian push buttons that indicate which street is controlled by the push button. Traditional street signs should continue to be used in addition to these supplemental signs.

Figure 2.19

Tactile Arrow

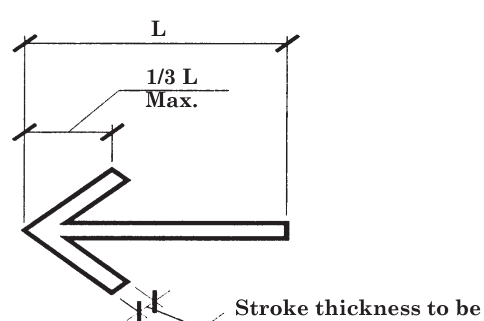
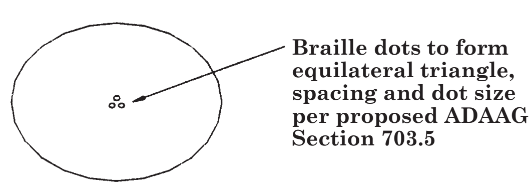


Figure 2.20

APS Universal Symbol



Audible signage may be provided in addition to Braille and tactile signage. Audible signage can provide auxiliary information about the intersection which can be of great value to persons with visual impairments and to persons benefiting from redundancies.

(D) **Crosswalk mapping**. Where a map of a crosswalk is associated with a push button, the map should be visual and tactile. Maps shall have at least 70 percent visual contrast, light on dark or dark on light. The characters and/ or symbols should be raised 1/32 of an inch minimum. The crosswalk should be represented by a vertical line, with the departure end of the crosswalk at the bottom of the map. The map should be on the side of the push button housing that is furthest from the street to be crossed.

For the universal tactile and visual symbol, PROWAAC suggests locating three dots in a triangle on the button, as close to the center as practicable.

Locator Tone for Pedestrian Signal

Where new traffic signals are installed, and in alterations, the locator tone should meet the following requirements.

(A) **Volume.** The volume of the locator tone should be at least 2dB and no more than 5dB greater than the ambient noise level and should be responsive to noise level changes. At installation, the signal system should be adjusted to be audible at 5-12 feet from the system, or at building line, whichever is closer.

(B) **Repetition.** The locator tone should be 0.15 seconds maximum in duration and repeat at one second intervals. Sound should operate during the DON'T WALK and flashing DON'T WALK (clearance interval) of the signal.

(C) **Deactivation**. Locator tone should be deactivated during periods in which the pedestrian signal system is inactive.

A locator tone notifies pedestrians who are blind or visually impaired of the need to push a button to request a WALK signal. It also indicates the location of the push button. These specifications are the same as the proposed MUTCD specifications.

Where new traffic signals are installed, Accessible Pedestrian Signals (APS) should be provided when the following conditions are present:

(A) pedestrian timing is affected by push button activation;

(B) timing includes a lead pedestrian interval; or

(C) where there is a fixed time signal with pedestrian signal indication information presented. In this instance, a push button should be provided that delivers the same information in an accessible format.

The primary technique that people who are blind or visually impaired have used to cross streets at signalized locations is to initiate their crossing when they hear the traffic alongside them begin to move, corresponding to the onset of the green interval. The effectiveness of this technique has been reduced by several factors including: increasingly quiet cars, right turn on red (which masks the beginning of the through phase), complex signal operations and wide streets. Further, low traffic volumes make it difficult for pedestrians who are blind or visually impaired to discern signal phase changes.

The increasing use of actuated signals, at which the pedestrian must push a button and cross during the pedestrian phase, requires blind pedestrians to locate the pedestrian push button and to cross only at the proper time during that phase. These changes in signalization make it necessary to provide the pedestrian signal information in an accessible format. In responding to a request for an accessible pedestrian signal, it is useful to work closely with the blind or sight impaired pedestrian(s) who will be using the intersection and with an orientation and mobility specialist.

Required Features of Pedestrian Signals

Where accessible pedestrian signals are provided, they should comply with the following requirements.

(A) **Crosswalk indication.** Accessible pedestrian signals should clearly indicate which crosswalk has the walk interval. The use of two different tones as sole indication of which crosswalk has the walk interval should not occur.

Separation of the push buttons with the vibrotactile information and arrow provided on the push button is a good means to provide crosswalk-specific information. A speech message may also be used to provide this information. The Manual on Uniform Traffic Control Devices (MUTCD) specifies the wording of such a speech message. Remote infrared audible signals, which are inherently directional, are another good way to clearly indicate which crosswalk has the walk interval. Additional strategies include an alternating audible signal or an audible signal from the far end of the crosswalk.

(B) **Walk indication.** When indicating the walk interval, the accessible pedestrian signal should deliver the indication in audible and in vibrotactile format.

(C) **Locator tone**. Where there is an accessible pedestrian signal, there should be a locator.

An audible tone should accompany an infrared signal. The tone may be initiated by a passive detector sounding only when pedestrian presence triggers the device.

(D) **Walk interval tone.** APS with audible tones should have a specific tone for the walk interval. If the same tone is used for the locator tone, the walk interval tone should have a faster repetition rate. The two signals should be distinguishable either by tone and/or by repetition rate. A voice message may be used for the WALK indication.

APS providing signal information with tones should utilize multiple frequencies with a large component at 880 Hz. The walk tone should have a repetition rate of 5 Hz minimum and a duration of 0.15 seconds maximum.

Note that frequencies above 1 kHz are difficult for persons with an age related hearing loss. Multiple frequencies assist a larger population of vision and hearing impaired persons.

(E) **Operating period.** Under stop-and-go operations, APS should not be limited by time of day or day of week. Rather than disconnect a device for periods of time, volume should modulate in response to ambient levels.

(F) **Activation.** Actuating a single APS on an intersection is not intended to activate all other devices at the intersection.

The APS specifications and sound levels recommended here are intended to provide precise information about the onset of the walk interval. Using special actuation, as specified below, they may also function as audible beacons, giving assistance in alignment and crossing within the crosswalk.

(G) **Audible beaconing.** Where provided, beaconing signals should be conveyed during the walk interval and clearance interval. No conflicting protected traffic movements are to be permitted.

Beaconing may be needed at intersections that are wide; have low parallel traffic volume; or have skewed crosswalks. Where beaconing is desired as an additional accessibility feature, it should be actuated by depressing the push button for a longer period of time.

Where beaconing is actuated, it will be most effective if it functions only for that crosswalk where the push button was actuated. The area of definite audibility in the direction of travel should be detectable within 1/3 of the width of the crossing from the entrance to the crossing.

Types of APS

There are now four types of APS available in the United States. Overhead signals mounted on the pedestrian signal are most commonly used, but problems noted include: difficulty identifying which signal is associated with which crosswalk; which

Crosswalk indication on Mill Avenue.

signal is associated with which intersection; noise complaints from neighbors; and difficulty by blind pedestrians in hearing traffic above the loud sound of the APS.

Signals in which the sound comes from the pedestrian push button with a locator tone and vibrotactile information are used extensively in Europe and Australia and are now available in the US. There are also signals that are vibrotactile only. Sound transmitted to a receiver carried by the blind pedestrian, using Remote Infrared Audible Signs (RIAS) or LED technology has also been used to provide information about the status of the walk signal and to provide additional information about the location and nature of the intersection. RIAS systems provide a beaconing effect by means of the directional sensitivity of the receiver units.

While sound beaconing is an alternative that may assist a blind pedestrian in aligning at a difficult crossing, the use of beaconing at all intersections is not necessary. There are concerns that loud overhead APS may mask traffic sounds that are useful to the blind pedestrian. Residents who live near the APS may find noise levels unacceptable. Nearby residents have objected to audible signals in the past where they used two different sounds in a beaconing manner to alert users. By providing tones with volumes that modulates to ambient noise levels, noise intrusions beyond the intended hearing range can be minimized and termination of the tone during night hours is unnecessary.

Other Pedestrian Signals and Timing Controls

Other pedestrian signals and timing controls not specifically described elsewhere should comply with the following recommendations.

Lead Pedestrian Intervals

Lead Pedestrian Intervals (LPI) are signal controlled pedestrian locators where the pedestrian signal releases the pedestrian before the similar vehicular movement is released, or where a pedestrian "scramble" exists where pedestrians have an "all way walk" phase. Where LPIs are used, APS should be required.

Mid-block crossings

At mid-block crossings, a locator tone should be considered to communicate the crossing presence to blind and sight impaired users.

Providing pedestrian signal indication on the near side of the crossing is of direct benefit to persons with low vision and to persons benefited by redundancies. Use of larger devices and signage, visible at near side curb, is encouraged.

Crosswalks

Where provided, crosswalks should comply with the following requirements. The cross slope of pedestrian street crossings, at either marked or unmarked crosswalks, should be not more than 1:48 (2 percent) measured perpendicular to the direction of pedestrian travel. The running grade of pedestrian street crossings, at either marked or unmarked crosswalks, should be no more than 1:20 (5 percent) in the direction of pedestrian travel in the crosswalk. Crosswalks at signalized intersections should be marked on the roadway with pavement markings. Crosswalks should be at least 8 feet wide, and preferably 10 feet wide (desirable minimum).

Pedestrian crossing intervals should be calculated using a pedestrian walking speed of 3.5 feet per second or less. Designers should consider extending the time for pedestrian crossings beyond the calculated requirement if any of the following factors are present: running grade of the crosswalk greater than 1:20; cross slope of the crosswalk greater than 1:48; or crosswalk length greater than 50 feet with no intermediate pedestrian refuge.

Extended time for pedestrian crossings may be initiated by passive detection of pedestrian movement in the crosswalk, provided that it provides detection of people using wheelchairs. Extended time may also be initiated by a long (e.g., greater than 3 seconds) button press.

When calculating pedestrian signal phase timing, total crossing distance should include the entire length of the crosswalk plus the length of one curb ramp.

Medians and Pedestrian Refuge Islands

Raised medians and pedestrian refuge islands in crossings should be cut through at street level or have curb ramps at both sides. Each curb ramp should have a level area (landing) 60 inches square, minimum at the top of the curb ramp in the part of the island intersected by the crossings. Cut-throughs should be aligned perpendicular to the street being crossed and should be parallel to the direction of the pedestrian access route if the pedestrian access route is not perpendicular to the street

Detectable Warnings at Medians/Islands

Medians and refuge islands level with the street at crosswalks and curb ramps, should have detectable warnings provided at the following locations (see Figures 2.21 through 2.27):

- where a pedestrian way crosses a vehicular way excluding unsignalized driveway crossings;
- where a rail system crosses pedestrian facilities that are not shared with vehicular ways;
- at reflecting pools within the public right-of-way that have no curb or rim protruding above the walking surface;
- at cut-through islands and medians where islands or medians are less than 4 feet wide, the detectable warning should extend across the full length of the cut through of the island or median; and
- where required by ADAAG Chapter 10.

Signing and Other Communication Aids

Signing is an essential aid for all pedestrians, including older adults and people with disabilities. Signing identifies nearby services, warns of possible hazards, and directs people to their destinations.

Signs should be readily observable, with clear and precise information. Place directional signage at decision points where access provisions are not obvious, to indicate the location of accessible parking spaces, building entrances, and restrooms. Redundancy is desirable for significant safety and directional information.

To provide accessibility in signing, planners and designers need to understand which signing components are important for those requiring accessibility. Street identification, bus route identification, and informational and warning signs provide basic information that pedestrians with sight impairments rely on to guide their mobility.

Street Identification Signing

Street identification signing is primarily provided for motorists, with usability by pedestrians almost an afterthought. As a result, the location for many street signs precludes the addition of accessible signage. Also, the lack of consistent locations for sign posts and other elements that could be used for placement of tactile signing makes installation of tactile signing less effective because users with sight impairments would not necessarily know where (or even if) those elements are present.

Where an APS is provided, visual and tactile street identification that complies with ADAAG should be provided above the push button.

Bus Route Identification

Where bus route identification signs are provided in the public right-of-way on or adjacent to a public sidewalk, visual characters, tactile characters and Braille signs providing the route number and route name should be provided. Raised print is necessary for route number identification

Figure 2.21

Detectable Warning at a Curb Ramp

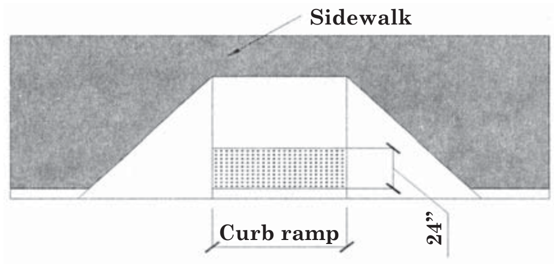


Figure 2.22

Detectable Warning at a Transition Ramp

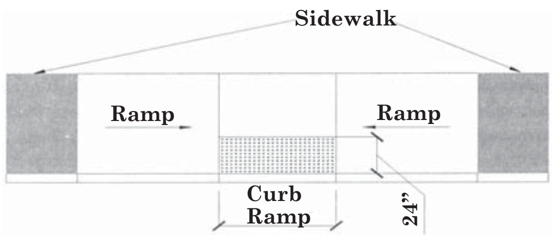


Figure 2.23

Detectable Warning at a Shared Ramp

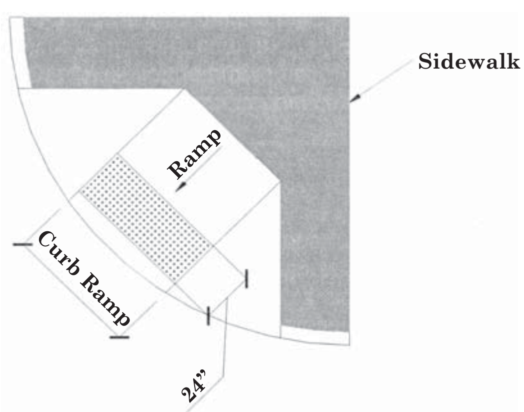


Figure 2.24

Detectable Warning at Blended Curb

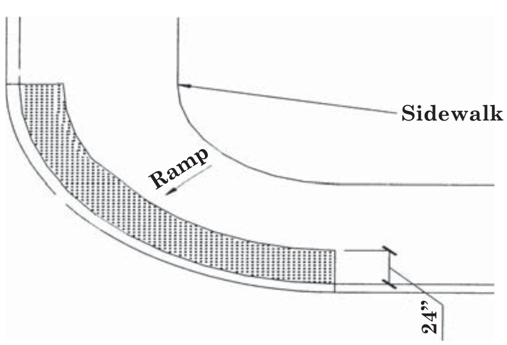


Figure 2.25

Detectable Warning at Multiuse Path

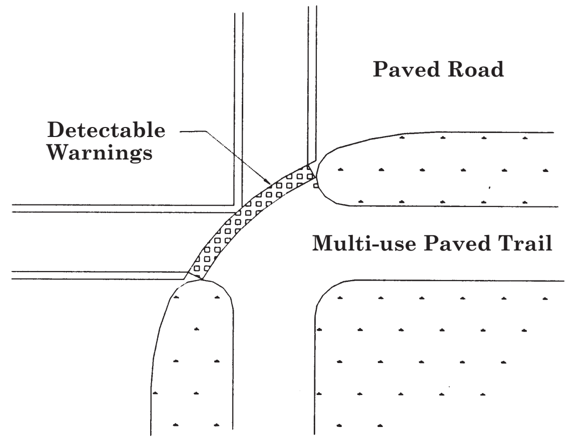


Figure 2.26

Detectable Warning at Railroad Crossing

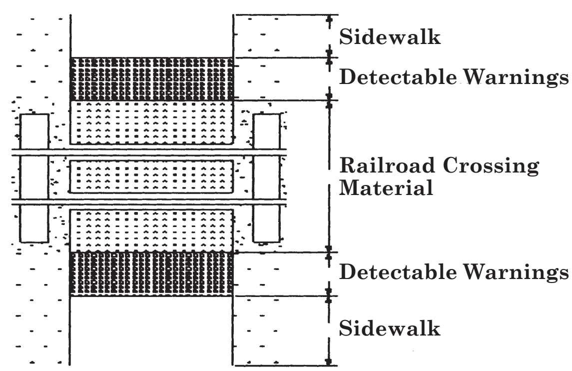
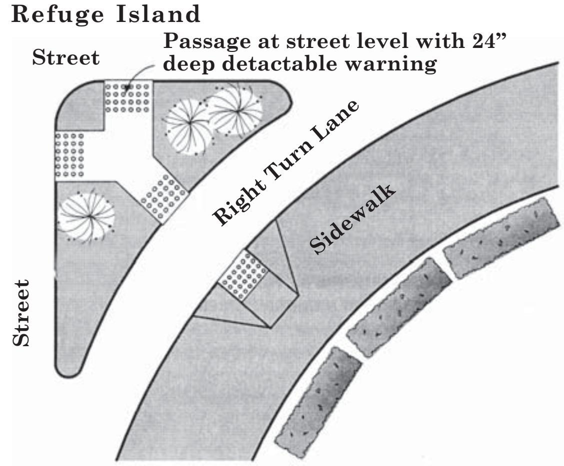


Figure 2.27

Refuge Island



only. If a variable message sign is used at a bus stop or shelter, an audible equivalent should be provided.

Bus stops and shelters are covered as transportation facilities in accessibility guidelines adopted by The United States Department of Transportation (USDOT) as part of the Title II regulation (49CFR Parts 27, 37 and 38). Bus route identification signs must comply with specifications for visual characters. The USDOT's ADA regulations do not require tactile signs at bus stops and shelters, but do require that bus stop locations be audibly and visibly announced on the vehicle.

Informational and Warning Signs

It is important to provide informational and warning signs in the public right-of-way in an accessible format. However, there are few recognized standards for making that information readily accessible to individuals who are blind or visually impaired. Signs at construction barriers are of particular concern. Additional discussion about signing for construction activities is provided in Section 11, Safety in Work Zones.

Sign Mounting Locations

Mounting height for all signs that include tactile characters should be 60 inches above the finish floor at the centerline of the sign.

Bus shelter signs should be mounted on the shelter wall closest to the front of the bus, as close to the street as possible, at 60 inches above the adjacent clear landing. Bus stop signage where no shelter is present shall be mounted on the pole at 60 inches above adjacent grade.

Variable Message Signs

Variable message signs presented using LED, LCD, flip-dot or other means should be legible from the same distance as conventional print signs. Character height for variable message signs should be about 35 percent greater than character height for conventional print signs in order to have equal legibility at the same distance.

Audible Signs

Audible signs should only be provided when visual equivalent signs are provided at the same location. *Building a True Community* extensively discusses standards for frequency, power, range, and other technical requirements for Remote Infrared Audible Sign (RIAS) Receivers. Transit stations and platforms are routinely used by persons who are blind or sight impaired. Tactile signs do not necessarily help blind people locate station entrances and exits, fare gates, fare machines, stairs and escalators, platforms, and other amenities, because they cannot be located consistently enough for persons who are blind to find them efficiently. RIAS are suggested as a wayfinding system because they enable users to scan the environment (using a personal receiver) and "read messages" from a distance. They provide directional and informational messages in a way that enables persons who are blind to travel as independently as persons who can read print signs.

Site Connections

ADA requires at least one accessible route of travel on sites connecting primary building entrances with accessible site facilities such as parking areas, bus drop-off zones, telephones, and drinking fountains. Accessible routes of travel should meet the requirements for walkways described above.

The route between accessible parking

spaces and the building entrance must be carefully planned to minimize the travel distance for a disabled person and to avoid obstacles and hazards. The maximum distance should be no greater than 100 feet. (See Section 9, Site Design, for more information.)

Lighting

Lighting is required along exterior accessible routes of travel any time the buildings on site are occupied. A minimum intensity of one foot candle is required on the surface of the route.

Table 2.4

Summary of Accessibility Requirements

- *Eliminate obstacles within pedestrian access routes*
- *3-foot clear width absolute minimum; 5-foot clear width desirable minimum*
- *5-foot wide passing areas every 200 feet on accessible routes less than 5 feet in width*
- *Maximum 1:20 (5%) grade is desirable, steeper grades up to 1:12 (8.33%) can be used for ramps*
- *Level landing areas, 5 feet in length, for every 30 inches of elevation change along 1:12 (8.33%) grade (ramps)*

Summary

Table 2.4 summarizes the ADA requirements presented in this toolbox section. All of the standards described throughout this section are required by federal and state governments unless otherwise noted as a recommendation, rather than a requirement.

Other Sources of Information

The following sources of information are recommended for design of accessible pedestrian facilities. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

Accessibility Design for All, An Illustrated Handbook, 1995 Washington State Regulations, Barbara L. Allan and Frank C. Moffett, AIA, PE

Americans With Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; State and Local Government Facilities; Interim Final Rule, Federal Register, Part II, Architectural and Transportation Barriers Compliance Board

Designing Sidewalks and Trails for Access: Part Two—Best Practices Design Guide, Beneficial Designs Inc. for the US Department of Transportation

Recommendations for Accessibility Guidelines: Recreational Facilities and Outdoor Developed Areas, Recreation Access Advisory Committee

Uniform Building Code (and state and local building codes)

Universal Access to Outdoor Recreation: A Design Guide, PLAI, Inc.

Building a True Community, report by the PROWAAC, a committee of the US Access Board

Who to Contact:

Thibault, Lois E., US Architectural and Transportation Barriers Compliance Board (Access Board), 1331 F Street NE, Suite 1000, Washington, DC, 20004-1111.

FRIENDLY STREETS AND SIDEWALKS

3

This Section Addresses:

- *Street Classifications*
- *Green Streets and Transit Streets in Tempe*
- *Sidewalks*
- *Curbs*
- *Bicycles*
- *On-Street Parking*
- *Access Management*
- *Furnishings and Utilities*
- *Landscaping and Street Trees*
- *Lighting*
- *Other Sources of Information*

This section applies to facilities within street rights-of-way that are adjacent to or parallel with the roadway, including the sidewalk corridor, bicycle lanes, on-street parking, curbs, and other amenities such as plantings and furnishings.

Street Classifications

Design of street facilities will vary depending on the width of the right-of-way and the nonmotorized traffic it generates. Some streets, such as arterials, are wider and carry more traffic, while local neighborhood streets are typically narrow and carry less traffic. Street classifications typically include principal arterial, minor arterial, collector arterial, neighborhood collector, and local residential.

Green Streets and Transit Streets in Tempe

The City of Tempe has designated various collector and local streets that are popular routes for bicyclists and pedestrians as “green streets” and arterial streets that serve as major transit routes as “transit streets.” Descriptions of the typical desirable characteristics of green streets and transit streets are provided below, along with a listing of the designated streets in Tempe.

Green Streets

“Green streets” typically include collector streets that already serve as high volume bicycle and pedestrian corridors. Green streets serve as priority routes for bicyclists and pedestrians and function as connectors between off-street multi-use paths. Green streets may be located both inside and outside pedestrian overlay districts and are particularly important in providing pedestrian and bicycle access to parks, shopping, schools, civic places, and other community destinations. With further enhancements and improvements, Tempe citizens will be able to immediately recognize these streets as pedestrian- and bicycle-friendly. Refer to Tables 3.1 and 3.2 for typical characteristics of green streets and designated green streets in Tempe.

Table 3.1 — Typical Characteristics of Green Streets

- *Wider sidewalks – Depends on street classification, but generally 6' minimum, 8' desirable where space permits*
- *Bike lanes – 5' minimum*
- *Traffic calming techniques*
- *Sidewalk extends to the curb at intersections*
- *Intersection improvements that accommodate accessibility needs (curb ramps, signals, signs, etc.)*
- *Consideration of access to transit at intersections*
- *Mid-block crossings and related improvements where needed*
- *Curb extensions at intersections or mid-block crossings*
- *Medians for pedestrian refuge*
- *Street trees and landscaping*
- *Shade and shelter (shade structures, trees etc.), particularly in the transit waiting area*
- *Pedestrian scale lighting*
- *Benches, low seat walls, or other seating and resting structures, particularly in the transit areas*
- *Wayfinding signs*
- *Street furnishings*
- *Water amenities*
- *Integration of public art and creative expression in design*
- *On-street parking where feasible*

Table 3.2 — Designated Green Streets in Tempe

- *Continental Drive*
- *McKellips Road*
- *Miller Road*
- *Weber Drive*
- *Curry Road*
- *College Avenue*
- *1st Street*
- *5th Street*
- *Ash Avenue*
- *Hardy Drive*
- *8th Street*
- *Lemon Street - Don Carlos Avenue - Orange Street - Victory Drive*
- *Dorsey Lane - Vista del Cerro Dr.*
- *Smith Road*
- *Evergreen Road*
- *13th Street*
- *Country Club Way*
- *Alameda Drive*
- *Lakeshore Drive*
- *Mill Avenue - Dartmouth Drive - Cornell Drive – Southshore Drive*
- *All America Way*
- *West Grove Parkway*
- *River Parkway*
- *Los Feliz Drive*
- *Carver Road – Secretariat Drive*
- *Warner Ranch Road*
- *Knox Road – Lakeshore Drive – La Vieve Lane – Caroline Lane*

Transit Streets

"Transit streets" include street corridors (typically arterials) that serve important functions as transit routes. Bus routes with 15-minute (or less) service frequency during the peak, and streets that share space with the light rail corridor are examples. Transit streets may include arterials that are inside and outside pedestrian overlay districts, and these streets will be improved for accessibility to transit by pedestrians and bicyclists. Refer to Tables 3.3 and 3.4 for typical characteristics of transit streets and designated transit streets in Tempe.

Table 3.3 — Typical Characteristics of Transit Streets

- *Wider sidewalks – depends on street classification, but generally 8' minimum, 10' to 14' preferred.*
- *Bike lanes -5' to 6' minimum*
- *Sidewalk extends to the curb at intersections*

  and transit stops, creating an accessible area

  at least 10' to 14 feet wide.
- *Intersection improvements that accommodate accessibility needs (curb ramps, signals, signs, etc.)*
- *Mid-block crossings and related improvements where needed*
- *Curb extensions at intersections or mid-block crossings*
- *Medians for pedestrian refuge*
- *Street trees and landscaping*
- *Shade and shelter (shade structures, trees etc.), particularly in the transit waiting area*

Table 3.3 (continued)

- *Pedestrian scale lighting*
- *Benches, low seat walls, or other seating and resting structures, particularly in the transit waiting area*
- *Wayfinding signs*
- *Street furnishings*
- *Water amenities*
- *Integration of public art and creative expression in design*
- *On-street parking where feasible*

Table 3.4 — Designated Transit Streets in Tempe

- *Scottsdale Road*
- *Rural Road*
- *Rio Salado Parkway*
- *Mill Avenue*
- *University Drive*
- *College Avenue (Between University Dr. & 5th St.)*
- *5th Street*
- *McAllister Avenue*
- *Apache Boulevard*
- *Broadway Road*
- *Southern Avenue*

Sidewalks

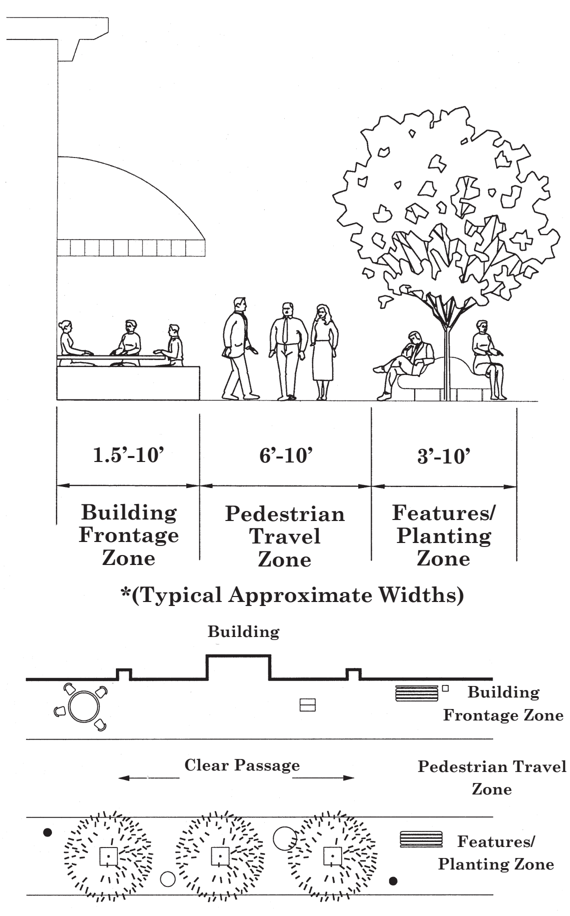
The sidewalk corridor includes elements located within street rights-of-way that are adjacent to or parallel with the roadway. This includes all elements from the property line to the edge of the roadway, including exclusive pedestrian sidewalks/ walkways, planting strips, and building frontage areas. Figure 3.1 illustrates a sidewalk corridor.

Sidewalks and Walkways

Sidewalks are typically constructed of concrete. They are raised and located adjacent to curbs, or separated from the curb by a linear planting strip. Sidewalk widths can vary, but typically are a minimum of 6 feet wide (clear width) on local residential streets, and 6 to 15 feet, or sometimes wider, on collector and arterial streets, and in special districts.

Figure 3.1

Sidewalk Corridor



In contrast to raised sidewalks, walkways are usually built over the existing ground surface without being raised. Instead of vertical separation by curb and gutter, walkways are usually separated horizontally by a planting buffer or swale. In some cases, extruded curbs or barriers are used to separate a walkway from adjacent street traffic (see Street Separation and Edge Treatments). Walkways are often constructed of materials other than concrete, such as asphalt, compacted granular stone, or crushed rock. Asphalt walkways can be considered interim facilities until concrete sidewalk improvements are built.

Sidewalks and walkways function as integral components of pedestrian-friendly street systems providing pedestrians with safety, comfort, accessibility, and efficient mobility. Sidewalks increase pedestrian safety by separating pedestrians from vehicle traffic. Table 3.5 lists priorities for pedestrians traveling along streets on sidewalks.

Table 3.5

Priorities for Pedestrians Traveling Along Streets
• *Safety and security*
• *Efficient mobility*
• *Defined space*
• *Visibility*
• *Accessibility*
• *Comfortable/ attractive environment*

Walkway along street with planting buffer

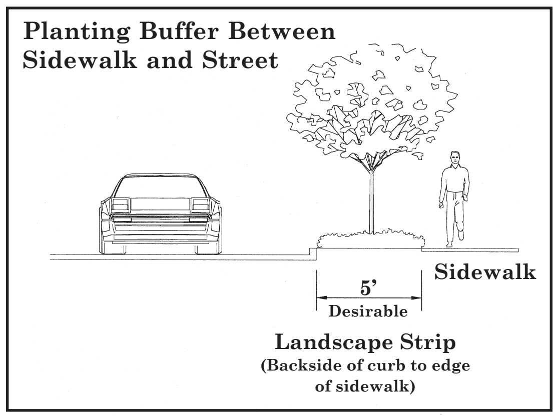
On sidewalks in areas such as downtown and on campus, it is desirable to provide as wide a clear space for pedestrian travel as possible. The pedestrian travel zone on downtown streets or arterial streets typically should be 6 to 10 feet wide or wider in areas where high volumes of pedestrians are anticipated.

Planting Strips and Fixtures

Planting strips consisting of natural vegetation or landscaping create a buffer from the noise and splash of moving vehicles. Planting strips (also referred to as planting buffers, landscape strips or buffers, and nature strips) are generally considered a very effective separation treatment between walkways and streets in all types of settings. The added separation of a planting buffer helps a pedestrian feel more comfortable when walking along the street. Trees and shrubs planted in the strip can provide shade and a cooling effect in the street cooridor. Trees and shrubs in the strip can provide shade and a cooling effect in the street cooridor. Planting buffers can be landscaped in a variety of ways to aesthetically enhance the streetside environment. (See Toolbox Section 10, Desert Vegetation, for more information.)

Planting buffers can be raised and bordered by curbing. They can also be bermed or developed at the same grade level as the roadway. It is recommended that planting buffers be a minimum of 6 feet wide where street trees are proposed. In areas where there is limited space, the width of the planting buffer can be reduced to a minimum of 2 feet in width, and provided again at full width where there is more space or right-of-way available. Figure 3.2 illustrates a planting buffer between a sidewalk and street.

Figure 3.2



Fixtures can also be located in the planting strip. Consolidate utilities, street furniture, and other elements within this zone to minimize obstacles in the pedestrian travel way and improve the visual appearance. Examples of consolidating include putting more than one utility on a pole system or more than one sign on a post, and clustering furnishings within the planting strip or to one side of the primary walking area.

The vertical clearance needed for sidewalks and walkways is typically 8 feet, as illustrated in Figure 3.3. The ADAAG requires that *"objects protruding from walls* *(e.g., signs, fixtures, telephones, canopies) with their leading edge between 27 and 80 inches above the finished sidewalk shall protrude no more than 4 inches into any portion of the public sidewalk."*

Traffic signs located directly adjacent to or within the sidewalk need to be mounted and tree branches need to be pruned high enough so that there is a minimum of 7 feet of clearance from ground level. Informational and directional signs for pedestrians can be lower if located a minimum of 3 feet from the sidewalk. A typical pedestrian travel way, designed to be clear of obstructions, is illustrated in Figure 3.4.

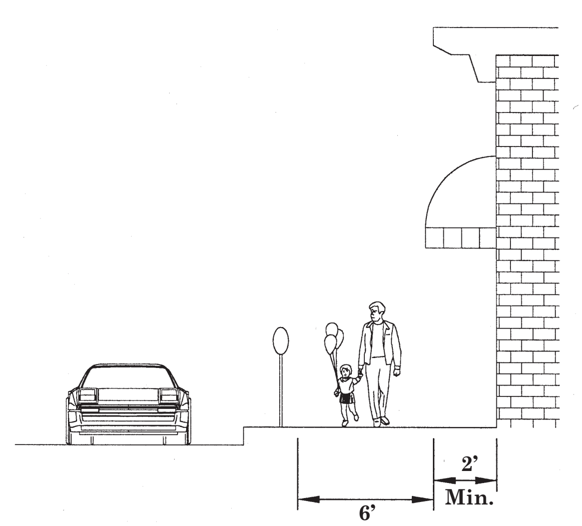
Frontage Zones

The frontage zone is the area where people enter and exit buildings adjacent to the street right-of-way. Frontage zones may be necessary in high traffic areas such as downtown Tempe and the ASU campus.

Many people do not feel comfortable moving at full pace directly adjacent to the building wall in this area, between the primary travel area and the building. It is an area where pedestrians may window shop or move more slowly without restricting other pedestrians. On some streets, the building frontage zone may become a pedestrian plaza, outdoor cafe, or gathering area depending on available space within the right-of-way. For this reason, the building frontage zone can vary in width from approximately 2 to 10 feet or more. At a minimum, people prefer about 2 feet of "shy" distance when walking adjacent to buildings, as illustrated in Figure 3.5.

Figure 3.5

Shy Distance Between Building and Walkway



Recommendations and Dimensions

To ensure adequate room and proper design for each element, sidewalk corridors should be planned at the onset of the design process. Each element has a minimum and a desirable width.

In general, the width of a sidewalk or walkway corridor needs to comfortably accommodate the volume of pedestrians normally using it. In high use areas, such as central business districts and on campus, sidewalk corridors are generally wider to accommodate high pedestrian flows and groups of people traveling in opposite directions. Conversely, when excessively wide sidewalks are located in areas where there are low pedestrian volumes, such as neighborhoods, the expansive pavement and empty-looking sidewalks may seem uninviting. The area exclusively used by pedestrians on the sidewalk, free of protruding objects, should be at least 5 feet wide, the amount of space for two people to pass one another. The desirable minimum width of 6 feet creates a more comfortable width for two wheelchairs passing each

Figure 3.3

Clearances for Sidewalks and Walkways

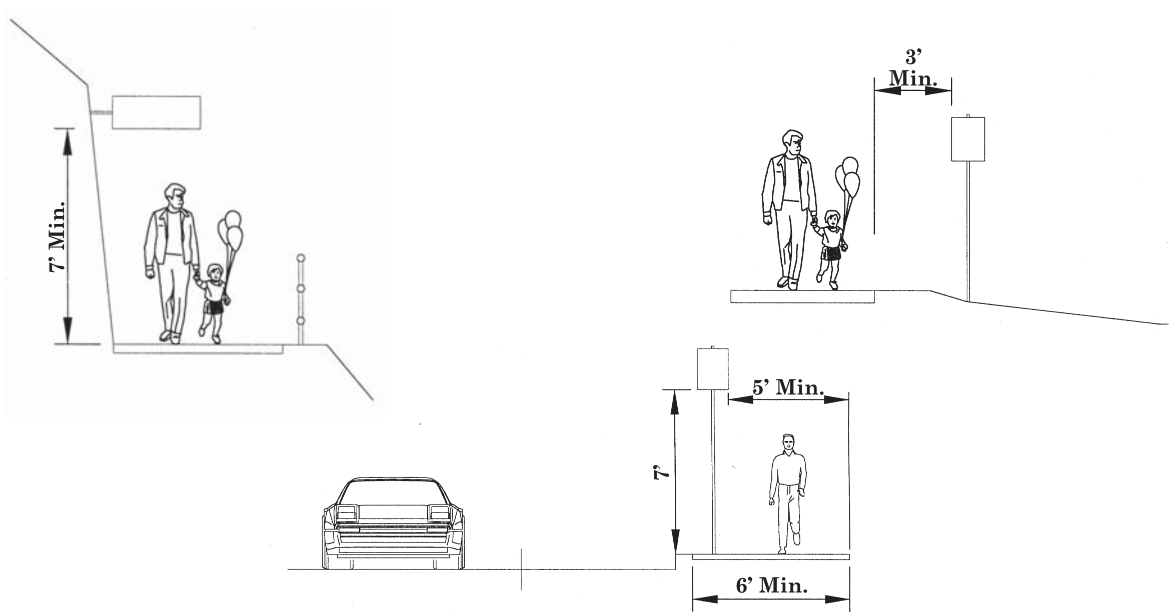


Figure 3.4

Pedestrian Travel Way, Clear of Obstructions

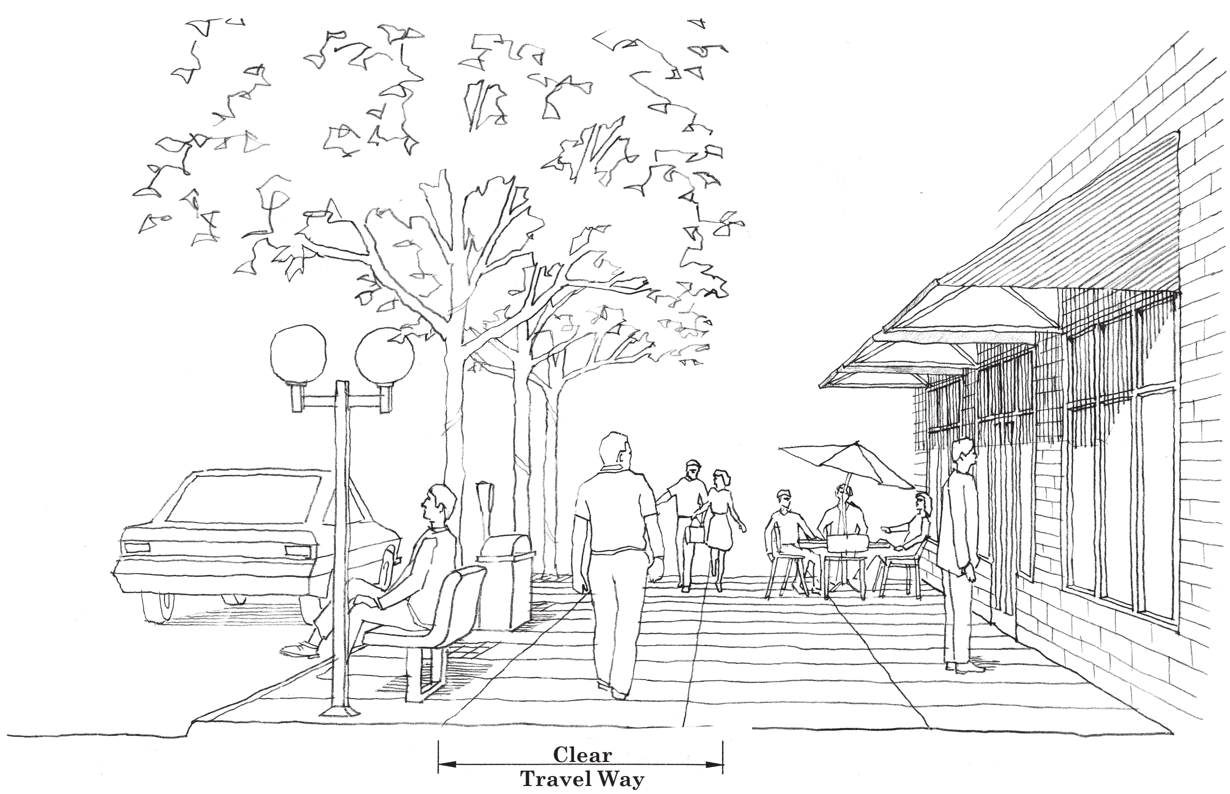


Table 3.6 - Recommended Dimensions for Sidewalks and Walkways

	Principal Arterial	Minor Arterial	Collector	Neighborhood Collector	Local Residential	Commercial Access	Downtown/ Campus
Right-of-way and Roadway Width	110-130 feet 4-6 lanes	84 feet 2 lanes	60 feet 2 lanes	60 feet 2 lanes	50-60 feet	60 feet	100-60 feet
Total Width for Sidewalk Corridor							
Minimum	12 feet	12 feet	12 feet	7-10 feet	5-7 feet	7-9 feet	15 feet
Desirable	18-23 feet	18-23 feet	18-23 feet	10-13 feet	8-10 feet	15-23 feet	20-32 feet
Sidewalk or Walkway							
Minimum	8 feet	8 feet	8 feet	5-8 feet	5-6 feet	5-8 feet	8 feet
Desirable	8 feet	8 feet	8 feet	5-8 feet	5-6 feet	5-8 feet	10-12 feet
Planting Strip/Fixtures							
Without Trees	2 feet	2 feet	2 feet	2 feet	2 feet	2 feet	5 feet
With Trees	5 feet	5 feet	5 feet	5 feet	5 feet	5 feet	5-10 feet
Building Zone							
Minimum	2 feet	2 feet	2 feet	N/A	N/A	2 feet	2 feet
Desirable	5-10 feet	5-10 feet	5-10 feet	N/A	N/A	5-10 feet	5-10 feet

other. Sidewalks should NEVER be less than 3 feet for an accessible route (ADAAG 4.3.3, US Access Board, 1991).

Recommended dimensions for sidewalk and walkway corridors along the different street classifications are set forth in Table 3.6. Dimensional requirements may vary with each project. It is necessary to consider projects on an individual basis to determine the best possible design solutions for pedestrians. For example, on a neighborhood collector that provides a high volume of pedestrian access to a school, park, or other popular destination, it may be appropriate to provide wider sidewalks than recommended in the table.

Curbs

Curbs are vertical barriers separating motor vehicles and pedestrians. Curbs are often required on streets with higher volumes and speeds and where efficiently controlled drainage is a necessity. Curb and gutter or vertical curb are commonly required for urban streets. There are several types of curbs, including curb and gutter/vertical curb, rolled curb, and extruded and timber curbs.

Curb and gutter and vertical curb provide a non-mountable barrier adjacent to street parking that keeps cars from parking on adjacent sidewalks. Curbs can be costly to construct, so they may not be practical to build in all areas. Figure 3.6 illustrates a sidewalk adjacent to curb and gutter, and Figure 3.7 illustrates a vertical curb adjacent to a planting.

Rolled curb is a mountable type of curb design often used in suburban neighborhoods. It provides an advantage to developers in that it eliminates the need for individual driveway cuts. However, rolled curb often presents a problem when used along sidewalks. Since rolled curbs are easily mountable by motor vehicles, drivers often park up on top of the curb and block

Figure 3.6

Sidewalk Adjacent to Curb and Gutter

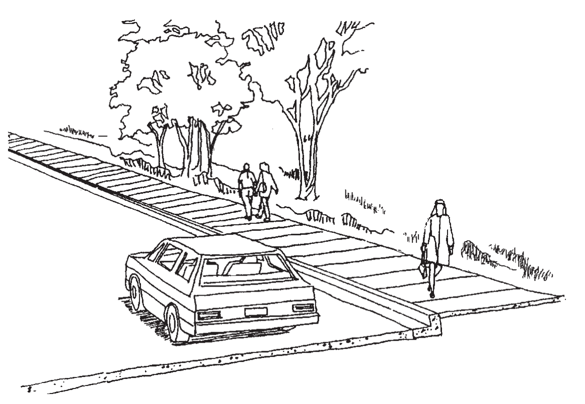
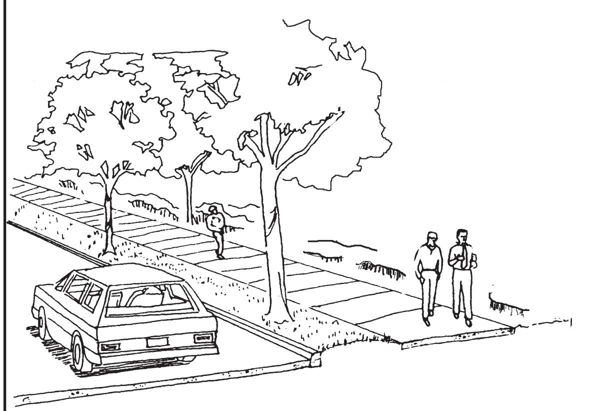


Figure 3.7

Vertical Curb Adjacent to a Planting Strip



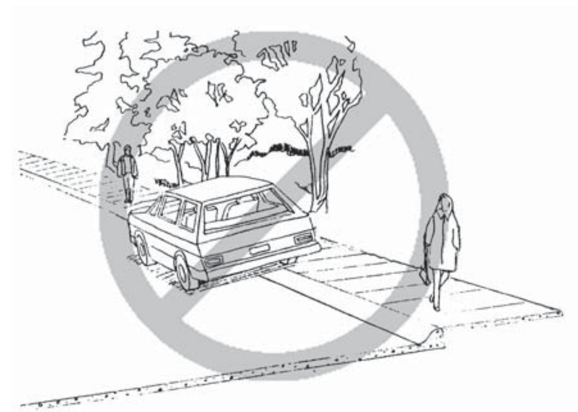
the sidewalk. Additionally, rolled curbs do not provide as strong a barrier as vertical curb between pedestrians and vehicles. Figure 3.8 illustrates a sidewalk with rolled curb.

Bicycles

There are several characteristics that streets and bikeways have to encourage people to bicycle. The degree to which cyclists mix with motor vehicle traffic is a key consideration. While some cyclists are comfortable riding on streets with heavy traffic volumes and high speeds, the majority of adult cyclists are not. The proportion of trucks and large vehicles in

Figure 3.8

Sidewalk With Rolled Curb



Rolled curb is undesirable because vehicles can park on the sidewalk, blocking pedestrian travel.

a traffic stream can also impact cyclists' comfort. Thoughtful street design (e.g., wider streets and special signing and striping) and the development of off-street facilities (e.g., paths) help to address the need to buffer cyclists from traffic and to accommodate the majority of cyclists.

In fact, surveys of non-cyclists suggest that the development of facilities designed with adequate width and buffers is critical in encouraging people to become cyclists.

Another general consideration for the cycling environment is land use. Cycling levels will tend to be higher in areas where different land uses are mixed together to some degree. In addition to breaking the monotony of the view from the bicycle, this pattern will tend to shorten trip distances as more jobs and errands fall into comfortable bicycling distances from residential uses. A related point is that cyclists enjoy bicycling through environments that are active and interesting. When the surrounding sidewalks are filled with pedestrians, sidewalk cafes, and other elements, a lively, more human-scale environment is created.

Bike lanes or a separate path for bicyclists should be provided on arterial roadways to keep the sidewalk clear for pedestrians.

A fundamental design detail for cyclists is that the roadway or path must have a smooth surface. Without suspension, cyclists are more sensitive to bumps in the road. Also, special consideration for cyclists should be made in the construction of utilities in the roadway. Examples of hazards include drainage grates with slots oriented parallel to the road, the creation of a raised edge where the gutter pan meets the actual roadway, and poorly constructed railroad crossings.

While they cannot always be addressed, there are several other aspects of bicycling comfort. Since significantly more physical exertion is required, cyclists typically avoid steep grades. Also, starting from a stop requires much more exertion than maintaining your speed on a bicycle, so routes that require frequent stops are undesirable. In hot climates like Tempe's, shade on the bicycle route is always welcome. Bicycling involves some "self-cooling" because of the breeze generated by traveling at a moderate speed. For this reason, shade is more critically needed at stopping points.

Having widespread bicycle parking is also key to encouraging cycling – particularly for errands and commuting.

Bikeway Design Standards

Dedicated bicycle facilities include four primary types of bikeways: shared roadways, bike routes, bike lanes, and multi-use paths. There has been a national effort to establish consistent design standards. Two manuals set fourth the standards: *The Guide for the Development of Bicycle Facilities* by the American Association of State Highway and Transportation Officials (AASHTO) and the *Manual on Uniform Traffic Control Devices (MUTCD)* by the Federal Highway Administration (FHWA). There is no overlap in the material – the AASHTO manual is concerned with the geometric design of the facilities (bikeway width, grades, etc.), while the MUTCD manual is concerned with signing and pavement markings for the facilities.

The City of Tempe adopted the AASHTO and MUTCD standards for the design of bikeways. The Bicycle Plan element of the Tempe Comprehensive Transportation Plan provides guidance on what type of bikeway is appropriate for different situations. Highlights from the bikeway design standards found in the AASHTO and MUTCD manuals follow.

Shared Roadways

These facilities consist of general traffic streets that have been built with extra width in the outside curb lane for bicyclists. While any curb lane width greater than 12 feet is considered wide, to truly accommodate bicyclists the lane width should be 14 feet. AASHTO also provides recommendations on special conditions where a width of 15 feet is more appropriate. Wide outside curb lanes are the only on-street bikeways that are not designated as such by signing or pavement markings. Each of the established wide outside curb lanes are indicated on the City of Tempe Bikeway Map, a free publication.

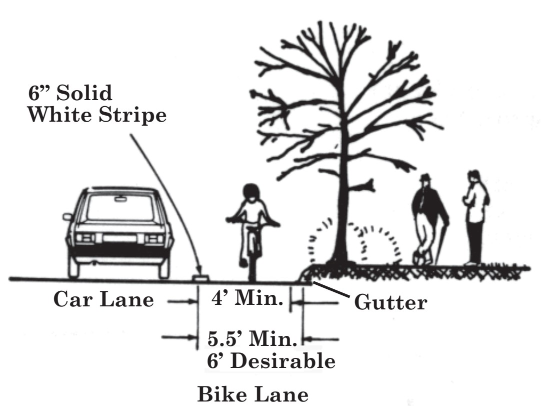
Bike Routes

Bicycle facilities as shown in Figure 3.9, are referred to as "Signed Shared Roadways" in the AASHTO manual. They are simply wide outside curb lanes that also have street signs designating them as a "Bike Route" (Figure 3.10) The addition of a sign is warranted when:

- The route connects two bike facilities such as bike lanes and multi-use paths;
- High levels of bicycling occur on the route; and
- The route serves neighborhood destinations such as parks, schools, community centers, etc.

Figure 3.9

Bicycle Facilities in the Roadway



CURBED STREET WHERE PARKING IS PROHIBITED

Source: Arizona Bicycle Facilities Planning & Design Guidelines

Figure 3.10

The MUTCD provides specifications the sign styles and placement on bike routes in Part IX – Bicycle Facilities.

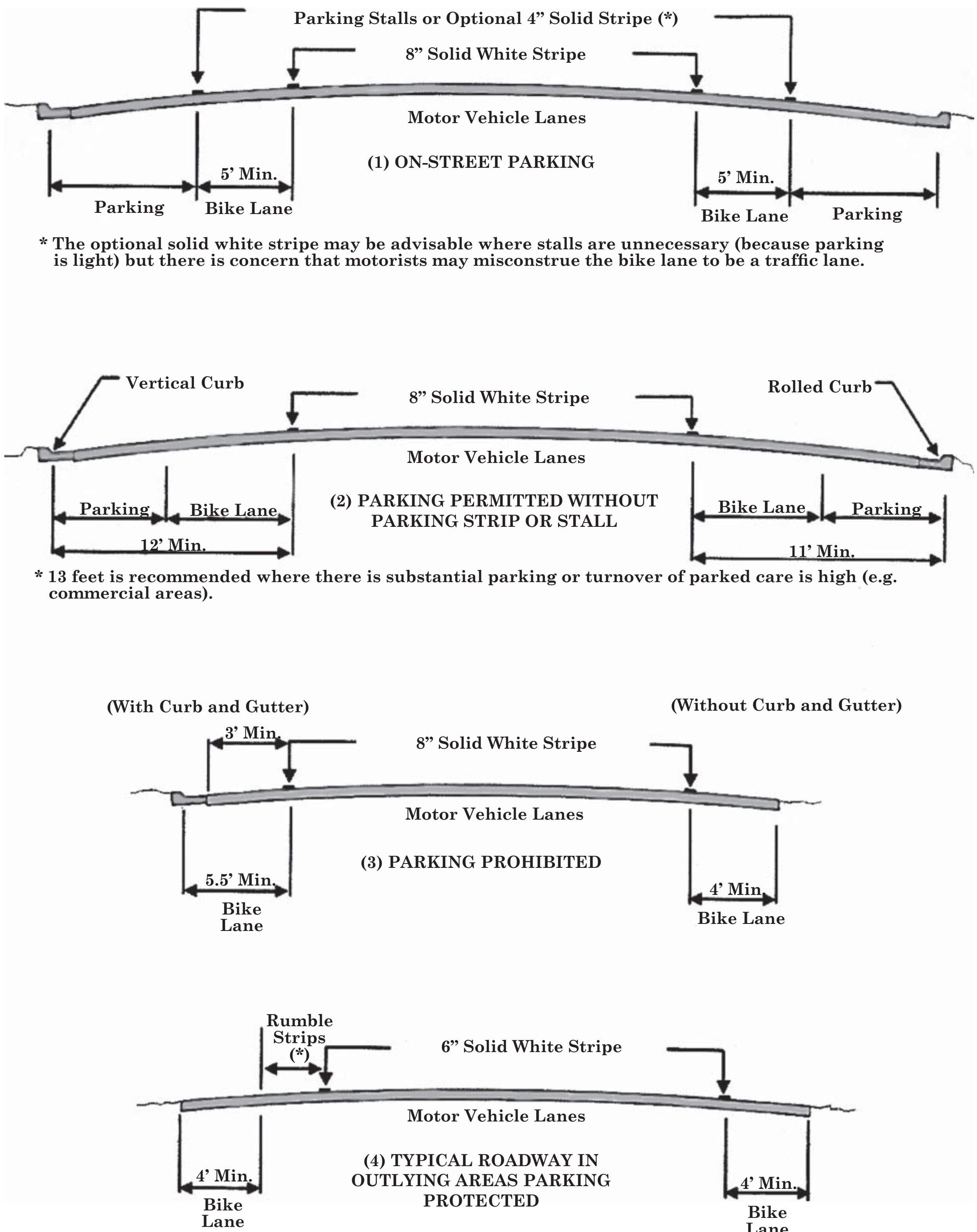
Bike Lanes

Bike lanes are special lanes striped on the right side of a street for the exclusive use of bicyclists. Periodic street signs that clarify the fact that the lane is a dedicated bikeway accompany the striping and marking. Bike lanes enhance the comfort of bicyclists sharing a street with high volumes and speeds of motor vehicle traffic.

Figure 3.11 illustrates the varied options for bike lane designs. When on-street parking exists on streets with bike lanes, the bike lane should be placed between the parking and the motor vehicle traffic lanes and should have a minimum width of five feet. If no stripe or stall markers are used between the bike and parking lanes, the minimum width of the combined lane should be 12 feet to a curb face or 11 feet if there is no curb face (rolled curb). Where parking is prohibited, the bike lane should be a minimum of 5.5 feet in width measured to the curb face. The AASHTO manual should also be consulted for bike lane design options at intersection approaches that include a right turn lane for motor vehicles.

Figure 3.11

Typical Bike Lane Cross Sections



* If rumble strips exist, there should be 4' minimum from the rumble strips to the outside edge of the shoulder.

Source: Guide for Development of Bicycle Facilities (AASHTO)

Multi-Use Paths

These facilities, referred to as "Shared Use Paths" in the AASHTO manual are off-street bikeways that may follow canals or utility easements or may pass through a large park. As the name implies, multi-use paths are generally shared with other user groups – primarily with pedestrians, but also with in-line skaters, runners, etc. (See Figure 3.12.)

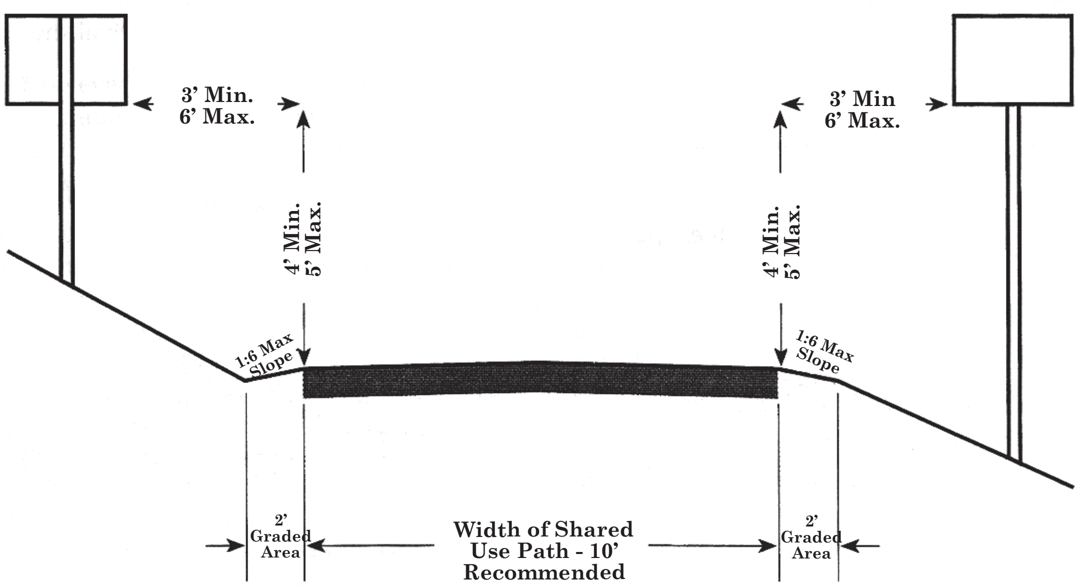
The Tempe Multi-Use Path Plan identifies several such projects. The plan also adopts AASHTO standards for paths, which are summarized here. When a multi-use path follows a roadway, it requires a significant barrier (physical barrier or lateral separation) from the roadway. Ten feet is the minimum recommended width for a multi-use path. AASHTO lists several conditions under which greater width should be considered, including high-traffic areas, steep grades, and sharp turns. While a vertical clearance (at path underpasses) of 10 feet is desirable for sight distance, clearances as small as 8 feet can be tolerated. Rather than specifying a maximum path grade, the AASHTO manual contains a table identifying the maximum distance for steep grades: the steeper the grade, the shorter the distance. The manual also contains formulas for vertical and horizontal curves in the trail alignment. These formulas set minimum standards for allowable sight lines at tight curves.

Bicycles on Sidewalks

Tempe currently allows bicycling on sidewalks, because bicyclists sometimes do not prefer traveling at the street edge. However, bicycling on sidewalks can be hazardous due to the different speeds of bicyclists and pedestrians. A classic

Figure 3.12

Cross Section of Two-Way Shared Use Path on Separated Right-of-Way



Source: Guide for the Development of Bicycle Facilities (AASHTO)

example is in a sidewalk in storefront environment. Pedestrians stepping out of buildings directly onto the sidewalk have little opportunity to see an oncoming cyclist. Similar conflicts can occur on sidewalks with high-traffic driveways, where motorists may have difficulty seeing a fast-moving bicyclist while pulling into or out of a driveway. For these reasons, bicycling on sidewalks in Tempe should be prohibited in certain high pedestrian volume areas (e.g., Mill Avenue) and avoided whenever possible. In areas where bicycles are prohibited on sidewalks, proper signing warning bicyclists is needed.

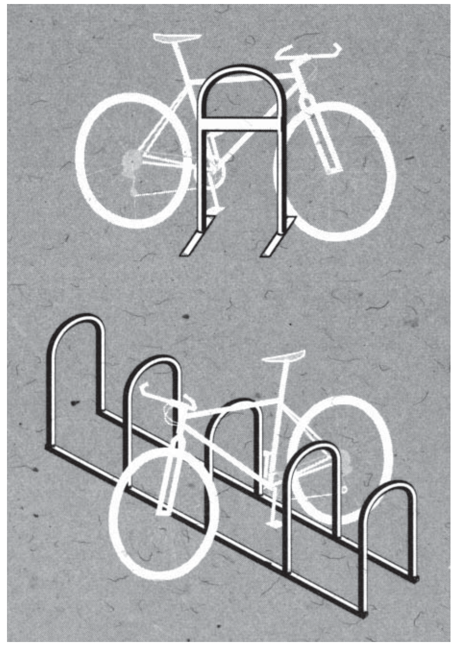
Bicycle Parking

The Tempe Zoning Code requires bicycle parking in all new commercial, institutional, and multi-family developments. While the zoning code specifies the number of bike parking spaces, the pamphlet “Bicycle Racks: A Guide to City of Tempe Requirements” contains detailed information and illustrations on the design of bike racks (Figure 3.13). Bike racks should:

- support the frame of the bike;
- allow at least one wheel along the frame to be locked to the rack to discourage theft;
- allow the cyclist the option of using either the popular U-lock or a cable/ padlock; and
- be easy to understand without instruction.

These are important criteria. Several widely available models of bike racks prohibit locking the frame because they only support the front wheel. In this situation, the wheel can be bent or the frame can be detached. Other racks have been designed with good intentions, but it

Figure 3.13
Preferred Bicycle Racks in Tempe



is not clear to casual cyclist how they are to be used. Bicycle parking should be located close to primary building entrances. An overhead covering above parking areas is a welcome amenity.

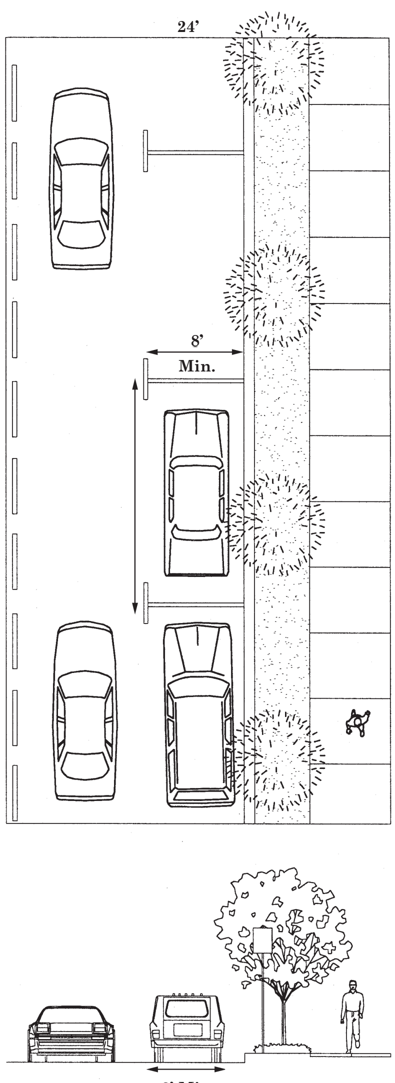
On-Street Parking

On-street parking provides a buffer zone between the roadway and the sidewalk. It also narrows the street, which tends to reduce vehicle speeds. On-street parking allows people to access the sidewalk directly from their vehicles and increases street activity. For these reasons, on-street parking is often supported in business and shopping districts, neighborhoods, and other high activity areas. Figure 3.14 illustrates how on-street parking provides a buffer between street traffic and pedestrians.

On-street parking may present problems when there is not enough space for people to safely get out of their cars or walk between cars. On roadways where there are no adjacent pedestrian facilities or undelineated crossings, parking is not desirable because pedestrians may be forced to walk in the roadway to get to their destination, or they may cross at several points along the roadway. A common cause of collisions is the lack of visibility of pedestrians entering the roadway from between parked cars. Informal on-street parking adjacent to a park or ball field is hazardous due to the high numbers of children who are not paying attention to traffic conditions.

Figure 3.14

On-Street Parking as a Buffer Between Street and Pedestrian Walkway



When on-street parking is provided, adjacent pedestrian walkways and clearly identified street crossing points are also necessary. On-street parking or loading zones that are too close to intersections and mid-block crossings can block views of pedestrians. Parking areas should be set back from intersections and crossings to allow pedestrians to see oncoming traffic, to enhance visibility.

The *ITE Design and Safety of Pedestrian Facilities* recommends:

- restricting parking within 50 feet of all intersection and mid-block crossings where the speed of travel is 35 to 45 mph and within 100 feet of crossings on streets where the speed of travel is above 45 mph;
- a setback of less than 50 feet in central business districts, downtowns, or other areas where travel speeds are typically slower and at signalized intersections or crossings; and
- a setback distance of 100 feet may be appropriate:
  - near schools where many children are crossing;
  - at intersections or crossings that are not signalized;
  - on roadways where travel speeds exceed 35 mph; and
  - on roadways with elements that affect sight and stopping distances (curves, bridges, vegetation, etc.).

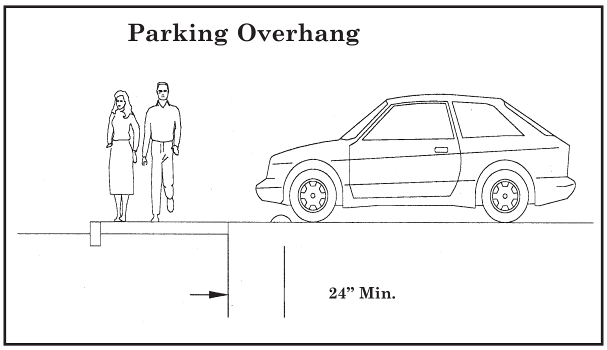
When perpendicular parking stalls are located adjacent to sidewalks, wheel stops or curbing should be constructed to eliminate vehicle overhangs that reduce usable sidewalk area. Figure 3.15 illustrates this treatment.

Curb extensions (bulb-outs) at intersections and crossing points provide space for pedestrians to stand in better view of approaching vehicles, and on-street parking can be placed closer to the crossing point without affecting visibility of pedestrians.

Access Management

Most pedestrian/motor vehicle collisions occur on busy streets, intersections, driveways, and alleys. Unlimited vehicle access on roads increases the level of conflicts between pedestrians walking along the roadway and cars entering or leaving the roadway. Pedestrians crossing the roadway need gaps in the traffic stream, but with unlimited access, vehicles entering the roadway quickly fill the available gaps. Pedestrian access to transit may also be complicated by excessive driveway access points, creating obstacles on the way to the bus stop.

Figure 3.15



There are several access management techniques including:

- reducing the number of existing driveways and consolidating driveways of parking areas and businesses; and
- providing raised or landscaped medians or concrete barriers to control turning movements from the street.

Good access management benefits the pedestrian because:

- conflict points are reduced;
- crossing opportunities are enhanced;
- accommodating people with disabilities is easier; and
- improved traffic flow may reduce the need for road-widening, allowing more space within the right-of-way for use by pedestrians, bicyclists, and enhancements, and maintaining fewer travel lanes to cross at intersections.

Figure 3.16 illustrates how controlled access and limited driveways reduce conflict points between pedestrians and motorists.

Good design can minimize conflicts where driveway and walkways intersect. Refer to Section 9, Site Design.

Furnishings and Utilities

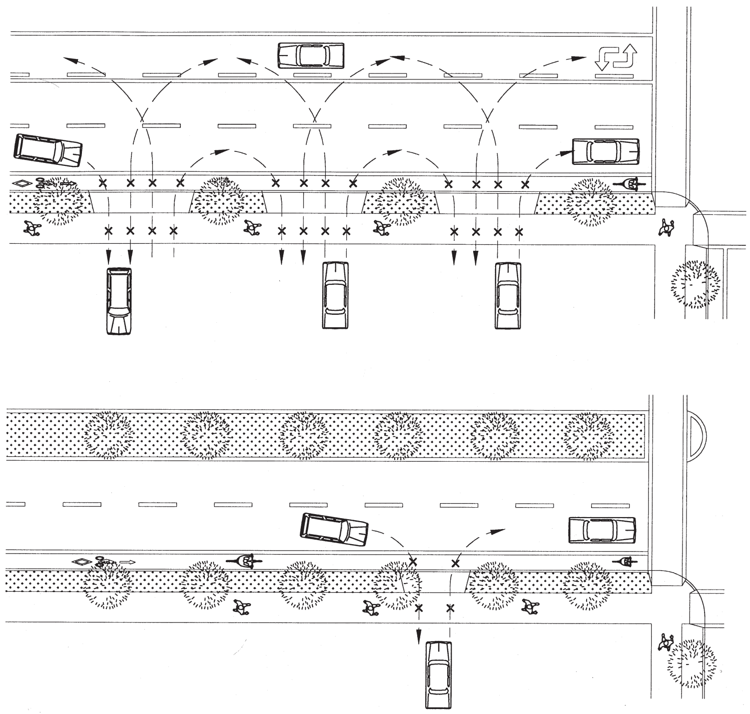
Urban streetscapes should be carefully designed in order to provide adequate space for furnishings and utility facilities. A clear travel way of three feet minimum is required on sidewalks, walkways, and all accessible routes of travel. Where pedestrian volumes are moderate to high, this clearance should be increased. Obstacles, such as signs, street furniture, and newspaper stands, should be placed off to the side of the travel way, in the "fixtures/planting zone," as discussed earlier in this Section. Figure 3.17 shows how a planting zone can also be used for utilities.

Landscaping and Street Trees

Landscaping and street trees in planting buffers and along streets can greatly

Figure 3.16

Access Management



Excessive access points require pedestrians to cross ingress/egress traffic often, increasing chances for conflict and disrupting efficiency of travel and enjoyment/comfort of walk.

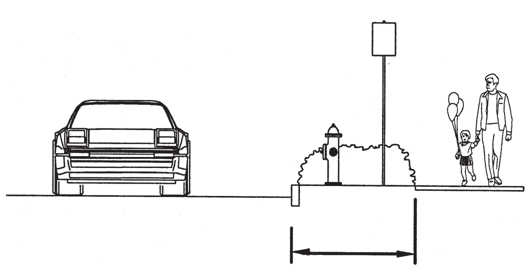
Reducing the number of access points improves safety and comfort for pedestrians.

Source: Adapted from Oregon Bicycle and Pedestrian Plan

enhance the pedestrian environment and provide shade and shelter. Careful thought needs to be given to the selection of trees and shrubs installed. Guidelines related to landscaping adjacent to pedestrian facilities are provided in Section 10, Desert Vegetation.

Figure 3.17

Planting Strips Provide Space for Signs, Utilities, and Street Furnishings



Lighting

Lighting of the street, including adjacent sidewalks, walkways, and bike lanes, increases security and pedestrian safety and comfort. Typically, the street lighting system in urban areas sufficiently serves pedestrian sidewalks and walkways along the street.

When introducing a new lighting system to replace or supplement the existing street lighting, incorporate light posts and fixtures that are pedestrian friendly (shorter and more in scale with pedestrians, with less obtrusive and harsh light sources). Additional lighting may be necessary at pedestrian crossing points, intersections, entrances to buildings.

Provide between 0.5 and 2.0 footcandles of light along pedestrian travel ways, depending on conditions. A minimum intensity of 1 foot candle is required on the surface of accessible routes of travel. Refer to Tempe's *Engineering Design Criteria* for specific requirements. Also refer to *Crime Prevention Lighting Guidelines* for determining light levels for pedestrian areas.

Other Sources of Information

The following sources of information are recommended for design of pedestrian and bicycle friendly streets. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

MAG Pedestrian Plan, 2000

MAG Pedestrian Design Guidelines, 2001

A Guidebook for Student Pedestrian Safety, Final Report, KJS Associates Inc.

A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials

A Working Approach to Accessibility in Public Rights of Way, Montana Department of Transportation

Accessible Sidewalks: A Design Manual, US Architectural and Transportation Barriers Compliance Board (The Access Board)

Accessibility Design for All, An Illustrated Handbook, 1995 Washington State Regulations, Barbara L. Allan and Frank C. Moffett, AIA, PE

Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling, Richard K. Untermann

Americans With Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; State and Local Government Facilities; Interim Final Rule, Federal Register, Part II, Architectural and Transportation Barriers Compliance Board

"Boulder Brings Back the Neighborhood Street," John Fernandez, *Planning*

City Comforts, How to Build An Urban Village, David Sucher

City, Rediscovering the Center, William H. Whyte

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Design Guidelines, Building/Sidewalk Relationships, Central Business District, City of Bellevue

Effects of Site Design on Pedestrian Travel in Mixed-Use Medium Density Environments, Anne Vernez-Moudon, PhD

Engineering Design and Development Standards, Snohomish County Public Works

Great Streets, Allan B. Jacobs

Handbook of Landscape Architectural Construction, Volume Two, Site Works, Maurice Nelischer

Handbook for Walkable Communities, Washington State Pedestrian Facilities Planning and Design Courses, Dan Burden and Michael Wallwork, PE

Bike lane on 5th Street in Tempe

Livable Neighborhoods: Rethinking Residential Streets, American Public Works Association and the University of Wisconsin-Madison

Livable Streets, Donald Appleyard

Manual on Uniform Traffic Control Devices for Streets and Highways, 1988 Edition, US Department of Transportation

Making Streets That Work, City of Seattle

Pedestrian Malls, Streetscapes, and Urban Spaces, Harvey M. Rubenstein

Planning and Implementing Pedestrian Facilities in Suburban and Developing Rural Areas Research Report, S.A. Smith, K.S. Opiela, and L.L. Impett

Planning Design and Maintenance of Pedestrian Facilities, Goodell-Grivas, Inc.

Public Streets for Public Use, Anne Vernez Moudon

Reclaiming Our Streets, Traffic Solutions, Safer Streets, More Livable Neighborhoods, Community Action Plan To Calm Neighborhood Traffic, Reclaiming Our Streets Task Force

Redevelopment for Livable Communities, Washington State Energy Office, the Washington State Department of Transportation, the Department of Ecology, and the Energy Outreach Center

Residential Streets, American Society of Civil Engineers

Sharing Our Sidewalks, Ensuring Access in Portland's Shopping and Commercial Districts, Metropolitan Human Rights Commission

Sidewalk and Curb Ramp Design, Governor's Committee on Concerns of the Handicapped

Streets for People, A Primer for Americans, Bernard Rudofsky

The Car and the City, 24 Steps to Safe Streets and Healthy Communities, Alan Thein Durning

Time-Saver Standards for Landscape Architecture, Design and Construction Data, Charles W. Harris

Designing Sidewalks and Trails for Access – Best Practices Design Guide

ACCESS TO TRANSIT

4

This Section Addresses:

- *Transit Streets*
- *Transit Compatible Design*
- *Improving Transit Facilities for Pedestrians*
- *Transit Stops and Bus Pullouts*
- *High Capacity Right-of-way Transit*
- *Transit Centers*
- *Park-and-Ride Facilities*
- *Transit-Oriented Development*
- *Coordination Between Agencies*
- *Other Sources of Information*

Transit includes several types of transportation modes, including public bus services, commuter and light rail lines, van pools, subways, and monorails. Expanding access to transit and improving transit facilities are complementary to promoting pedestrian travel as an alternative transportation mode.

Pedestrian and transit travel work well together. Every transit trip begins and ends with pedestrian travel. Good pedestrian facilities often make the trip to transit stations or stops more enjoyable. All transit facilities and the transportation routes that lead to them need to be safe, convenient, and accessible in order to create an active and successful pedestrian system. If people do not feel safe or comfortable walking to transit stops, then they are likely to choose other modes of travel, such as a car. Fewer cars contribute to a pedestrian-friendly community.

This section discusses design practices that promote and enhance transit access for pedestrians and improve conditions at transit facilities, encouraging both transit use and higher levels of walking. The focus of this section is not on overall design of transit facilities, but rather on the specific design of features and facilities that enhance pedestrian access to transit. Refer to the list at the end of this section for other useful documents.

Many of the design guidelines suggested in this section are a summary of current practices throughout the United States. Consult Valley Metro to verify specific local requirements for boarding pads, bus stop locations, and other important design criteria that may be unique to the local transit authority.

Transit Streets

The City of Tempe has designated various arterials as “transit streets.” Please refer to Toolbox Section 3, Friendly Streets and Sidewalks for more information.

Increasing access to transit will increase transit use.

Transit Compatible Design

Site and building design should provide transit compatible features. Figure 4.1 is an example of how a suburban office park was converted to mixed use and improved for better pedestrian access to transit.

Improving Transit Facilities for Pedestrians

The success of transit as a mode of transportation is highly dependent upon good pedestrian access. People with disabilities (including people who use wheelchairs or are sight-impaired) often rely on transit as their primary source of transportation, and transit facilities need to be designed to meet their needs. Some important design guidelines improve access to transit facilities.

- Provide adequate sidewalks and walkways on streets with bus routes.
- Design sidewalks that access transit with a minimum of 6 feet in width, enabling 2 adults to walk comfortably side-by-side and 2 wheelchairs to pass. In urban areas, where street furnishings, parking meters, sign posts, and other elements clutter the sidewalk, the desirable minimum width is 10 feet.
- Provide a landing pad at bus entrances and exits as required by ADA. The width of this landing area will vary, but it must be a minimum of 9 feet wide. The desirable width is 10 feet to 15

Figure 4.1

Transit Compatible Objectives
(Retrofitted Mixed-Use Residential and Office Complex in Suburban Setting)

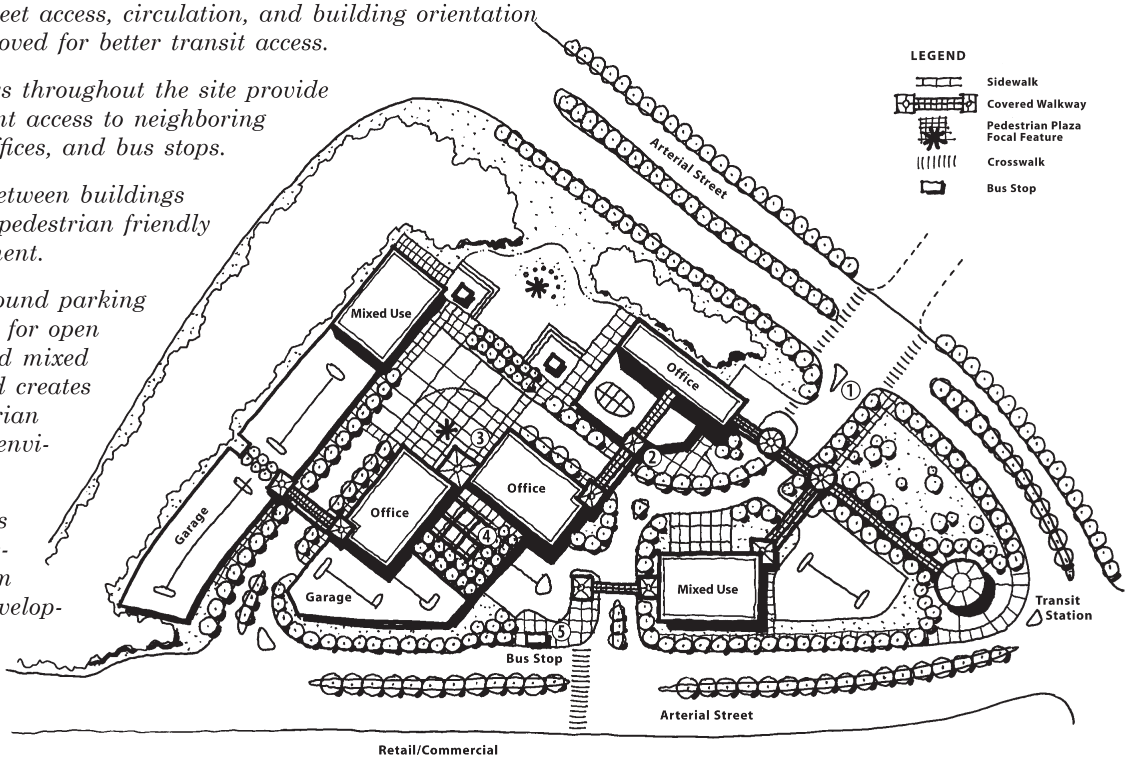
1 Local street access, circulation, and building orientation are improved for better transit access.

2 Walkways throughout the site provide convenient access to neighboring stores, offices, and bus stops.

3 Plazas between buildings create a pedestrian friendly environment.

4 Underground parking frees site for open space and mixed uses, and creates a pedestrian friendly environment.

5 Bus stops are accessible from entire development.



Source: A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts feet wide typically measured from the curb in the direction of getting on or off the bus. The length of the landing pad (measured parallel to the street) will vary, but typically ten feet is desirable to provide sufficient area for boarding and deboarding. It may be desirable to build a continuous sidewalk along the entire length of the bus stop, rather than try to predict where the landing should be located. Buses may not stop in the exact location each time. Refer to Figure 4.2 for an illustration of a widened bus loading area. Figure 4.3 illustrates a typical bus stop cross-section.

Figure 4.2

Widened Sidewalk in Bus Loading Area

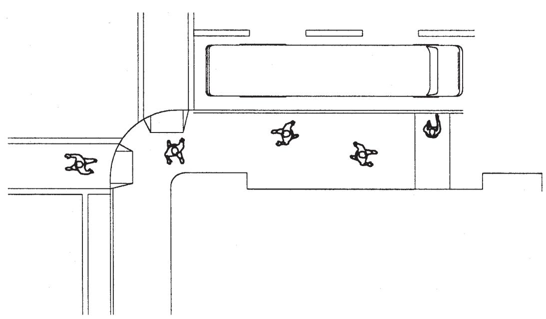
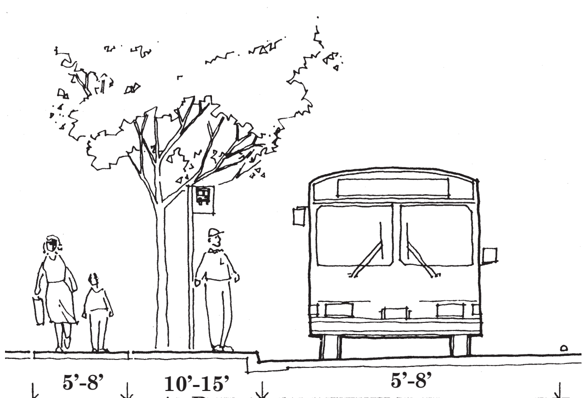


Figure 4.3

Typical Bus Stop Cross-Section



Source: A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts

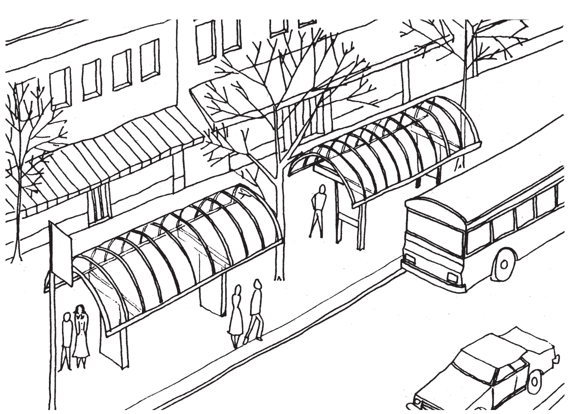
- Design secure, open, inviting, well-lit, and easily accessible waiting areas at light rail and transit stops.
- Encourage transit use by providing shortcuts that reduce the distance a pedestrian must walk. Bridges over streams, paths through parks and neighborhoods, and walkways that connect to dead-end streets can provide expanded access opportunities for pedestrians.
- Provide well-lit access ways to transit facilities. Transit riders often commute to work or school in early morning and late afternoon and evening hours.
- Coordinate pedestrian signals and other traffic control devices with timings that allow pedestrians sufficient time to comfortably cross the street to reach the transit station or bus stop.
- Improve pedestrian mobility and transit function by providing separate spaces for those waiting, passing through, transferring between buses, and queuing to board and deboard.
- Locate bus stops to encourage safe crossing of streets at designated locations.
- Provide good visibility and clear lines of sight at pedestrian crossings near at-grade light rail and commuter stops.
- Create space directly adjacent to bus loading areas that is free of street level obstacles. Street furnishings such as benches, pay phones, light posts, shelters, kiosks, and garbage receptacles should be set back a minimum of 8 feet from the curb where adequate space is available. Where space is not available, provide 3 feet of lateral clearance required by the ADA.
- Maintain open sight lines between the bus operator's view and the passenger waiting

and loading areas. Shelters should be constructed with windows or transparent materials to provide a view of waiting passengers. The recommended minimum height clearance for all signs in the bus stop zone is 7 feet from the bottom of the sign to ground level. Overhanging tree branches need to be at least 8 feet above the ground.

- Provide open zones that promote visibility for users to increase personal security.
- Provide shelters and covered structures where feasible to protect passenger waiting areas from wind, sun and precipitation (see Figure 4.4).
- Provide accessibility for people with disabilities by installing curb cuts, ramps, detectable warning features, and clearly delineated pedestrian spaces.
- Reduce risks of slipping and falling by providing paved surfaces with good traction. Pavement texture and color can also be used to communicate function and spatial relationships for the visually impaired.
- Install street furniture that is durable, comfortable, and vandal resistant.

Figure 4.4

Bus Shelters and Covered Structures



Source: A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts

- Consider aesthetics and maintenance requirements in the initial design phase, rather than as an afterthought.

Transit Stops and Bus Pullouts

Transit stops and bus pullouts or zones provide designated space for loading and unloading passengers. A bus bay length accommodating one bus is normally from 40 to 80 feet in length, and maybe longer in business districts with high levels of use. Bus pullouts and loading zones accommodating multiple buses can be much longer. Bus stops can be as simple as a sign and a pullout area, designated space at the curb, or shoulder for the bus to stop. Or they may include shelters, benches, and other furnishings.

There are three choices for location of bus stops: near-side, far-side, and mid-block. Near-side stops are located on the approaching side of an intersection in relation to the direction of travel. Far-side stops are located on the departing side. Mid-block stops are not close enough to an intersection to be affected by the intersection. Far-side stops are generally more desirable than near-side stops from the perspective of the pedestrian, but near-side stops can be successfully designed to adequately accommodate pedestrians.

The following recommendations apply to bus stops and pullouts.

- Provide a minimum 4-foot wide clearance zone measured perpendicular to the curb, so that opening bus doors are not blocked by street furnishings, sign posts, landscaping, or other obstructions.
- Provide 9 feet of clearance from the curb for wheelchair lift operation (4 feet

for the lift to extend and 5 feet for the wheelchair to maneuver beyond the lift.) The ADA requires a minimum width of 3 feet for accessible routes of travel, but path widths adjacent to transit should be wider to accommodate wheelchair lifts, as well as groups of pedestrians. In high use urban areas, a 10- to 15-foot minimum is preferable.

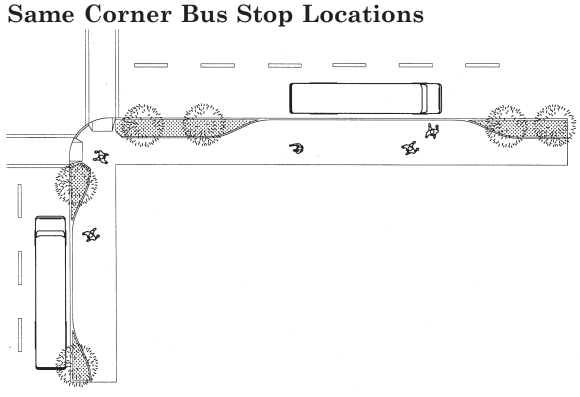
- Provide open sight lines and avoid placing shelters, furnishings, and vegetation that may obstruct driver and waiting passenger views.
- Shelters should be well-lit and constructed of materials that do not obstruct views out of or into the shelter.
- Sidewalks should be provided within designated bus zones with a landing area for wheelchair access to transit services.
- Transit riders need to be able to cross the road safely at transit stops. On a typical two-way street, with residences and development on both sides, half the riders will need to cross the road when boarding or exiting the bus. Mid-block crossing facilities should be provided at mid-block bus stop locations. See Toolbox Section 6, Intersections and Crossings for discussion on mid-block crossings.
- Curb heights should never be higher than the height of the bus step to prevent falls during passenger boarding and departing. Older buses tend to have a bottom step that is 14 to 18 inches above the roadway. Newer buses can have bottom steps as low as 11 inches above the roadway.
- On streets with parallel parking, users of near-side bus stops can benefit from elongated curb bulb-outs that provide passengers adequate area to board or exit the bus without having to step into the street or the stream of pedestrian travel on the adjacent sidewalk.
- Bus stop design should avoid conflicts with other types of uses. For example, bus stops should not interrupt bike lanes, and waiting areas and shelters should be provided to the side of the walkway so that pedestrians can pass passengers waiting to board.
- When there is a planting strip directly adjacent to the curb, provide a sidewalk slab that extends from the existing sidewalk to the curb so that passengers do not have to cross wet grass or mud during inclement weather.
- Avoid locating bus stops where there are curbs of varying heights.
- Strategically locate bus stops to minimize crosswalk movements of transferring passengers where transfer movements between bus routes are heavy. For heavy transfer movements, locate bus stops on the same corner of an intersection so users are not required to cross the street (see Figure 4.5).
- Transit stops should include sheltered, visible, and comfortable seating areas and waiting spaces set back from the walkway. Protection from sun and wind are important considerations.

Providing space for shelters and waiting areas is essential.

• Bus pullout locations are often warranted for heavy traffic conditions. When pullouts are located near intersections, a far-side location is preferred. The needs of the passengers boarding and exiting the bus should not conflict with the needs of pedestrians and bicyclists moving through the area. Curb bulb-outs at the intersection help pedestrian crossing movements, prevent motorists from entering the bus pullout area, and reduce conflicts with bicyclists traveling through. Pullouts should be designed to meet roadway conditions and bus characteristics. Configurations of pullouts should allow buses to pull up directly adjacent to the curb.

Figure 4.5

Same Corner Bus Stop Locations



High Capacity Right-of-Way Transit

Tempe is currently constructing Light Rail Transit (LRT) stations. The station platform area will be approximately 16 feet wide by 300 feet long for passengers boarding or exiting trains in either direction. Stations will be located in the center of the street, and passengers can access the stations from a lighted intersection. The station entry area will have ticket vending machines. Stations will also have shade canopies, louvered panels to provide additional shade, seating, route maps, timetables, drinking fountains, public telephones, garbage containers and landscaping. They will also be well lit to enhance passenger security. All stations will be designed for accessibility in compliance with the Americans with Disabilities Act (ADA).

A document produced by the Central Phoenix/East Valley LRT Project called *Urban Design Elements* outlines design standards for elements in and around the LRT stations. These elements will "positively affect the user's experience and the system's community-image" (*Urban Design Elements*, 2001). Below is a list of the elements that can enhance the surrounding neighborhoods and provide safety for pedestrians near or at high-capacity transit stations.

Landscape

Landscaping around transit stations provides a visually pleasing environment and shade relief from the heat. Distinctive plants should be used to identify the stations as landmarks. Plants that represent the local and natural environment should be also be encouraged. Trees that will provide maximum shade should be planted around the station. Transit authorities should seek partnerships with surrounding businesses and/or neighborhoods to create small gardens or parks to enhance the pedestrian environment around stations.

Adjacent Activity Areas

The adjacent activity area is defined as the curb side transition space for transit riders arriving both center (median) and side (curbside) by foot or by drop-off from buses or private vehicles. These areas should be designed as "park-like" spaces that provide decorative plants, fountains, art opportunities, drinking fountains, information kiosks, LRT arrival and departure information and "sociability" opportunities such as shaded seating areas. The activity area should also accommodate linkages to existing community amenities, provide sufficient bicycle parking and storage facilities, and provide space for outdoor food vendors. The design of this area enhances the pedestrian environment and encourages use of the transit system.

Bus Connections

Highly efficient, comfortable, and convenient intermodal transfer connections between buses and high capacity transit are vital to the success of the entire integrated system. High capacity transit agencies should work with bus agencies to relocate bus stops, if necessary, to decrease walking time for pedestrians using both modes of transportation. Bus stops should also be positioned to minimize street and driveway crossings to increase pedestrian safety. Pedestrian flow between high capacity transit and bus stops should be projected to help determine walkway widths.

Signs

Wayfinding, directional and identification signs will help direct pedestrians to stations from bus connections, park and ride lots, adjacent pedestrian areas, major neighborhood intersections, and key cultural, educational, and recreational facilities. Regulatory and safety signs will encourage safe pedestrian activity in and around transit stations.

Lighting

Lighting should provide a safe and secure experience for pedestrians. Lighting should be designed to be at a pedestrian-level and scaled appropriately to canopies and the pedestrian level of activity. Shadows and low light should be minimized to decrease the potential for hiding places.

Transit Centers

Transit centers provide an area for transit line buses on two or more routes to come together at the same time for transferring riders and as points of origin and destination. Transit centers should be sited to optimize pedestrian access to major activity centers, such as downtown Tempe and ASU. Transit centers can also promote transfer connections between different transportation systems. Because they are highly visible facilities within the community, transit centers help increase public awareness of the availability of transit service. Both off-street and on-street transit centers can be developed, depending on the space requirements, street traffic volumes, passengers within walking distance, and other factors.

Transit centers function best when designed to meet the demands of peak user levels. Platform space needs to be adequate to accommodate all pedestrians, including those who are waiting, queuing, or simply walking up and down the sidewalk or platform. A common rule of thumb for determining space requirements for platform areas is 10 square feet per person, using the peak pedestrian volume anticipated.

The most important element of design for transit centers is minimizing circulation conflicts between buses, pedestrians, bicyclists, light rail vehicles, and autos. Pavement delineation with texture, color, or striping helps to identify spaces that are for exclusive use by pedestrians. Buffering

Transit centers help increase public awareness of the availability of transit service.

techniques with planter boxes, street trees, furnishings, or other circulation design elements can be used to provide separation between pedestrians and automobiles.

Park-and-Ride Facilities

In addition to the general conditions recommended for all transit facilities described previously, park-and-ride lots that function well for pedestrians generally include the following:

- at least one accessible route of travel, minimum 3 feet wide, safely delineated over the entire site;
- sidewalks next to curb-side parking lanes and loading zones;
- minimum 6-foot wide sidewalks for two-way pedestrian travel, and greater width if feasible; the recommended minimum width of sidewalks adjacent to a bus or taxi loading zone is 9 feet of unobstructed space next to the curb with a 10- to 15-foot width minimum in urban/high activity areas;
- a maximum walking distance of 800 feet from the car to the bus loading zone;
- security lighting;
- public pay phones;
- easy access to and from surrounding neighborhoods and businesses;
- aesthetically pleasing and interesting things to look at, such as artwork, planters, and fountains;
- quality paving material and street furnishings; and
- litter receptacles, drinking fountains, and restrooms.

Mixed use development, when integrated with the park-and-ride, provides services and retail that enhance the pedestrian experience.

Transit-Oriented Development

The concept of Transit-Oriented Development (TOD) aims to create pedestrian-friendly communities that have good access to public transit. The mixes of uses that should be encouraged near a transit station to make it effective as a pedestrian and transit destination include higher density residential development, public facilities such as parks and service centers, employment centers, and commercial and retail centers.

The Central Phoenix/East Valley LRT project highlights some of the important features of TOD in *Urban Design Elements*. These include:

- development of uses adjacent to LRT stations that create a viable “24 hour” area;

- stations in the direct line of sight for pedestrians; and
- public facilities and community services adjacent to stations such as libraries, police stations, and day care facilities.

See *Creating Transit Station Communities* for a more in depth look at TOD. This document discusses benefits, specific design principles, market analysis, and funding strategies for Transit-Oriented Development.

Coordination Between Agencies

Coordination between transit agencies, local jurisdictions, and transportation system planners and designers is essential when planning and designing pedestrian facilities for access to transit. Land use planning efforts should consider ways to support transit use in communities. Communication and coordinated reviews between transit agency staff and local planners and engineers should occur during the beginning stages of projects.

Successful transit-oriented developments include pedestrian-friendly facilities and amenities.

Other Sources of Information

The following sources of information are recommended for pedestrian access to transit.

Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling, Richard K. Untermann

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Urban Design Guidelines, Central Phoenix/ East Valley Light Rail Transit Project, Valley Connections

Creating Transit Station Communities – A Transit-Oriented Development Workbook, Puget Sound Regional Council

Linking Bicycle/Pedestrian Facilities With Transit, M. Replogle and H. Parcells

Metro Transportation Facility Design Guidelines, Municipality of Metropolitan Seattle

Non-Motorized Access to Transit, Final Report, Wilbur Smith Associates

Non-Motorized Access to Transit, Technical Appendices, Wilbur Smith Associates

Pedestrian Malls, Streetscapes, and Urban Spaces, Harvey M. Rubenstein

Planning and Design for Transit, Tri-County Metropolitan Transportation District of Oregon

Using GIS for Transit Pedestrian Access

Analysis, Orange County Transportation Authority Transit Programs Department

The Role of Transit in Creating Livable Metropolitan Communities, Project for Public Spaces, Inc.

The Transit Metropolis: A Global Inquiry, Robert Cervero

Planning, Developing, and Implementing Community Sensitive Transit, Livable Communities Initiative

How to Promote and Enhance Urban Development Around Light Rail Transit Stations, SE Wisconsin Regional Light Rail Transit Study

Building Livable Communities: A Policymaker's Guide to Transit-Oriented Development, Center for Livable Communities

This Section Addresses:

- *Introduction to Traffic Calming*
- *The Traffic Management Approach*
- *Traffic Calming Techniques*
- *Traffic Calming on Arterial Streets*
- *Tempe's Streetscape and Transportation Enhancement Program*
- *Other Sources of Information*

Traffic calming focuses on reducing vehicle speeds, vehicle noise, and visual impacts. It may include a reduction in traffic volumes. Traffic calming techniques use various means to influence the behavior of motorists: physical, psychological, visual, social, and legal (regulatory and enforcement).

This section provides an overview of different traffic calming techniques. There are many good resources listed he end of this section that provide information about the effectiveness and design approaches related to traffic calming methods. They provide more detail and guidelines on selecting the most appropriate traffic calming solution for a specific situation.

Introduction to Traffic Calming

The first traffic calming programs were developed in the 1960s in European countries such as the Netherlands and Germany. These were a direct response to community demands to reclaim residential streets as safe areas for pedestrians. The early techniques consisted of devices such as speed humps and chicanes. While a few cities in North America had programs dating back to the 1970s, widespread development of these programs is a relatively recent trend. As these programs have evolved, several jurisdictions adopted their own terms for traffic calming such as "traffic mitigation," and "neighborhood traffic management." The recent Institute of Traffic Engineers (ITE) publication *Traffic Calming: State of the Practice* has provided the following definition for traffic calming:

> *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.*

In the United States, the need for reduced speeds in residential areas is echoed in ITE's *Handbook on Residential Street Design*:

> *". . . research has shown that pedestrians are not usually seriously injured when hit by a car moving at a speed of less than 20 miles per hour at the time of impact. If impact speeds are between 20 and 35 mph, injuries are usually serious, while at speeds above 35 mph they usually endanger life and are fatal."*

Statistics provide important insight into the need to improve traffic conditions to increase pedestrian safety. The trend for more livable and sustainable communities has been gaining momentum over the past several years and residents are demanding that their neighborhoods become less oriented toward automobiles and more oriented toward walking, bicycling, and access to transit.

The Traffic Management Approach

Traffic calming programs seek to reduce traffic speeds and volumes on neighborhood streets, making them safer for pedestrians, bicyclists, and those with special needs (children, older adults, and people with physical challenges).

Although traffic management and calming techniques are often used in areas other than residential neighborhoods, most programs are focused on areas where traffic problems impact the day-to-day livability of the community. A wider range of techniques is generally more acceptable in residential areas where streets provide local access and do not function as major conveyors of commuting traffic or as primary emergency routes.

When traffic calming techniques are applied to target neighborhoods and districts, the behavior of motorists tends to be more significantly influenced and the traffic problems of the area are more noticeably improved. Isolated applications can be problematic because they may divert traffic to nearby neighborhoods rather than managing it on an area-wide basis. To address this issue, the traffic calming program of the City of Portland, Oregon includes a “diversion tolerance” policy:

> *a traffic calming feature will not be added to a street if the resulting diversion is estimated to add more than 150 vehicles per day to a parallel street.*

Establishment of such an objective standard can be particularly helpful when traffic calming efforts become controversial.

Figure 5.1 illustrates a typical urban neighborhood and how its traffic problems can be resolved through the use of various traffic management tools.

Traffic Calming Techniques

Traffic calming techniques include:

- active speed control and street design treatments that affect motorists in a tangible way such as speed humps and traffic circles;
- passive speed techniques affecting motorist behavior through changing the psychological “feel” of a street — examples include narrowed roadways and colored/textured pavement; and
- active speed control techniques including deflection, horizontal deflection, and constrictions.

Table 5.1 is a quick reference relating typical traffic calming goals to the means of achieving the goal.

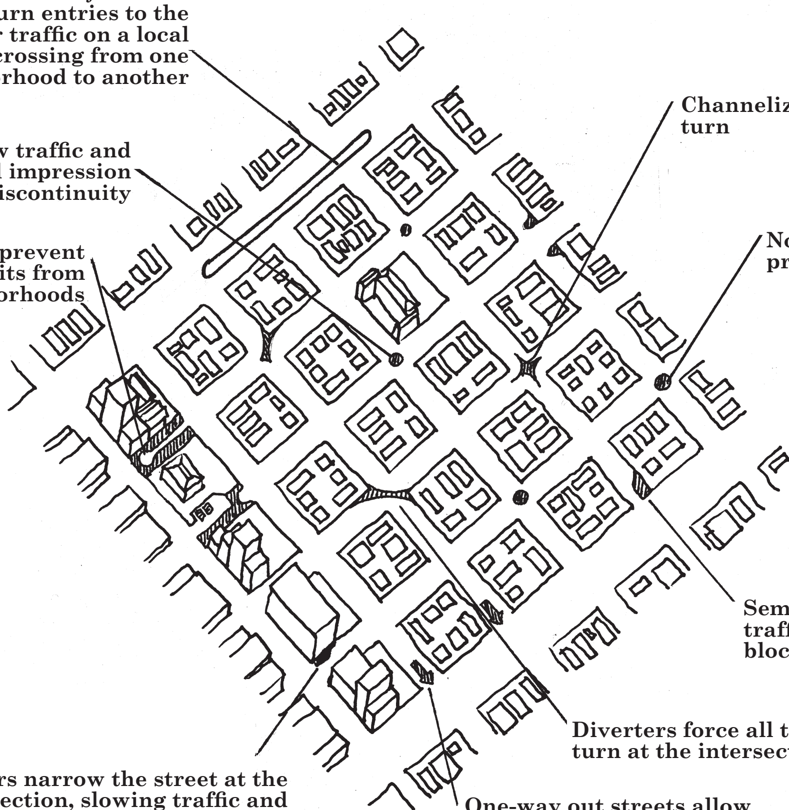
Table 5.2 illustrates some of the more common types of traffic calming methods currently used. Each of the techniques has successfully resulted in slowing traffic and reducing collisions on residential streets.

Traffic Calming Circles

There are many types of traffic circles. Larger traffic circles, such as rotaries and roundabouts, function primarily to improve traffic flow through an intersection. Smaller to intermediate traffic calming circles (10 to 20 feet in diameter) are used to control speeds at the intersection of two local streets. These circles are commonly

Figure 5.1

Traffic Management Approach — Solving the Problem



Source: Adapted from State of the Art Report: Residential Traffic Management, Federal Highway Administration; A Guidebook for Residential Traffic Management, WSDOT; and Traffic Calming, Hoyle

used for neighborhood traffic calming.

Traffic calming circles are very effective in reducing vehicle speeds and discouraging non-local trips through neighborhoods. They create a condition where vehicles are forced to stop or significantly reduce their speed at the intersection, allowing better opportunities for pedestrians to cross.

A drawback of some traffic calming circle designs is that vehicles need to swing wide at the intersection to avoid the center barrier. Vehicles may intrude into the pedestrian crossing area if insufficient space is provided for the turning movement. A minimum of 13 feet of clearance between the circle edge and the crossing location is recommended.

Some drivers try to take the shortest path through the traffic calming circle and turn toward the left, rather than going all the way around the circle. This creates an unexpected movement to crossing pedestrians. For this reason it is best not to locate traffic circles at intersections where there are high volumes of left-turning movements.

Traffic circles are often landscaped and provide a nice amenity to the neighborhood. Sometimes local residents take on the

Table 5.1 - Common Residential Traffic Management Program Actions

Reducing	By What Means	Examples
Traffic volumes	Physical	Traffic circles, traffic diverters
Vehicle noise	Psychological	Variable-spaced paint stripes
Visual impacts	Visual	Landscaping to block through views
Traffic speeds	Social, physical	Neighborhood “Speed Watch” program, speed humps/tables
Collisions/ speeding	Legal, physical	Strict speed enforcement; spot safety improvements

Source: Adapted from A Guidebook for Residential Traffic Management

Table 5.2 - Common Types of Traffic Calming Methods

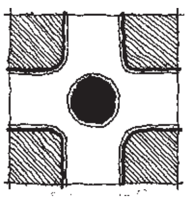
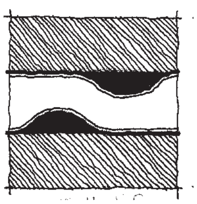
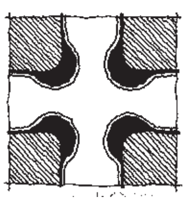
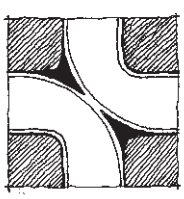
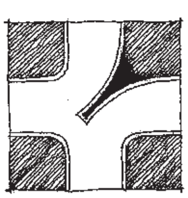
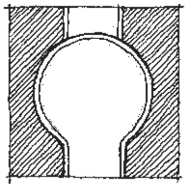
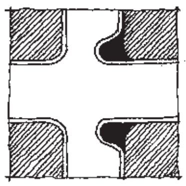
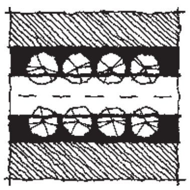
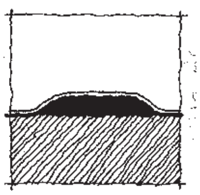
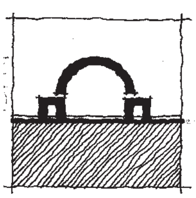
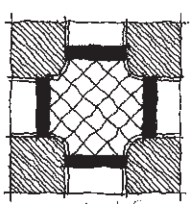
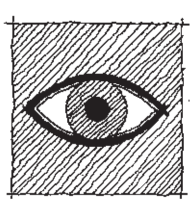
Drawing	Technique	Description
	Traffic Circles	Circular islands centered within intersections - circles can be landscaped or surfaced with special paving. Landscaping can be maintained by the local jurisdiction or by neighborhood volunteers.
	Chicanes	Alternately placed curb extensions into the street force motorists to drive in serpentine pattern. Chicanes are offset from each other in mid-block locations and can be used to keep through-trucks versus local deliveries off residential streets.
	Curb Bulb-Outs, Chokers/Neckdowns	Curb extensions placed at mid-block locations or intersections narrow the street to provide visual distinction and reduce pedestrian crossing distances. These “bulb-outs” help to provide a clear visual signal to drivers that a crossing is approaching and make waiting pedestrians more visible. Neckdowns are often longer than bulb-outs and may line up with and help define parallel street parking areas. They narrow the appearance of the street and can be attractive, especially when landscaped.
	Diagonal Diverters	Diverters eliminate through traffic while providing partial access in opposite directions - the island can become an amenity and provide refuge for pedestrians.
	Forced Turns and Partial Dividers	Truncated diagonal diverters (one end remains open) and other types of partial diverters discourage commuter traffic by forcing turns while still providing local access opportunities.

Table 5.2 *(continued)* - Common Types of Traffic Calming Methods

	Cul-de-sac/Street Closures	Street is closed to vehicular traffic and turned into a cul-de-sac. End of street becomes a neighborhood amenity and focal point (landscaped mini park). The ongoing provision of pedestrian and bicycle access is important.
	One-Way Entry and Exit	Curb bulbs/extensions are used to close one lane traffic at intersections. This approach stops through traffic but allows ingress or egress depending on the direction and location of the closure.
	Narrower Streets	Narrower streets limit the expanse of pavement visible to the driver and can be effective in slowing traffic, especially when lined with trees and/or on-street parking.
	Speed Humps/Tables	A speed hump is wider and smother than a speed bump, and effective in slowing cars as they approach pedestrian zones. These are most appropriately used on neighborhood streets.
	Signs and Neighborhood Gateways	Signs such as “Residential Street,” “Local Access Only”, or other terms and monuments that identify neighborhood districts can be effective, especially when used in conjunction with other techniques, including those listed above and others, such as pavement markings and textured warning strips.
	Special Paving	Alternate road surfaces, such as brick, colored concrete or special pavers, can be used at crossings, intersections, or along the sides of the street to break up the visual expanse of pavement and define pedestrian travel areas.
	Speed Watch Programs	Citizens and organizations can utilize radar devices and/or electronic sign boards to measure speeds of passing vehicles in their neighborhoods. Letters of warning can be sent to the registered owners of offending vehicles. These programs promote neighborhood awareness of speeding.

Traffic circle in residential neighborhood

responsibility of maintaining the circle. It can become a neighborhood garden or art opportunity. Care must be taken to select landscaping that will not block views between motorists and pedestrians crossing on opposite legs of the intersection. Vase shaped, more vertical branched trees are suggested, along with shrubs, annuals, and perennials that do not exceed a height of 2 to 3 feet.

Mountable curbs at the perimeter of the traffic circle are recommended to provide the ability for large vehicles, including emergency vehicles, to drive over the edge of the circle if they are having trouble making the turn around the island.

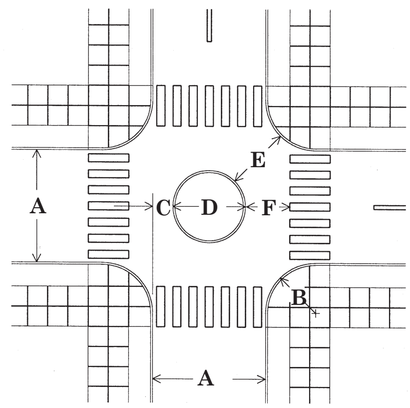
Figure 5.2 illustrates a traffic circle design successfully implemented in neighborhoods.

Narrowed Streets

Narrowed streets that are either physically narrower, or create the perception that they are narrower, are effective methods for calming traffic. Reduced street widths in residential and suburban areas are more commonly allowed by local jurisdictions. Narrow streets not only provide the benefit of traffic calming, but also help to create more attractive, pedestrian-friendly character along the street. Narrow streets also reduce construction and maintenance costs.

Figure 5.2

Recommended Traffic Calming Circle Design



LEGEND

A Street Width
B Curb Return Radius
C Off-Set Distance
D Circle Diameter
E Opening Width
F Turning Area 13' Min.

OPTIMUM CRITERIA

Off-set Distance (C)	Opening Width (E)
5.5' Max.	16' min.
5.0'	17' +/-
4.5'	18' +/-
4.0'	19' +/-
3.5' or Less	20'

NOTE:
Crosswalks optional, depending on setting (check with your local agency)

Source: Adapted from the City of Seattle standard design for traffic circles.

Narrowed street through the use of striping

A street is perceived to be narrow when street trees are planted on both sides of the street, thus narrowing the driver's field of vision. On-street parking, separated walkways with planting strips, striping treatments, and bike lanes also narrow the look of a street. The use of contrasting pavement or texture in the bike lane or as a dividing strip at the edge of the road can further help to make the roadway appear narrower. Figure 5.3 illustrates an example of how a street lined with trees and bike lanes looks narrower than one identical in width without these elements.

Medians and Refuge Islands

Refuge islands benefit pedestrians by reducing crossing distances and by reducing the amount of jaywalking. Medians and refuge islands calm traffic because they help to narrow the field of vision of the approaching motorist, especially when they contain trees and landscaping. Refuge islands also provide a place for pedestrians to wait or rest.

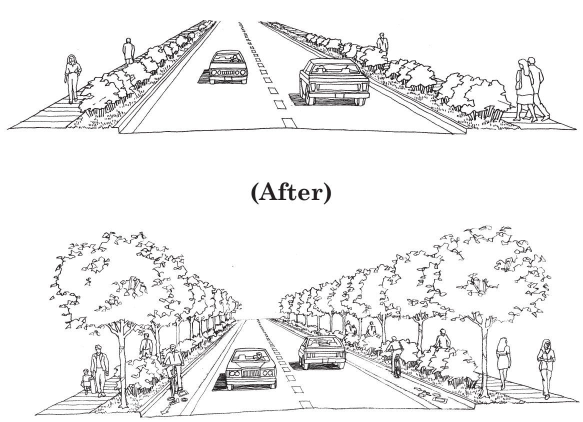
Chicanes

Chicanes are curb extensions or other features (such as landscape islands and on-street parking) that alternate from one side of the street to the other. One lane of traffic is either fully closed at "pinch points" causing one car to wait for another to pass before proceeding, or partially closed with enough roadway width remaining for two cars to pass. A study of the use of chicanes in Seattle, Washington concluded that traffic volumes decreased up to 48 percent on higher volume streets. (Seattle Transportation Division, *Traffic Calming*, Hoyle). Significant reduction in vehicle speeds was documented. Speeds on neighboring streets without chicanes continued to increase.

Chicanes provide the advantage of not blocking emergency vehicle access while allowing local access opportunities. Drivers are more likely to violate chicanes, especially on streets with low traffic volumes. Chicanes should be made visible with signs, painted curbs, landscaping, reflectors, and street lights. Figure 5.4 illustrates a chicane used along a neighborhood street. On-street parking is not permitted at the ends of the street.

Figure 5.3

Narrowed Street with Bike Lanes & Trees
(Before)



Curb Extensions and Bulb-Outs

Curb extensions and bulb-outs can be designed in a variety of ways. When placed at intersections and mid-block crossings, they provide the advantage of reducing

Chicane

the crossing width for pedestrians. Curb extensions are often used in conjunction with landscape treatments to enhance the street and buffer adjacent parking. They also help to more clearly identify mid-block crossing locations to both pedestrians and motorists. The recent FHWA report, *The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior,* summarizes research on curb extensions and concludes that their installation can directly reduce motorist speeds.

In some cases, a curb extension or "choker" is used at intersections to create a one-way entry or exit point for that specific street segment. Autos are allowed to exit the street, but not enter it. Entrance occurs at side streets. Pedestrians and bicyclists are allowed to travel in both directions. Figure 5.5 illustrates typical curb extensions and bulb-out designs.

Diverters and Street Closures

Diagonal diverters close roads and eliminate through traffic, while providing access to the surrounding neighborhood. The diverter island provides an area for landscaping and aesthetic enhancement. The island also provides a crossing refuge area for pedestrians.

Full street closures eliminate all through traffic, improving the safety of the street by significantly reducing traffic volumes and speeds near the closure.

A disadvantage of full street closures and diagonal diverters is that they cut off emergency vehicle access. They also limit

Figure 5.5

Curb Bulb-Outs and Extensions

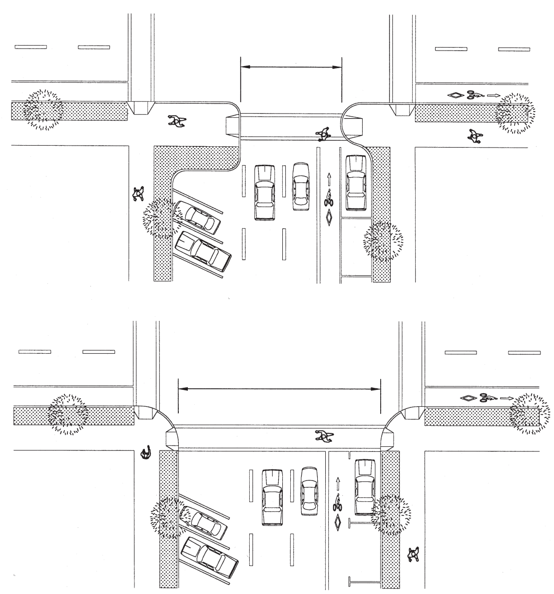
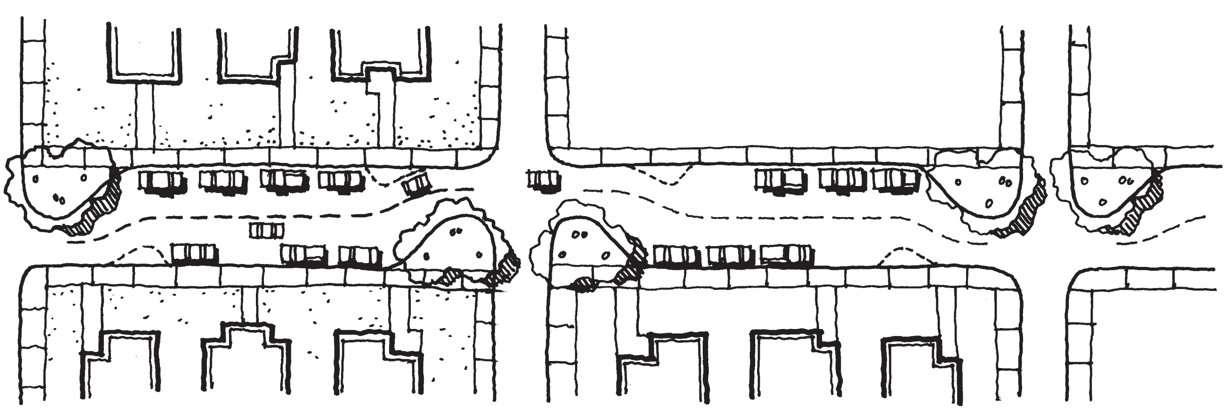


Figure 5.4

Chicanes



Source: Traffic Calming, Hoyle

Diagonal diverter

access opportunities for the local residents. Through-traffic may transfer to other local streets in the area if not managed, and the closure of streets may contradict other transportation and land use planning goals that encourage an open grid system of streets.

Partial street closures reduce through-traffic in one direction and partially in the other. Traffic is diverted, while allowing for emergency vehicle and local residential access.

When streets are either fully or partially closed, it is always important to continue to provide pedestrian and bicycle access through the closed area.

Speed Humps (Not Speed Bumps)

Speed humps are raised areas in the roadway that do not function as crossing areas. They are designed similarly to raised crosswalks and speed tables. Speed humps can be located on Tempe's residential, local or collector streets with daily vehicle volumes greater than 400 vehicles per day but less than 3,000 vehicles per day. Well designed speed humps allow vehicles to proceed over the hump at the intended speed of 15 to 20 mph with minimal discomfort, but driving over the hump at higher speeds will rock the vehicle.

Speed humps are ***not*** speed bumps, which are smaller raised areas of 1 to 3 feet wide located in parking lots and private roads.

Typically, speed humps are placed in series at 200-600 foot intervals. Speed humps should not be placed on curves, transit routes, or major emergency response routes.

Many designs have been developed for speed humps. The City of Tempe parabolic speed hump design is shown in Figure 5.6, on the following page.

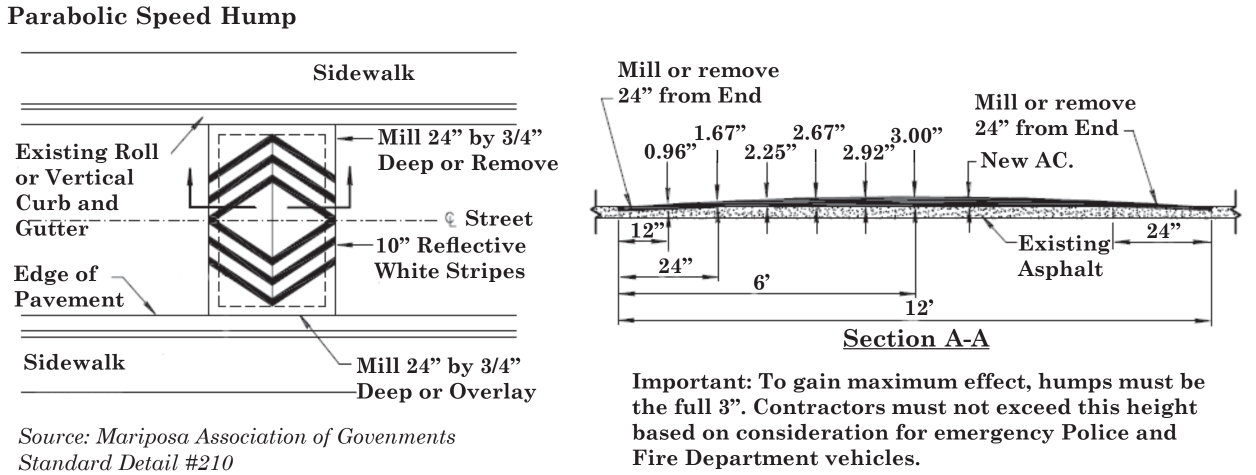
The MUTCD provides standards for signing and marking of speed humps. It is desirable to install advance warning signs 100 feet in advance of speed humps on streets that are 30 mph or less. MUTCD speed hump design, as well as signing and marking recommendations are illustrated in Figure 5.7. Ideal speed humps are 12 feet in width and 3 to 4 inches high.

Raised Intersections

Raised (or tabled) intersections provide the advantage of slowing vehicles at one of the most critical locations for pedestrian crossing activity. Raised intersections are often paved with contrasting material (stamped, scored, or colored concrete or unit pavers) to the roadway and stand out visually to approaching motorists. The use of special paving also helps to delineate the pedestrian crossing area.

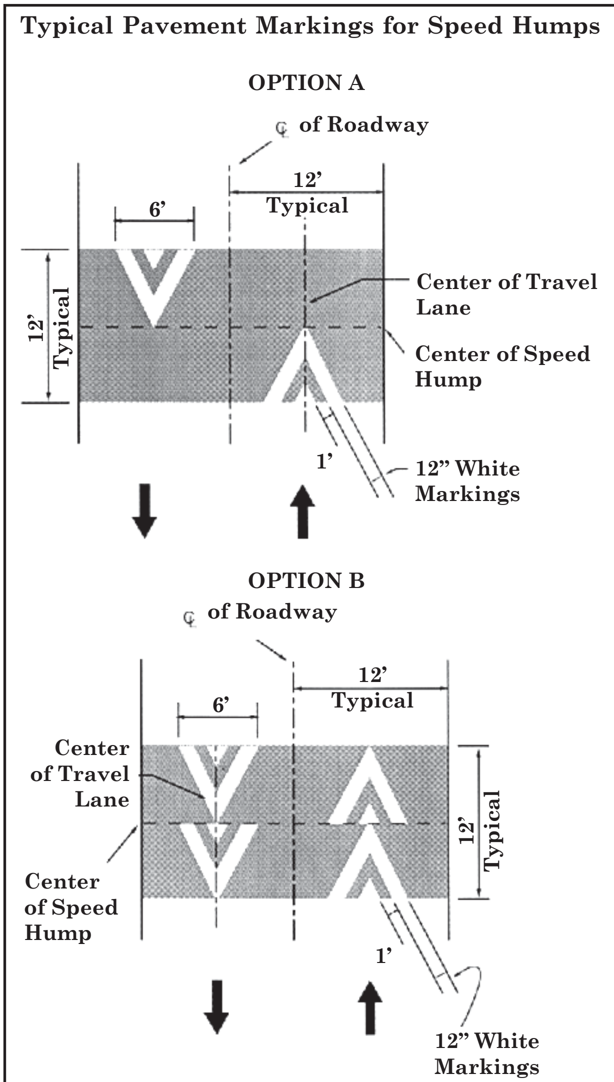
Raised intersections create an area clearly designated for pedestrians. Approaching motorists can see the intersection is not a location designed for rapid, through-movement, which causes them to slow down and yield the right-of-way to pedestrians. Raised intersections are not appropriate for high speed thoroughfares and major

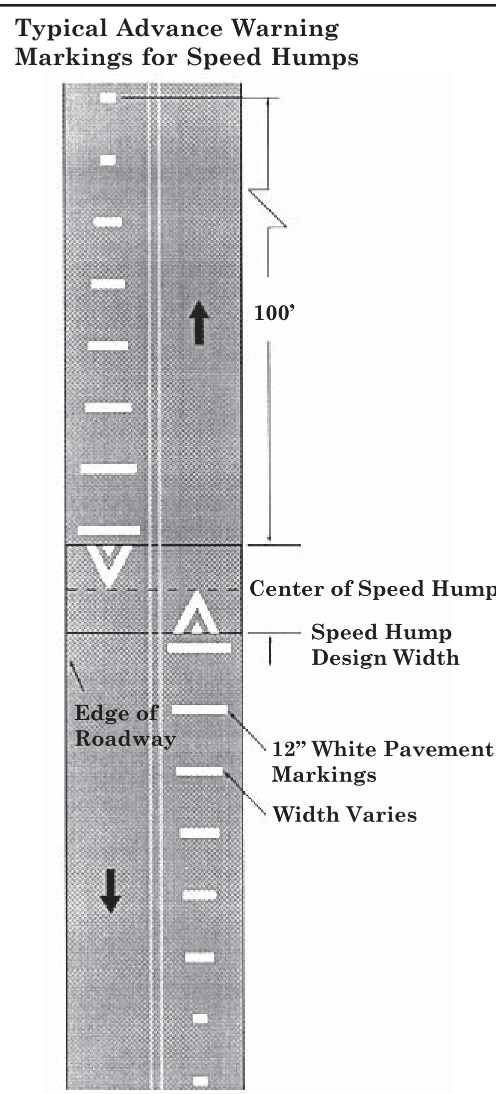
Figure 5.6



Source: Mariposa Association of Govenments Standard Detail #210

Figure 5.7





Source: MUTCD

Speed hump

arterials and collectors. Local requirements may prohibit their use under a variety of circumstances.

Raised intersections may make it easier to meet the Americans with Disabilities Act requirements because the crosswalk is a natural extension of the sidewalk, with no change in grade. However, since the curb line is harder for sight-impaired pedestrians to detect at intersections, special treatment such as tactile warning strips or audible signals are needed to make them detectable.

Placement of drainage inlets is simplified at raised intersections, because surface water will drain away from the center of the intersection. In areas without storm drains, drainage may be a problem.

Changes in pavement color and texture at the intersection raise a motorist's awareness through increased visibility, noise, and vibration. Crossings constructed with special paving should use nonslip bricks or unit pavers. Scored or stamped and colored concrete surfaces can also be used, and are generally more durable over the long term than unit pavers, with more uniform joints and less chance of displacement. Special paving surfaces should be installed and maintained in a smooth, level, and clean condition. Care should be taken to ensure that grooves and joints are not so deep as to impact accessibility.

Raised Crosswalks/Speed Tables

Raised crosswalks have a flat top for crossing. They may be wider than typical speed hump designs. Raised crosswalks are appropriate at mid-block locations on local streets, some subcollectors and collector roads, and in other locations like at airport drop-off and pickup zones, shopping centers, and campuses. Raised crosswalks are typically marked with high visibility crosswalk designs or may be surfaced with special paving (see Raised Intersections). The recent FHWA report, *The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior* summarizes research on raised crosswalks. It concludes that they can directly reduce motorists' speeds and increase the occurrence of motorists yielding to crossing pedestrians. Figure 5.8 illustrates a typical raised crosswalk.

Gateways

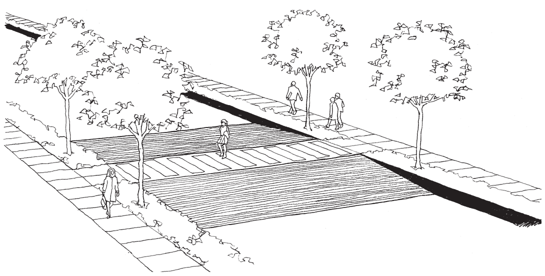
Gateway treatments generally encompass a wide variety of techniques that provide neighborhood identification, such as signs, monuments, landscaping, special paving, narrowed entrances, and other elements. These enhancements help to provide an indication to motorists that they are entering a neighborhood area from an arterial road or other type of street where traffic was moving at higher speeds.

Traffic Calming on Arterial Streets

In many communities there are instances where residential streets have an arterial designation. Sometimes this is part of the original development scheme, while other times it is a more recent designation as a consequence of community growth. In any event, there can be compelling reasons to limit speeds and introduce traffic calming on arterial streets. With some street networks, a neighborhood's pedestrian accessibility can be "cut-off" if all traffic

Figure 5.8

Raised Crosswalk/Speed Table



is channeled onto a high-speed arterial to leave the neighborhood. This renders any efforts to calm the residential streets futile.

European countries offer the best examples of arterial street traffic calming. Programs have been developed in these countries that prescribe traffic calming treatments for any design speed up to approximately 37 mph. Standards have been developed, for example, for speed humps with a drawn-out profile that allows for much higher speeds than typical humps in the United States. At the upper-limit of 37 mph, the techniques are limited to gateways and mild horizontal shifts in roadway alignment.

Another European measure for calming arterial streets is reallocation of right-of-way. This can take the form of narrowed roadways and even narrowed travel lanes. Where adjacent buildings form a street wall, roadway narrowing can change the field of vision for motorists. The remaining space can take on the form of a more dramatic-sized sidewalk.

Advance warning of traffic-calming measures on arterials is important, particularly after a transition from a highway.

Since arterials serve commuters and emergency response vehicles, there is a higher chance for controversy when applying traffic calming to arterial streets.

Tempe's Streetscape and Transportation Enhancement Program

The City of Tempe created the Streetscape and Transportation Enhancement Program (STEP) in response to citizens' interests to create a safer environment for pedestrians, bicycles, and motorists. The goals of the STEP are:

- to slow traffic through neighborhoods to posted speed;
- to discourage the use of local streets as commuter routes;
- to prevent accidents; and
- to create a safe environment for pedestrians and bicyclists.

The STEP includes a number of ways to achieve the above goals. Options used for traffic calming on local streets include:

- signing for stops, yields, speed limits, stop ahead, loading zones, and permit parking (Type 1);
- striping for street centerlines, lane lines,

crosswalks, red curbs, yellow curbs, stop bars, and parking areas (Type 1);

- enforcement including increased police presence, radar trailer use, and speed alert program (Type 1); and
- traffic calming facilities including circles, road closures, diverters, chicanes, chokers, speed humps, and cul-de-sacs (Type 2).

For Type 1, traffic enforcement typically begins when a neighborhood identifies the traffic problem and submits an action request form to the city. City staff then review the request, meet with the neighborhood, and schedule installation of the selected traffic calming measure.

Traffic calming installation is a longer process for Type 2 applications and generally only occurs if Type 1 options have not solved the problem. For a Type 2 option to be considered, households in the affected area have to agree to the traffic calming option and studies have to conclude that the option is needed.

Other Sources of Information

The following sources of information are recommended for traffic calming. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

A Guidebook for Residential Traffic Management, Final Report, Washington State Department of Transportation

A Sampler of Neighborhood Traffic Calming Efforts, Chris Leman

"A Toolbox Approach to Residential Traffic Management," Joseph Savage and R. David MacDonald

Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling, Richard K. Untermann

"Boulder Brings Back the Neighborhood Street," John Fernandez

City Comforts, How to Build An Urban Village, David Sucher

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Florida Pedestrian Planning and Design Guidelines, University of North Carolina

Great Streets, Allan B. Jacobs

Handbook for Walkable Communities, Washington State Pedestrian Facilities Planning and Design Courses, Dan Burden and Michael Wallwork, PE

King County Neighborhood Traffic Control Demonstration Program, The KJSA Team

Livable Neighborhoods: Rethinking Residential Streets, American Public Works Association and the University of Wisconsin-Madison

Livable Streets, Donald Appleyard

Portland Pedestrian Crossing Toolbox for Pedestrian Program Bureau of Transportation Engineering and Development, Charles V. Zegeer

Preparing Your Own Design Guidelines, A Handbook for Seattle's Neighborhoods, City of Seattle Department of Construction and Land Use and Planning Department

Reclaiming Our Streets, Traffic Solutions, Safer Streets, More Livable Neighborhoods, Community Action Plan To Calm Neighborhood Traffic, Reclaiming Our Streets Task Force, City of Portland Bureau of Traffic Management

Redevelopment for Livable Communities, Washington State Energy Office, the Washington State Department of Transportation, the Department of Ecology, and the Energy Outreach Center

Residential Streets, American Society of Civil Engineers

Traditional Neighborhood Development: Will the Traffic Work? Walter Kulash

Traffic Calming, Cynthia L. Hoyle

Traffic Calming, A Guide to Street Sharing, Michael J. Wallwork, PE

"Traffic Calming — An Overview," Walter Kulash

Traffic Calming — The Solution to Urban Traffic and a New Vision for Neighborhood Livability, Citizens Advocating Responsible Transportation, Ashgrove, Queensland, Australia

Traffic Calming State-of-the-Practice, Institute of Transportation Engineers and Federal Highway Administration, 1999.

The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior, Federal Highway Administration, 2001

INTERSECTIONS AND CROSSINGS  6

This Section Addresses:

- *Effects of Pedestrian Improvements on Vehicle Capacity*
- *Design Practices at Intersections*
- *Crosswalks*
- *Minimizing Crossing Distances at Intersections*
- *Minimizing Pedestrian/Motor Vehicle Conflicts*
- *Mid-block Crossings*
- *Other Innovative Technologies*
- *Grade Separation*
- *Railroad Crossings*
- *Other Sources of Information*

This section addresses intersections and crossings, as well as traffic regulating practices that can improve conditions for pedestrians at intersections. It also discusses the need for and describes different types of mid-block crossing treatments, including marked crosswalks, mid-block actuated signals, median refuge islands, overhead signs, and flashing beacons. Standard practices, as well as some new techniques being tried around the country and in Canada, are discussed. Other types of non-street intersection crossings, such as railroad crossings, grade-separated crossings, multi-use trail and pathway crossings, and bridges are also addressed.

Intersections are commonly designed with more of a focus towards motor vehicles than pedestrians. Even the best network of streets with well-developed pedestrian facilities can suffer from low pedestrian use if there are inadequate facilities and obstacles at intersections and crossings. Intersections can be made more pedestrian friendly by implementing designs that improve crossing conditions, reduce crossing distances, and minimize conflicts

Intersections are the most common location for pedestrian and motor vehicle collisions.

between pedestrians and other intersection users. The crossing treatment design applied to a specific location should be guided by a traffic engineering study of the existing conditions and intended function of the crossing.

Effects of Pedestrian Improvements on Vehicle Capacity

The needs of pedestrians deserve equal consideration with the needs of motorists and other intersection users. Pedestrians historically have been treated as an afterthought in design of transportation facilities, but current practices encourage design approaches that improve conditions for pedestrians and fully integrate them into the transportation system.

When determining the type and extent of improvements needed at intersections, the needs of all user groups should be considered and balanced. In some cases, installation of improvements that reduce crossing distances (such as curb extensions or reduced curve radii) can affect vehicle capacity at intersections. Increased pedestrian use and relocation of bus stops may also affect vehicle capacity. To improve pedestrian safety and mobility, it may be necessary to reduce vehicle capacity. Capacity loss may be a compromise in improving the function of an intersection for all users, creating the best overall system.

A traffic engineering analysis should be conducted as part of the design process to clearly determine needs and provide recommendations for channelization, turn lanes, acceleration and deceleration lanes, intersection configurations, illumination, and traffic control devices. Solutions should seek to provide maximum protection to pedestrians in balance with accommodating the operational needs of motor vehicles and other intersection users.

Design Practices at Intersections

Intersection design requires consideration of all potential users of the facility, including pedestrians. Design approaches need to find ways to protect the access and safety of pedestrians (the most vulnerable user group at intersections), while still adequately meeting the needs of motor vehicles.

Sometimes meeting the needs of pedestrians may require a compromise in providing full service and capacity to motor vehicles at intersections, but more often, designers can balance these competing needs, resulting in adequate levels of operation for all users. Table 6.1 lists some basic principles of intersection design related to the needs of pedestrians.

Intersections should be designed to accommodate all users.

Table 6.1

Basic Principles of Intersection Design to Accommodate Pedestrians
• *Intersections that function well for pedestrians are typically compact.*
• *Free-flowing motor vehicle movements are either eliminated or vehicles are forced to a significantly lower speed through the intersection.*
• *All legs of an intersection should be available for pedestrian use; closing a crosswalk doesn't necessarily prevent pedestrians from crossing in that direction. (Note that on some tee intersections, it may not be desirable for pedestrians to cross in front of left turning vehicles.)*
• *Pedestrians need to be able to travel in a direct line across the intersection leg and the direction of travel needs to be clearly identified for all pedestrians, including those with sight impairments.*
• *Avoid increasing potential conflicts or the level of pedestrian exposure to motor vehicles (as would occur at multiple and skewed intersections).*

Crosswalks

Whether marked or unmarked, crosswalks function as extensions of the approaching sidewalks, and when pedestrians are crossing in these areas, they have the right of way. Arizona Revised Statute 28-792 states:

> "The driver of a vehicle shall yield the right-of-way, slowing down or stopping if need be in order to yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is on the half of the roadway on which the vehicle is traveling or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger. A pedestrian shall not suddenly leave any curb or other place of safety and walk or run into the path of a vehicle that is so close that it is impossible for the driver to yield."

Designing crosswalks to adequately meet the needs of all pedestrians is important. But design isn't the only consideration. If crossing improvements are not functioning properly, there may be other problems, such as inadequate enforcement, poor visibility and obstructed sight lines, or level of service deficiencies.

Determining the Need for Crossing Improvements at Intersections

Crossing improvements at intersections, such as crosswalk markings, signs, signals, refuge islands, and other elements, help to clearly delineate the pedestrian right-of-way to all users, including motorists, bicyclists, and pedestrians.   An important question often asked is, "How should the need for crossing improvements at intersections be determined?" The *Manual on Uniform Traffic Control Devices* (MUTCD) provides warrants for various crossing improvements, including signals, crosswalks, and other devices, and these warrants should be analyzed for all intersection projects. The MUTCD also states that intersection improvements are necessary for traffic control devices to function properly.   In addition to reviewing the MUTCD and other guidelines, good professional judgement and specific traffic engineering analyses on a case-by-case basis are recommended.

This section generally describes current established processes for determining the need for improvements at intersections, such as marked crosswalks and signals.

Marked Versus Unmarked Crosswalks

In recent years, there has been much debate surrounding the safety implications of marking crosswalks at uncontrolled intersections. Figure 6.1 shows both marked and unmarked crosswalks. Previous research results were contradictory in terms of whether pedestrian and vehicle crashes were occurring with more, less, or the same frequency at marked and unmarked crosswalks. The contradictory findings can be attributed to limitations of the research, which contained many confounding variables and small, potentially biased sample sizes and sites.

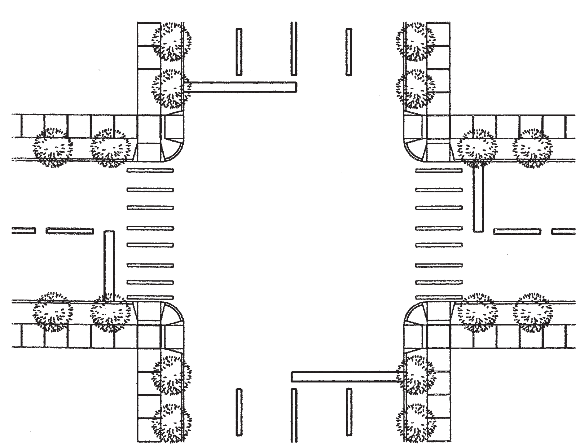
A study entitled *Evaluation of Pedestrian Facilities* was completed by the Federal Highway Administration to address the limitations found in previous research (Zeeger, Stuart, & Huang, 1999). None of the sites in the study had traffic signals or stop signs on the approach to the crosswalk. The study examined the safety of marked and unmarked crosswalks and the impact of additional pedestrian treatments, such as signal indications, lights, and traffic calming measures. The study evaluated 1,000 marked crosswalks at uncontrolled locations or locations with no traffic control devices and 1,000 matched but unmarked sites in 30 geographically dispersed cities in the United States. Detailed information collected for each site included pedestrian crash history, pedestrian and traffic volumes, number of lanes, speed limit, type of median, type and condition of crosswalk markings, and crosswalk location. Results of the study indicated that:

- higher pedestrian volumes, higher average daily traffic (ADT) rates, and a greater number of roadway lanes are related to a higher incidence of pedestrian crashes;
- crosswalk location, speed limit, direction of traffic flow, crosswalk condition, and crosswalk marking pattern were not related to the incidence of pedestrian crashes;
- the presence of a median decreased the pedestrian crash risk;
- marked crossings had a higher incidence of pedestrian crashes on multi-lane (4 or more lanes) roads with high ADTs;
- marked and unmarked crossings had similar incidences of pedestrian crashes on all 2-, 3-, and multi-lane roads with lower ADTs;
- pedestrians ages 65 and above were more likely to be involved in crashes; and
- the installation of marked crossings did not alter motorist behavior (e.g., stop or yield to pedestrians) or pedestrian behavior (e.g., crossing without looking).

According to the research, on smaller roadways with lighter traffic volumes,

Figure 6.1

Marked and Unmarked Crosswalks at Intersection



markings do not decrease the pedestrian crash risk. Conversely, on large, high-volume roadways, the risk actually increases. However, Zeeger, Stuart and Huang (1999) indicated that the higher risk observed on multi-lane roadways with high ADT rates results from:

- an overall higher risk as the number of lanes or ADT rate increases regardless of markings;
- recognition that multi-lane roadways with high ADT rates represent the most difficult scenarios for pedestrian crossings; and
- the fact that marked crossings draw pedestrians to cross in that location, particularly in areas where the crossing is perceived to be difficult.

Zeeger, Stuart, and Huang emphasized that the needs of pedestrians to safely cross streets cannot be ignored and that engineering and roadway treatments should be used to minimize the pedestrian crash risk. Based on these recommendations, it is not appropriate to always remove crosswalk markings from multi-lane roadways with high average daily traffic. Instead, the markings should be enhanced with appropriate additional pedestrian treatments such as signing, traffic calming, signalization, or other countermeasures.

Zeeger, Stuart and Huang (1999) offered a variety of recommendations based on the results of their research. Refer to their study for these recommendations.

Crosswalk Dimensions

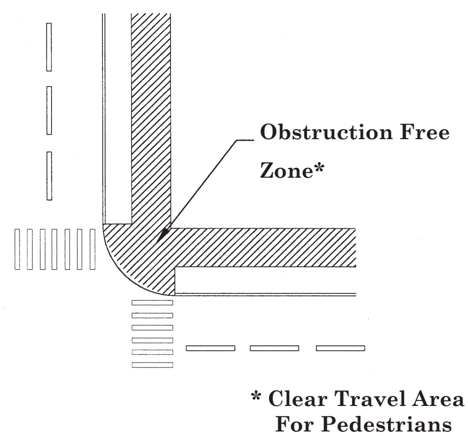
The MUTCD outlines requirements for minimum crosswalk widths and markings. The MUTCD requires a minimum crosswalk width of 6 feet. Wider crosswalks are often installed, particularly at crossings that receive high use. A width of 10 feet is commonly used for crosswalks. Crosswalks need to be at least the width of the approaching sidewalk (ITE *Design and Safety of Pedestrian Facilities*). The approaching sidewalk or walkway and corner area at the intersection need to be free of obstructions so that pedestrians can freely travel in either direction to cross the street (see Figure 6.2).

Crosswalk Markings

Crosswalks can be marked using various methods. Crosswalk marking patterns vary and limited information is available about the effectiveness of different designs.

Figure 6.2

Clear Travel Area for Pedestrians at Intersection Corners



There is no evidence to support that one design is better than another, but some designs provide better visibility than others. Local jurisdictions have developed their own preferences, so check with Tempe engineering representatives for the preferred standard practice. Pedestrian visibility and safety can also be enhanced with advance stop or yield bars.

Generally, high visibility markings are suggested for locations where greater motorist warning is considered beneficial and where pedestrians may not be expected to cross (such as mid-block locations), or where there are substantially higher pedestrian crossing volumes. Horizontal bars (two stripes perpendicular to vehicle traffic) are most often used at stop controlled intersections.

Diagonal markings or "zebra" stripes are more visible than horizontal bars, but diagonal markings tend to require replacement more often since they are subject to more friction from the wheels of motor vehicles. Ladder bar and piano bar markings are being used more frequently because they provide the benefit of good visibility and easier maintenance. With the piano bar pattern (and the ladder bar), the wheels of motor vehicles typically pass on either side of the markings, minimizing friction and deterioration. Table 6.2 illustrates several styles of crosswalk markings and lists advantages and disadvantages of each.

The minimum width of the horizontal bars recommended by the MUTCD is 6 inches. Wider bars, 10 to 12 inches, are recommended by the ITE, particularly at crosswalks that receive high use or deserve special attention.

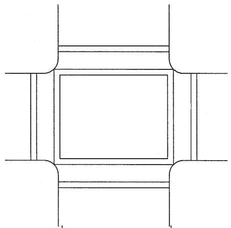
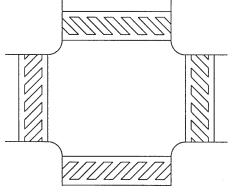
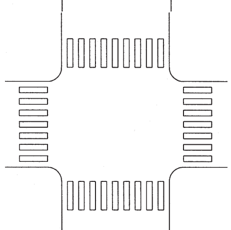
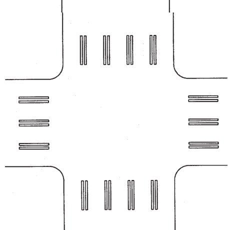
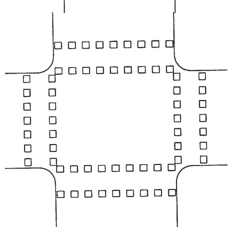
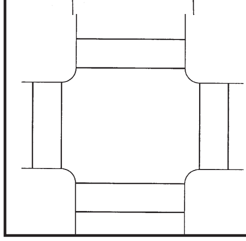
Stop bars are typically placed at intersections where motorists are required to stop to prevent overhang into crosswalk areas. Stop lines are normally 12- to 24-inch wide white stripes that extend across all approach lanes. Stop bars need to be located at least 4 feet in advance of the crosswalk, and can either be parallel to the crosswalk or angled or staggered in each lane to increase visibility. Strategically locating and skewing stop bars improves

Example of ladder bar crosswalk

visibility of pedestrians, as well as operations for right-turn-on-red vehicles and for vehicles turning left from the cross street.

Advance stop and yield markings have been shown to increase the visibility of pedestrians to motorists by providing a wider range of visibility on multiple lane roadways. When vehicles stop only four feet from the crosswalk (the typical standard,) they tend to screen the view of pedestrians from vehicles approaching in the other lane(s). Buses, trucks, and today's larger sport utility vehicles, in particular, cause this problem. As the potential for larger vehicles to approach a crossing increases, the potential for pedestrians to be screened and blocked from the view of other vehicles increases. The underlying principle behind advance stop lines is that they increase the safety of pedestrians by reducing the screening effect of vehicles yielding to pedestrians.

Table 6.2 - Advantages and Disadvantages of Crosswalk Marking Patterns

	Marking Pattern	Advantages	Disadvantages
	Horizontal Bars	Common practice at stop controlled intersections, less expensive, easy to install and maintain	Not as visible as some other marking types, bars tend to wear faster than other types, not appropriate for mid-block locations
	Zebra	Highly visible	More maintenance required since wheel friction rubs off diagonal stripes, surface can be slippery
	Ladder Bar	Highly visible	Wider stripes rub off with wheel friction, but can be placed to minimize this effect, surface can be slippery
	Piano	Highly visible and becoming more commonly used, easier to maintain since stripes can be placed outside the wheel friction	
	Dashed (Eurpoean)	Captures attention because not a commonly used pattern	May not define space as well as some of the other choices
	Solid	Visible (but may not be as eye catching as othe patterns), not commonly used	More expensive, more difficult to instal and maintain, surface can be slippery

At controlled approaches to intersections (with traffic signals or stop signs), the stop line can be placed well in advance of the crosswalk to provide this increased visibility of pedestrians. This provides notable safety benefits to pedestrians by keeping vehicles from stopping within the crosswalk, increasing pedestrian visibility, and reducing the likelihood of free right turning vehicles not seeing pedestrians. One of the drawbacks of advance stop bar markings include increased time for a vehicle to enter an intersection on green, and a possible modest reduction in intersection capacity. However, advance stop bars can provide a benefit by reducing the frequency of crashes from running red-lights.

One of the problems that can limit the application of advance stop lines is the reluctance to use stop lines in what is a “yield” rather than a “stop” situation. Advance yield bars are a relatively new technology that are in the research stage, and have the potential to mitigate the concern about stop lines in yield situations. Also, because they are unusual and not frequently used, they are much more noticeable by motorists. Since they are currently in the experimental stage, permission for their use must be requested from FHWA, and the proponent must agree to restoration of the location to comply with MUTCD if they prove to be ineffective. However, current research indicates that they are effective in gaining compliance by motorists.

Advance yield markings should be located a minimum of 30 feet in advance of the marked pedestrian crossing, and should be used with complementary signing. There is currently no standard for the “yield here for pedestrians” sign.

Markings should be monitored regularly and maintained in good condition. They should also be removed when no longer needed. Painted markings are less expensive than plastic markings, but the plastic markers have a longer life. Check with your local agency for crosswalk and pavement marking requirements. Also, for more specific design details related to pavement striping and marking techniques, refer to other sources, such as the MUTCD and City of Tempe standards.

Advance yield markings

Rumble strips with raised pavement markers or buttons are sometimes placed in advance of crosswalks in rows, which create a “rumbling” effect alerting approaching drivers of the upcoming crosswalk. Use of these types of markers is not generally recommended unless they can be placed far enough in advance of the crosswalk to be an effective warning device (at the same location as the crosswalk advance warning sign). Raised pavement markers should not be placed near the right edge line because they are an obstacle to bicycle travel (see discussion in Toolbox Section 3, Friendly Streets and Sidewalks). If raised pavement markers are used, they should be placed outside the required clearance area for bike lanes. The use of raised pavement markers should be analyzed on a case-by-case basis. They should only be installed after a traffic engineering study determines they are needed.

Curb Ramps

Curb ramps are often considered to be the most important elements of an accessible pedestrian environment. Curb ramps provide accessibility at the grade transition between intersection corners and lower street grades. They facilitate crossing for wheelchair users, people pushing strollers, bicyclists, and others. If properly located, they can also help to direct pedestrians, including sight-impaired people in the direction of the crosswalk if they are properly located. Toolbox Section 2, Accessibility, discusses placement and design of curb ramps.

Lighting

The street lighting level provided at intersections may need to be supplemented with additional lighting in areas of heavy pedestrian traffic during early morning, late evening, or nighttime hours. Refer to the standards and design guidelines of the Illuminating Engineering Society of North America and local policies and standards.

Location of Drainage Inlets and Grates

Drainage grates should be located away from crosswalks and curb ramps and outside the route of pedestrian travel. It is preferable to locate drainage inlets on the upstream side of the crosswalk to avoid excessive drainage flows across the crossing area. Roads and gutters should be graded to direct drainage away from intersection corners and walking areas.

Pedestrian Related Signs

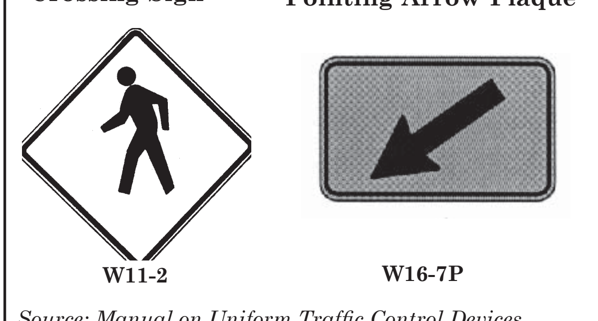
It may be necessary to provide signs at or near an intersection. Regulatory signs are generally rectangular shaped signs that identify special conditions and regulate motorists and pedestrians. Warning signs are diamond shaped, with black and yellow colors and are used to identify upcoming conditions that may not be expected.

Pedestrian related warning signs include the standard pedestrian crossing signs used at locations to identify upcoming crossings (refer to Figure 6.3). The pedestrian warning sign with the pedestrian symbol and no crosswalk should be used in advance of crossings or areas of high pedestrian use. Refer to the MUTCD for distance requirements for advance signing. The warning sign with the pedestrian symbol in the crosswalk should only be used ***at*** the crosswalk location and supplemented with a diagonal downward pointing arrow plaque (MUTCD W16-7P).

Minimizing Crossing Distances at Intersections

Minimizing the crossing distance at intersections enables pedestrians to cross the street more safely, efficiently and comfortably. Techniques that reduce

Figure 6.3



Source: Manual on Uniform Traffic Control Devices pedestrian crossing distance and time also provide the added benefit of improved timing at signalized intersections (without sacrificing the need for an adequate protection phase for the pedestrian). Several design techniques for reducing crossing distances at intersections are described in the following text.

Curb Return Radius

Historically, design of curb return radii at intersections has not typically considered the needs of pedestrians. With new design and retrofit design of intersections, it is important to consider the needs of all users of the intersection and to balance these needs to provide the safest operating conditions for all.

The use of shorter curb return radii at intersections is beneficial for pedestrians because it reduces the crossing distance of the intersection. Reduced radii also help to slow vehicles as they travel through the intersection, enabling drivers to respond more quickly to signal changes and crossing pedestrians.

The need for shorter pedestrian crossing distances and reduced vehicle speeds needs to be balanced with the need to provide adequate curb radius lengths to accommodate the types of vehicles that commonly turn at the intersection. A radius that is too small can cause large vehicles and buses to jump the curb, causing deterioration of the curb and intrusion into the waiting and standing space for pedestrians.

It may not always be practical to reduce the curb return radii at all intersections used by pedestrians, particularly at existing intersections. However, at intersections where there is heavy pedestrian crossing activity and limited truck and bus turning movements, it may be desirable to shorten the radius by adding curb extensions or bulb-outs. It may also be desirable to analyze transportation routes in the area and to reroute trucks onto streets that receive less pedestrian use. This would enable streets more heavily used by pedestrians to be retrofitted with shortened curb radii without significantly affecting the overall operational needs of large trucks and buses in the area.

If truck and bus turning activity occurs at a minimal level, AASHTO standards permit 15 to 25 feet curb radii on minor streets. On major streets, AASHTO allows a minimum turning radius of 30 feet if the occasional truck can turn with some minimal encroachment. These standards may vary at the local level. In some cases local jurisdictions may encourage the use of shorter than standard curb radii at intersections where there is likely to be frequent pedestrian crossing activity, particularly in urban areas.

Curb return radii larger than 30 feet generally are not desirable where there are high numbers of pedestrians crossing.

Figure 6.4 illustrates how reduced curb radius at an intersection shortens the pedestrian crossing distance by comparing the crossing distance between two 15-foot radius corners with the crossing distance between two 30-foot radius corners at an intersection.

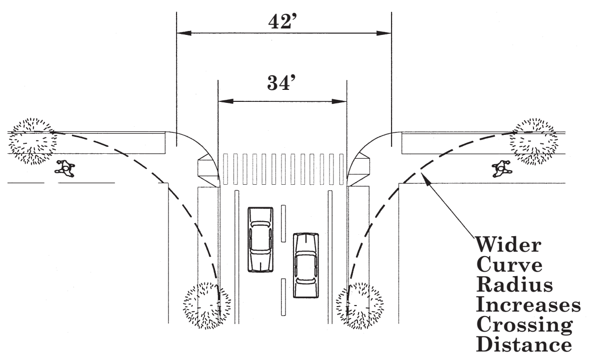
In certain situations, very short curb radii of 5 feet can be used on one-way streets at the corner where no turn turning movements are possible. Figure 6.5 illustrates how the use of a one-way street patterns can enable reduced curb radii.

Right-Turn Channelization (Slip) Lane with Refuge Island

At wide intersections, there is often a triangular space between the through-lane and the right-turn lane (also called a "slip" lane) unused by motor vehicles. Placing a raised island in this area provides pedestrians a refuge area when crossing. This may be an appropriate solution where curb return radii of larger than 30 feet are unavoidable. This type of design is only

Figure 6.4

Reduced Crossing Distance With Reduced Curb Radius



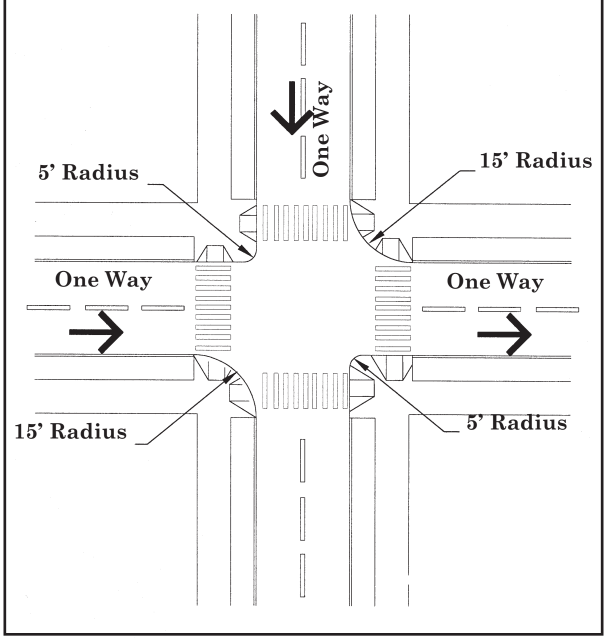
appropriate for use when it fully addresses the needs of pedestrians. If designed properly, these devices can help to balance the needs of large vehicles and pedestrians at busy intersections.

At locations with extremely high numbers of right turning movements, slip lanes should be protected with a signal to provide pedestrians opportunities to cross.

Also, refuge islands should be designed with an elongated tail (see Figure 6.6 on page 6-13), which stretches out the turning movement and provides vehicles more space to slow and observe pedestrians crossing the lane. (This elongated design is recommended by the *Handbook for Walkable Communities* as

Figure 6.5

Reduced Curb Radii at One-Way Intersection



a method to make right-turn slip lanes safer for pedestrians. It has not yet been incorporated into the AASHTO Green Book).

The refuge islands should be raised to provide a vertical barrier and added protection between vehicles and pedestrians. Refuge islands need to provide curb cuts, or cut-throughs if space is limited, for accessible passage. AASHTO requires that curbed islands generally be no smaller than 54 square feet, but preferably a minimum of 97 square feet. Triangular refuge islands should be a minimum of 20 to 25 feet long and not less than 3.3 feet wide in the crossing region and 1.6 feet wide in the tail region. A wider area is needed to provide curb ramps and a level area between the curb ramps in the crossing region.

Pedestrian push buttons may be needed when the signal timing doesn't allow all pedestrians to cross the street on one

Right-turn slip lane with refuge island

crossing phase. These areas should be clear of obstacles such as utility facilities and landscaping above 2 feet. The crossing point may be marked with a highly visible crosswalk design and a stop bar. Directional barriers or devices (such as bollards, signs, or other elements) may be necessary to keep pedestrians from stepping off the curb in areas other than the crosswalk.

Refer to Figure 6.7 for an example of a right-turn channelization lane and refuge island at a larger curb radius intersection.

Medians and Center Refuge Islands

Medians and refuge islands are raised longitudinal spaces separating the two main directions of traffic movement in the street. Refuge islands are shorter than medians, typically up to 20 feet long, compared to over 100 feet long. Refuge islands are more commonly used at mid-block crossings than medians, but either provides major benefits for pedestrians and motorists.

Medians and center refuge islands at intersections provide waiting areas for pedestrians and eliminate the need for pedestrian to cross both directions of traffic all at once. Medians and center refuge islands can be created at intersections or mid-block to help define the pedestrian walking space and provide protection and refuge from motor vehicles.

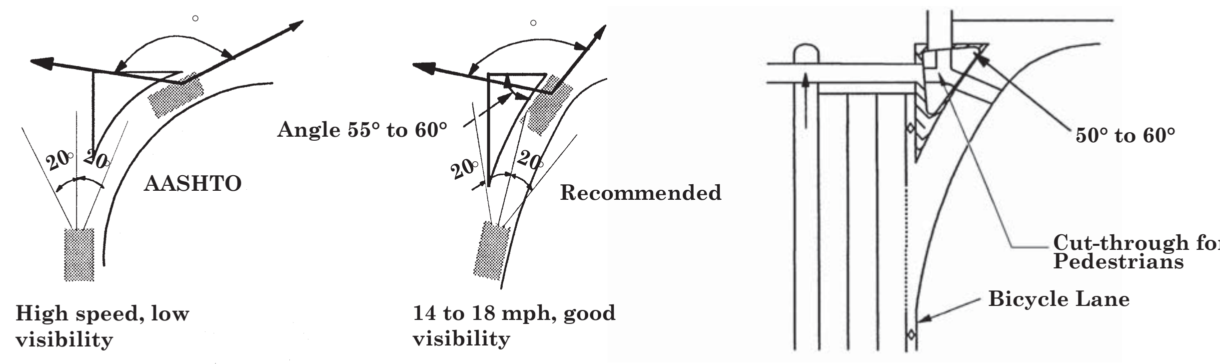
Medians and center refuge islands need to be large enough to provide refuge for several pedestrians waiting at once. They generally should be a minimum of 6 feet wide and preferably 8 feet wide or more where possible. These areas also need to be accessible, with either curb ramps or at-grade cuts. Cut-throughs are generally easier to construct and easier for pedestrians to negotiate than curb ramps, particularly on smaller islands.

Medians or refuge islands are recommended whenever crossing distances exceed 60 feet to provide a waiting and resting area for slower pedestrians. Medians and refuge islands also can be designed to block side street or driveway crossings of the main road and block left-turning movements. Because center medians reduce turning movements, they have the ability to increase the traffic flow rate and safety of the roadway.

Refuge islands can be installed with more flexibility in a variety of locations because they are shorter. Refuge islands are easily located on low volume, low speed roadways, such as 25 to 30 mph collectors or subcollectors through neighborhoods. When collectors are longer and handle more traffic and higher speeds, medians or refuge islands are helpful. On multi-lane minor and major arterials, raised medians or refuge islands are essential.

Figure 6.6

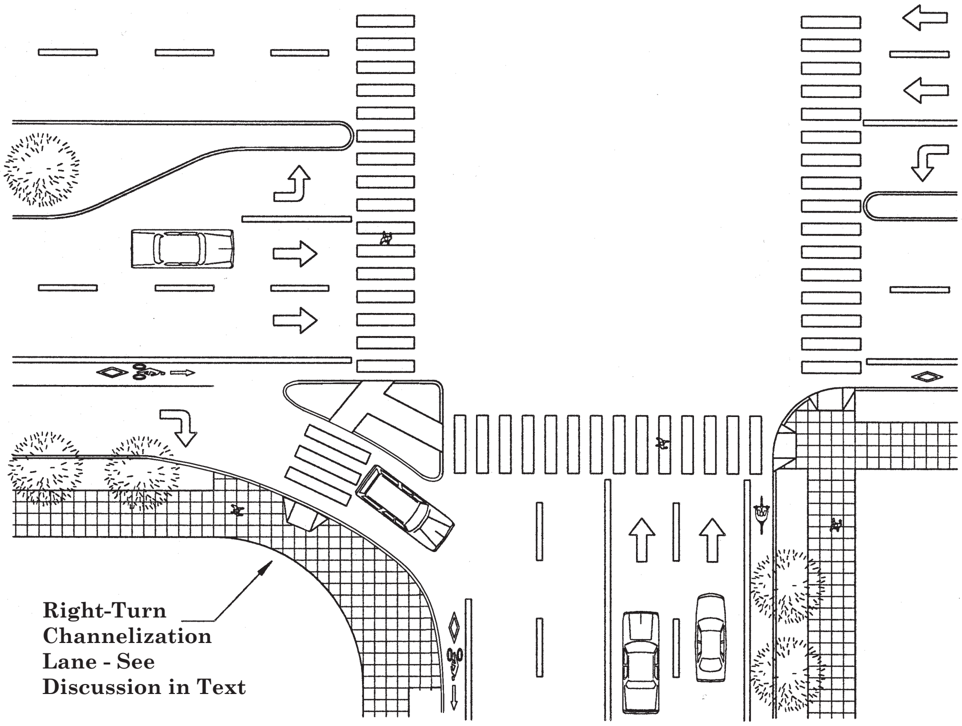
Elongated Refuge Island at Right-Turn Slip Lane



Source: Adapted from Handbook for Walkable Communities, Burden and Wallwork

Figure 6.7

Right-Turn Slip Lane and Refuge Island



Curb Bulb-Outs and Extensions

In addition to reducing crossing distances, curb bulb-outs and extensions make pedestrians more visible to motorists at intersections. Curb bulb-outs and extensions at intersections and mid-block crossings may help to slow traffic by narrowing the street.

Curb extensions and bulb-outs work particularly well on urban streets where there is limited turning traffic by buses and large vehicles or that accommodate one-way traffic, and on minor streets in residential areas. They are also effective in delineating on-street parking zones. Other types of traffic calming techniques are described in Toolbox Section 5, Traffic Calming.

Avoiding or Reconfiguring Multiple and Skewed Intersections

Multiple intersections are intersections with more than four legs or vehicle approaches. Skewed intersections are created when intersections join at awkward angles. These intersections present confussion and problems for pedestrians, bicyclists, and motorists because visibility is sometimes more difficult and turning movements by vehicles are harder to predict.

Minimizing Pedestrian/ Motor Vehicle Conflicts

Visibility and Sight Distance

Providing good sight distance at intersections is commonly overlooked. Facilities such as signs, utility poles, bus stops, benches, and other elements are often added after design and construction of an intersection, inhibiting driver and pedestrian visibility. These elements should not be located in areas that interfere with sight distances. Figure 6.8 illustrates the area at an intersection that typically should be kept clear of obstructions. Refer to ADOT or City of Tempe design standards for the adopted method to calculate sight distance triangles at intersections and driveways.

Elements that obstruct the downward views of high-seat position drivers (such as bus and truck drivers) should also be avoided at intersections (within the sight distance triangle area), including low branching trees, signs, hanging banners, or other elements.

Turning Movements

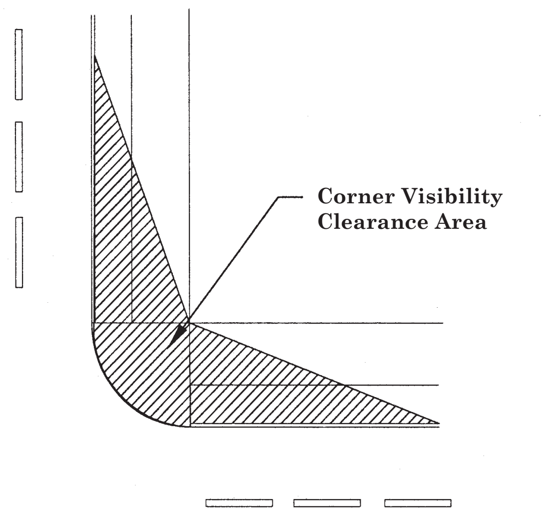
Regulating turning movements at intersections can improve conditions for pedestrians. According to the ITE, 37 percent of all pedestrian/motor vehicle collisions at signalized intersections involve left- or right-turning vehicles. Table 6.3 lists potential solutions to minimize pedestrian/motor vehicle conflicts involving left- or right-turning vehicles.

Right-turn channelization should be used only where warranted by traffic study. The addition of a right-turn lane increases crossing distances for pedestrians and allows vehicles to travel more freely when turning right through the intersection. This may cause inattentive drivers to not notice pedestrians on the right.

Elimination of free-right-turn-on-red movements may be an appropriate solution at certain intersections where there is a high level of anticipated conflict with motor vehicles.

Figure 6.8

Sight Distance at Intersection Corners



Dual Turning Movements

It is strongly recommended that dual turning movements be avoided at intersections used by pedestrians. Warrants for dual turn lanes should be used to ensure that they are provided only if necessary. If dual turn lanes are installed, a separate pedestrian crossing phase in a signal or prohibiting crossing may be necessary.

Dual turning movement lanes are particularly difficult for pedestrians. Dual turn lanes increase the level of unpredictable movements at intersections. Visibility is impaired when multiple vehicles are turning at the same time. In addition, dual turning lanes may not be well utilized by motor vehicles. One lane may be favored and as a result, motor vehicle speeds may be different in each lane. Drivers are often not able to see beyond the car in front or to the side of them to determine if there is a pedestrian crossing the street, a common cause of pedestrians being hit at intersections.

Table 6.3

Reducing Turning Conflicts

- *Design compact intersections with small turning radii that force slower speeds.*
- *Prohibit right-turn-on-red.*
- *When right-turn slip-lanes are used, place crosswalks as far upstream as possible to provide highly visible markings.*
- *Use a separate left-turn phase in conjunction with a "WALK'/"DON'T WALK" signal; or restrict left turns at downtown intersections and on commercial streets, during certain hours when there are higher concentrations of pedestrians at intersections.*
- *Shorten crossing distance and exposure time with curb extensions or bulb-outs.*
- *Provide medians and refuge islands.*
- *Place signs to remind motorists of their duty to yield to pedestrians while turning left or right.*
- *Consider providing an exclusive "pedestrians only" signal phase for all crossing legs at once (pedestrian "scramble") at high pedestrian use intersections.*

Interchanges and Expressway Ramps

Expressways and freeways often present barriers to pedestrian circulation. Pedestrians crossing exit and entrance ramps often conflict with drivers traveling at high speeds. Drivers' attention is often focused on other traffic and not on pedestrians.

Several design treatments can be applied to improve pedestrian crossings at interchanges.

- Provide as short a crossing distance as possible and at a right angle to the ramp.
- The crossing point should be located at either the terminus or the beginning of the ramp, where the vehicle is just entering or has slowed from its exit.

- Entrance and exit ramps that encourage free-flowing motor vehicle movements are not desirable in areas where there is heavy pedestrian crossing traffic. Slowing or stopping of motor vehicles in these areas is strongly recommended.
- Interchanges and access ramps connecting to local streets at right angles are easiest for pedestrians to cross, because crossing distances are reduced and visibility is enhanced. These intersections should be designed in accordance with accepted practices. Controls such as stop signs and signals provide pedestrians opportunities to cross.
- With ramps that merge into the local street system at expressway access points, channelization islands can be installed to provide refuge area for crossing pedestrians. This reduces crossing distances for pedestrians, which helps to improve signal timing. The shorter the ramp crossing distance, the better.
- Pedestrian crossings at controlled access ramps need to be clearly marked and identifiable to approaching motorists.
- Good sight distance and visibility at ramp terminals is an important necessity.
- Grade separation may be necessary. (See discussion later in this section).

Signalization

The needs of all pedestrians shall be considered at all traffic signal installations where pedestrian activity might be expected.

Pedestrian Indications (Signal Heads and Symbols) and Exclusive Pedestrian Phase

Pedestrian signal indications include "WALK"/"DON'T WALK" or the symbolic man/hand symbol used in conjunction with traffic signals. The MUTCD provides a list of warrants for pedestrian indications. Traffic signal symbols used to direct motorists may not provide the correct message to pedestrians. For this reason, it is strongly suggested that traffic engineers fully consider the need for pedestrian indications at ***all*** signalized crossings that have the potential to be used by pedestrians.

Pedestrian indications are typically provided when vehicular movement is controlled by actuated equipment and when pedestrian actuators have been installed.

Pedestrian indications and signal heads need to be installed in clearly visible locations from the crosswalk approaches. Audible devices are being used in some areas. This type of indication is particularly helpful to sight impaired pedestrians.

Research has documented that many pedestrians do not understand the meaning of pedestrian signal indications, particularly the flashing "DON'T WALK" symbol.

Figure 6.9 illustrates the pedestrian indication symbols commonly used throughout the United States, as well as the action to be taken during each phase of the signal indication.

The Pedestrian "Scramble"

Where there is heavy pedestrian crossing activity (near a transit center or college campus, for example), an exclusive pedestrian signal phase may be provided to allow pedestrians to cross in one or more directions. A "pedestrian scramble," where pedestrians are allowed to cross at all directions (including diagonal) within a well-defined intersection area is an example of an exclusive phase application. During this exclusive pedestrian phase, no vehicular movement typically takes place.

Times Countdown Displays at Crosswalks

Timed countdown displays are being installed more commonly in U.S. cities. These displays help pedestrians better understand how many seconds are left in the pedestrian crossing phase of intersections.

Pedestrian Actuated Signals

Pedestrian actuated signals may be warranted at intersections (and mid-block locations) where the there are inadequate gaps in the stream of traffic to provide frequent enough opportunities for pedestrians to cross. Install pedestrian actuated signals only at locations where they are warranted in accordance with the MUTCD guidelines. Adequate sight distance is necessary at these locations, and warning signs should be installed in advance of the signal.

Some examples of locations where pedestrian actuated signals may be appropriate include:

- Intersection crossings where the level of pedestrian activity may be relatively low, but the traffic volume and speed of vehicles is high, or gaps in traffic are not adequate to allow pedestrians to cross;
- Mid-block crossings on streets where pedestrian activity is high and the volumes and speeds of vehicular traffic are also high; and
- Heavily used mid-block bus stops (increased responsiveness of the actuation during times of peak hour pedestrian access to the bus stop should be provided).

Figure 6.9

Pedestrian Indication Sequence

Source: Manual on Uniform Traffic Control Devices

Push Buttons (Actuators/Detectors)

Pedestrian push buttons and detection devices should be conveniently located near the end of crosswalks and in easy to reach positions. They should be located no more than 5 feet from the pedestrian travel way and face toward pedestrians. It is recommended that signs be mounted on the push-button poles to identify which button to cross for each crossing direction. The purpose and use of push buttons should be clearly identified, and they should clarify which crosswalk they are linked to.

In addition to being located at intersections, pedestrian actuators may also be located in intersection or mid-block refuge areas, where pedestrians may be caught crossing during the end of the walk cycle. In some areas with heavy pedestrian volumes, or where signal cycles are particularly long, it may help to place additional actuators in advance of the intersection to decrease pedestrian waiting time. Research shows that when pedestrians have to wait on average over 30 seconds, they have a tendency to not wait. Pedestrian use should be considered when selecting cycle lengths.

The use of motion detectors, infrared, or video devices to automatically change the signal phase when pedestrians approach the crossing is experimental. Also, special signals are being tested that allow vehicles to proceed in an intersection during the pedestrian cycle when there are no pedestrians present. Refer to the MUTCD for additional information.

Signal Timing

Signals are often installed with a focus toward accommodating smooth motor vehicle flows rather than accommodating the needs of pedestrians. Traffic signals are usually timed for vehicle speeds, causing pedestrians to have to stop at nearly every intersection.

Signals with excessively long waits may cause pedestrians to cross against the signal, increasing the potential for pedestrian/motor vehicle conflicts.

Pedestrian push button actuator

Research indicates that many pedestrians stop watching for the light to change, and instead start looking for gaps to cross streets when their delay exceeds 30 seconds. Installation of pedestrian actuation devices can help with this problem.

Signals that do not provide enough time for pedestrians to cross are also a major concern. The walking speed normally used for calculating pedestrian walking time is 4 feet per second, but this may not provide adequate crossing time for all pedestrians.

Studies have indicated that up to 30 percent of the population does not normally walk as quickly as 4 feet per second. Recent research by Knoblauch, Pietrucha, and Nitzburg determined that for design purposes, values of 3 feet per second are appropriate for older pedestrians. Other studies have indicated that some pedestrians with mobility impairments travel at 2.5 feet per second or slower. Table 6.4 depicts the length of time necessary to cross various distances at these speeds. This table is provided to compare the differences in crossing time that can occur with different pedestrian groups.

Set or adjust signal timing to accommodate a greater cross-section of the population. Several sources, including the ITE manual *Design and Safety of Pedestrian Facilities*, are recommending the use of the 3 feet per second travel speed for signal timing. When there is a known presence of slower pedestrians (including elderly and people with mobility impairments) who regularly use a crossing (near a retirement home or hospital), the possibility of extending signal crossing time in these areas should be considered.

WALK Signal Timing

At some intersections, the 4 to 7 second "start-up" time walk interval recommended by the MUTCD may present a dilemma to pedestrians who see the "DON'T WALK" display before they are more than one or two lanes across the street, especially since as discussed earlier, many pedestrians do not always understanding that the flashing "DON'T WALK" symbol doesn't mean to stop walking. It may be desirable to provide a longer "WALK" interval at some locations, like at particularly wide intersections, or in areas where there is clearly confusion among crossing pedestrians.

Mid-Block Crossings

In some urban areas where distances between intersections are long, mid-block crossing points provide pedestrians opportunities to cross safely and conveniently. Mid-block crossings can also provide convenience and safety in less developed areas, where pedestrian activity is high (such as between an apartment site and a grocery store; a school and park; or a transit stop and a residential neighborhood). Figure 6.10 illustrates a typical mid-block crossing.

Determining the Need for Mid-Block Crossings

Locations being considered for a mid-block crossing needs to be carefully studied. The following guidance for determining locations for mid-block crossing installation is provided by the ITE manual, *Design and Safety of Pedestrian Facilities*:

- where significant pedestrian crossings and substantial pedestrian/vehicle conflicts exist (should not be used indiscriminately);
- where the crossing can serve to concentrate or channelize multiple pedestrian crossings to a single location;
- at approved school crossings or crossings on recommended safe school walk routes;
- where land uses create high concentrations of pedestrians needing to cross (such as residential areas across from retail or recreation, and transit stops across from residential or employment);

Table 6.4

Crossing Distances, Speeds, and Time

Crossing Distance	Average Pedestrian Crossing Time at 4 ft/second	Older Adult Crossing Time at 3 ft/second	Mobility Impaired Pedestrian Crossing Time at 2.5 ft/second
24 ft-2 lanes	6 seconds	8 seconds	9.6 seconds
34 ft-2 lanes with bike lanes	8.5 seconds	11.3 seconds	13.6 seconds
46 ft-3 lanes with bike lanes	11.5 seconds	15.3 seconds	18.4 seconds
58 ft-4 lanes with bike lanes	14.4 seconds	19.3 seconds	23.2 seconds
70 ft-5 lanes with bike lanes	17.5 seconds	23.3 seconds	28 seconds

- where pedestrians could not otherwise recognize the proper place to cross or there is a need to delineate the optimal location to cross;
- where there is adequate sight distance for the motorist and pedestrian—any obstacles that would interfere with visibility at the crossing location (mailboxes, utility poles, street furniture, and landscaping) should be removed or relocated, and on-street parking should be set back from the crossing point for improved visibility; and
- installed on the basis of an engineering study if located at other than an existing stop sign or traffic signal.

Smith and Knoblauch developed criteria relating to pedestrian and vehicle volumes for determining where marked crossings should be located. Mid-block crosswalks should generally be avoided under the following circumstances (unless they are stop controlled):

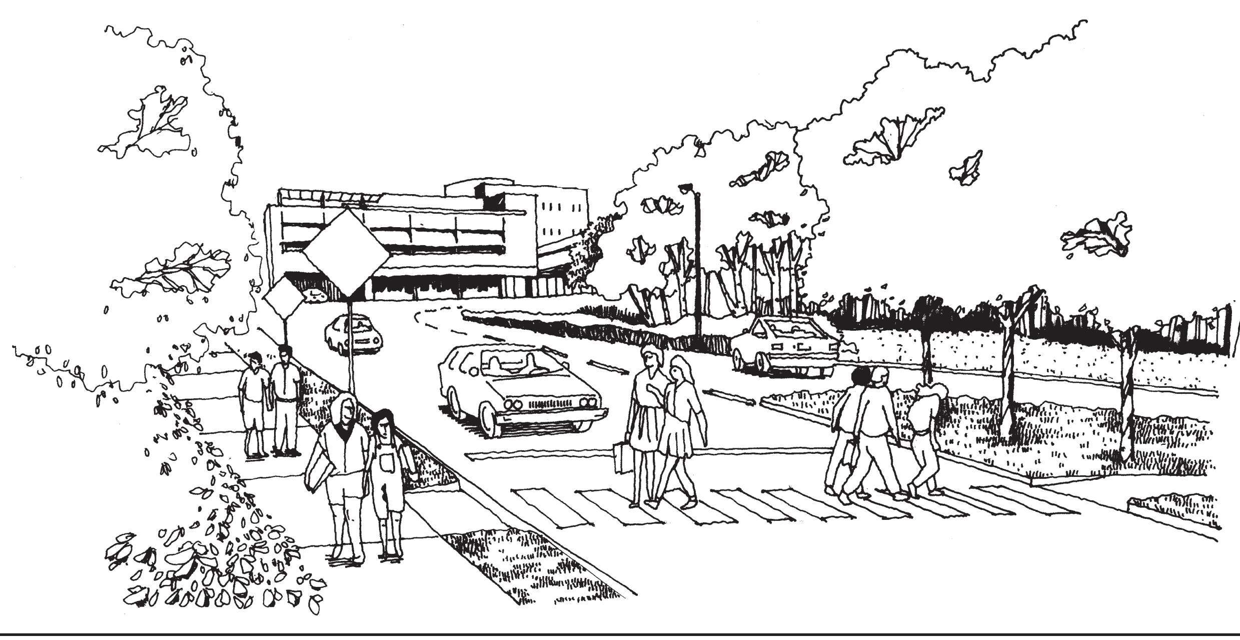
- immediately downstream (less than 300 feet) from a traffic signal or bus stop where motorists are not expecting pedestrians to cross;
- within 600 feet of another crossing point (Knoblauch et. al.), except in central business districts or other locations where there is a well defined need—the recommended minimum separation in most cases is 300 feet; and
- on high speed streets with speed limits above 45 mph.

Mid-block Crossings

Crossing design treatments are often used in combination with one another at mid-block crossings. Standard practices, as well as some more innovative techniques being tested around the country, are described. Determining methods of crossing design treatments and related traffic control requires careful consideration and traffic engineering analysis of existing conditions on a project by project basis.

Figure 6.10

Typical Mid-Block Crossing



It is strongly recommended that all mid-block crossings be marked with highly visible crosswalks, otherwise pedestrians and motorists may have trouble recognizing the designated crossing point. According to the Arizona's "Revised Statutes" (ARS 28-793), pedestrians are not allowed to cross at any place except in a marked crosswalk between adjacent intersections where traffic control signals are in operation. The rules also state that every pedestrian crossing a roadway at any point other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to all vehicles upon the roadway. These rules confirm that all mid-block crossings should be clearly marked so that they are easily recognizable to pedestrians and motorists.

A mid-block crossing of a two-lane arterial is illustrated in Figure 6.11. A mid-block crossing of a five-lane arterial is illustrated in Figure 6.12. Various types of devices that can be used in conjunction with crosswalks at mid-block locations are discussed later in this section.

Mid-Block Pedestrian Actuated Signals

The MUTCD bases the need for pedestrian crossing traffic control on the number of adequate gaps or space between vehicles in the roadway's traffic stream. It states that pedestrians must wait for a gap in traffic that is of sufficient duration to permit street crossings without interference from vehicular traffic. When the delay between adequate gaps or spaces becomes excessive, pedestrians may become impatient and endanger themselves by attempting to cross the street during inadequate gaps.

Pedestrian actuated signals are often appropriate for roadways that have high traffic volumes or speeds, or four or more lanes. Since these signals only operate in the presence of foot traffic, they do not cause undue delay to vehicles during periods of low pedestrian volumes. A signal warrant analysis should be performed to study specific conditions and determine if a pedestrian actuated signal should be installed.

Flashing Beacons

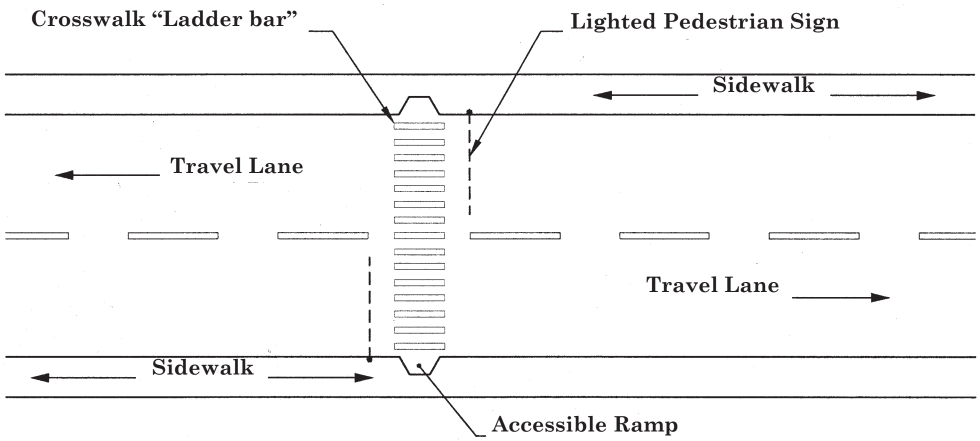
The use of flashing beacons is controversial, because if they are used indiscriminately, motorists eventually tend not to notice them as much. A crosswalk with a flashing beacon provides a relatively low cost treatment for mid-block pedestrian crossings. These devices are authorized by the MUTCD, under the sections related to hazard identification beacons. The flashing light alerts drivers in advance of potential pedestrians without forcing them to stop, unless there is actually a pedestrian in the crosswalk. This sort of device can be used on roadways with higher vehicular volumes without causing any undue delay to drivers. Refer to Toolbox Section 8 — Children and School Zones for more information.

Advance Warning Signs and Pedestrian Crossing Signs (Side or Overhead)

Advance pedestrian crossing signs should always be installed in advance of mid-block crossings (MUTCD Sign W11-2; see Figure 6.3). Placement of advance warning signs depends on the speed of motor vehicle travel and other conditions, such as available sight distance. Refer to the MUTCD for sign placement criteria.

Figure 6.11

Mid-Block Crossing of Two-Lane Arterial



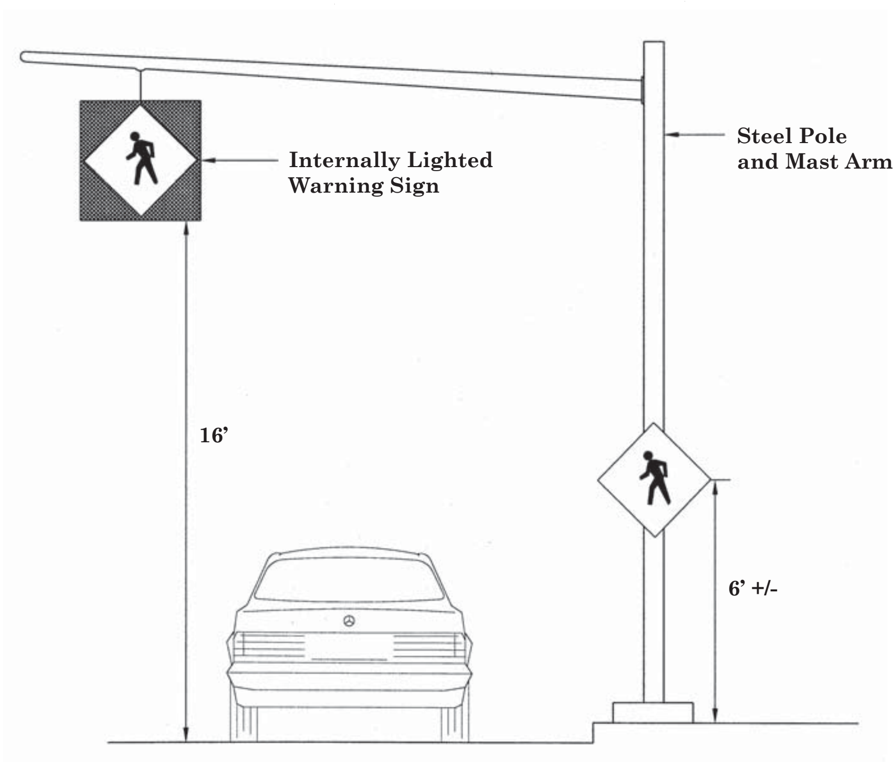
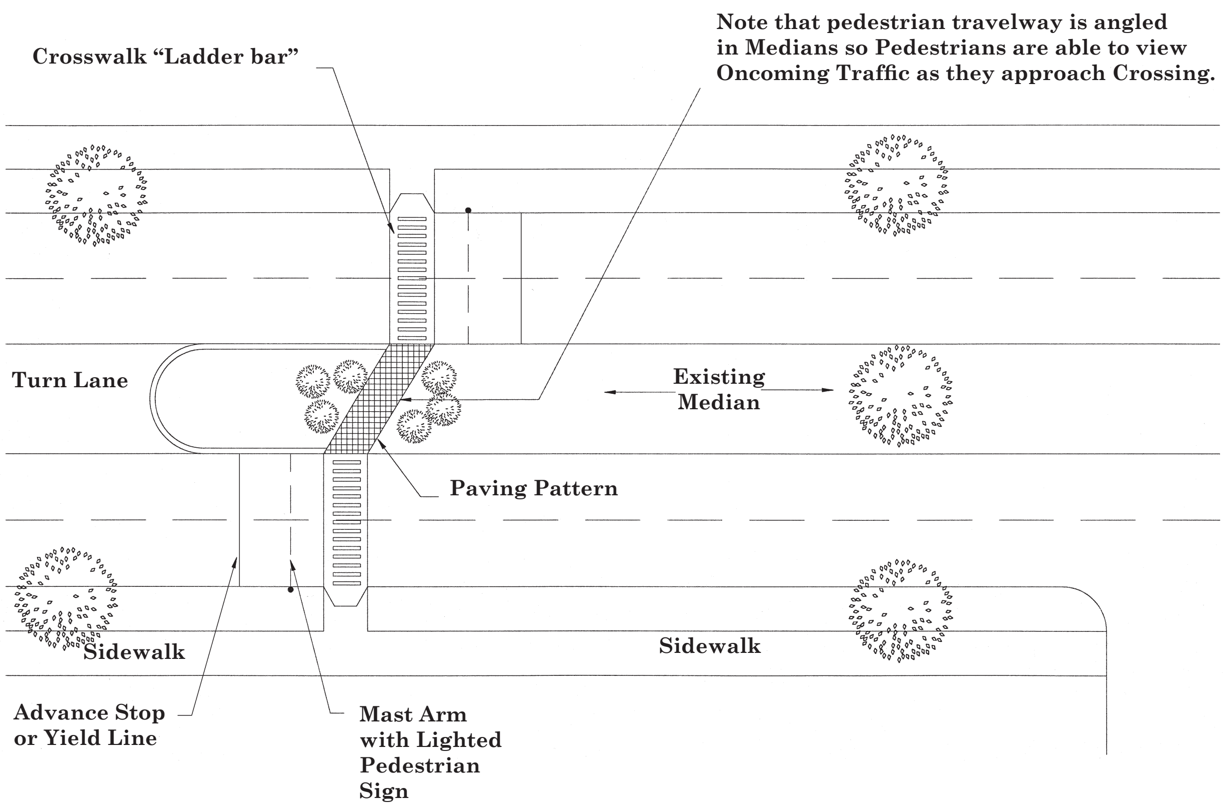
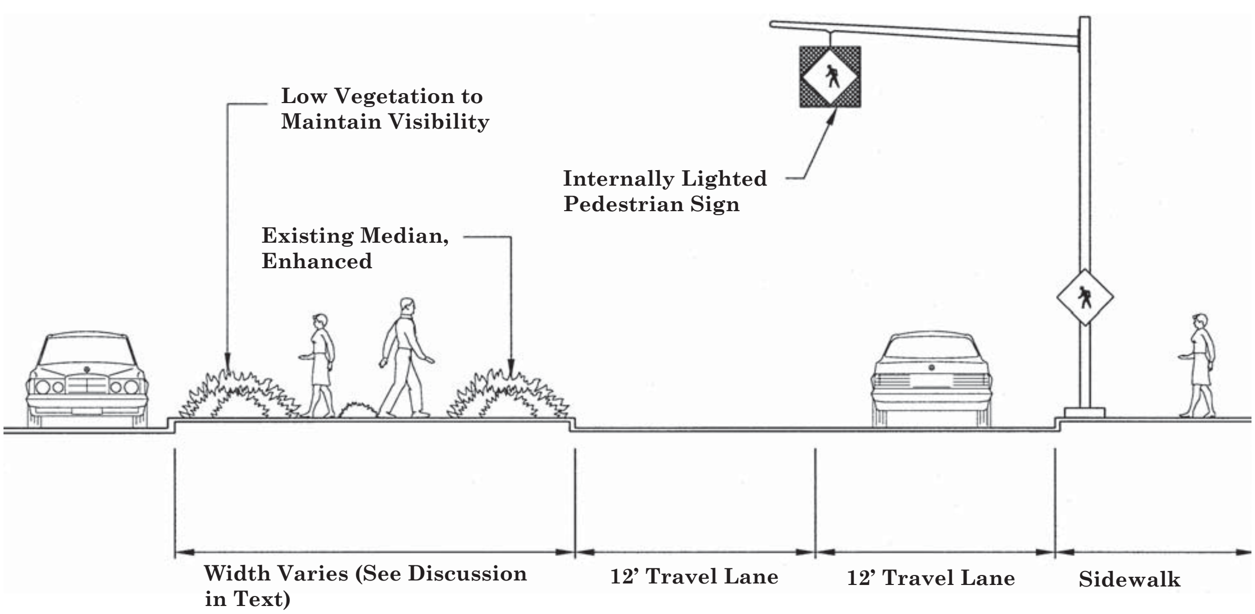


Figure 6.12

Mid-block Crossing of Five-Lane Arterial With Existing Median





Advance pedestrian crossing signs should not be mounted with another warning sign (except for a supplemental distance sign or and advisory speed plate) or regulatory sign (except for NO PARKING signs) to avoid information overload and allow for an improved driver response.

The advance pedestrian crossing sign should be used only at the crosswalk location and not in advance of it. This sign is now commonly being placed overhead of the crossing on a steel pole and mast arm. In some situations the sign is equipped with internal lighting for increased visibility at night.

Other Design Considerations

It is usually necessary to supplement the existing street lighting system with additional lighting at new mid-block crossing locations. It is extremely important that these crossing locations be well-illuminated, so they are clearly visible to motorists driving at night. Fences, barriers, signs, or sidewalk ramps can be used at mid-block crossings and refuge islands to channelize pedestrians to the crossing. Trees and landscaping can also be used to enhance and identify the crossing area, but care must be taken to ensure that these do not obstruct visibility at the crossing in any way.

Other Innovative Technologies

Soft Sandwich

This technique is being used in New Jersey and involves the use of heavy plastic "sandwich board" signs cautioning motorists to yield to pedestrians. These signs are typically placed in the center of the roadway (see Figure 6.13). Earlier "hard" versions of these signs were banned by the New Jersey Department of Transportation because they could become projectile objects when hit by a vehicle. Some towns are now testing flexible or "soft" versions of these signs that will not injure pedestrians or cars when hit. Contact the New Jersey DOT for more information.

Overhead flashing beacon

PUFFIN and PELICAN Crossings

Victoria, British Columbia is experimenting with signalization techniques that help to reduce delays for motorists and pedestrians at pedestrian crossings. PUFFIN (Pedestrian User Friendly INtelligent) signals involve the use of special microwave detectors that sense the presence of pedestrians in the crossing and prevent the light from changing until all pedestrians have cleared the roadway. PUFFIN crossings can help at locations where there is high usage by slow moving pedestrians (hospitals, schools, and retirement homes).

PELICAN (PEdestrian LIght CONtrolled) signals are different from usual pedestrian operated signals in that motorists will face a yellow flashing light sequence in the change over from red to green that allows drivers to proceed if there are no pedestrians in the crossing.

In–Roadway Warning Lights

An effective warning system that alerts motorists when a pedestrian is crossing or waiting to cross the street are in-roadway flashing warning lights. Originally developed from airport pavement warning lights for airplanes, they have been applied in a number of locations around the country. They are now manufactured by several fabricators, and installations are becoming more competitively priced.

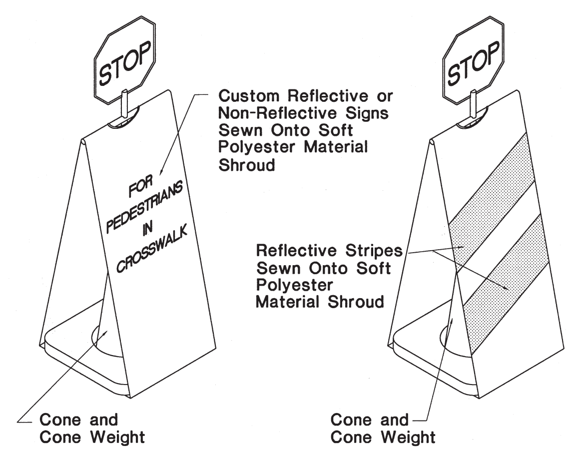
The flashing warning lights are in housings that are slightly larger than reflectorized lane markers and placed directly on the pavement surface 10 feet outside the crosswalk lines. When activated, they flash toward oncoming traffic and are very noticeable by motorists on all but the sunniest, brightest days. Fortunately, when the in-pavement flasher visibility is lowest during sunny days, pedestrian visibility is better because of the weather. On overcast days or at night, in-pavement flashers are very noticeable and provide good warning to drivers.

Animated Eyes

The "animated eyes" sign is another effective method that provides a higher level of warning to motorists when a pedestrian is crossing. These signs were developed by the Center for Education and Research in Nova Scotia, Canada, and have been installed in Florida and other locations, but are still considered to be an experimental technology.

Figure 6.13

Soft Sandwich



Source: Adaptable Barricade Clifton and Cone System, New Jersey

Animated eyes can be used to alert motorists of an impending pedestrian crossing, and they can also be used to remind pedestrians to look both ways for approaching traffic before crossing.

Actuation for these devices requires the same considerations as for in-pavement flashers and other warning devices for pedestrians.

Use of advance stop or yield lines with in-roadway lights and animated eyes is generally appropriate and provides an added element of safety.

Grade Separation

Grade separation may be necessary at crossings where extreme conditions dictate the need for pedestrians to be completely separated from the roadway (or from railroad tracks or waterways). Overpasses and tunnels can provide safe pedestrian crossing opportunities. However, they can also be extremely costly and make it difficult to provide accessibility, unless there is sufficient space for ramping (if not, elevators are necessary). In some cases, if the added travel distances are excessive, pedestrians who want the most direct route may be discouraged from using the grade separated crossing. The use and placement of grade separated crossings should be carefully considered. Types of grade separation treatments are described below.

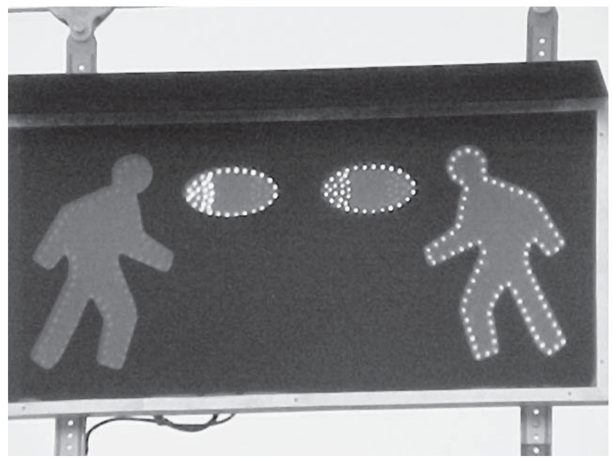
Overpasses and Bridges

Overpasses and bridges should be easy and convenient for pedestrians to access. Pedestrian bridges can vary in their structure and may be constructed of cast-in-place concrete, prestressed concrete, steel, or wood. Choosing the appropriate type of structure requires knowledge of the conditions at the proposed location. Consideration should be given to cost, constructability, maintenance, aesthetics, community connectivity, accessibility, and physical site constraints.

The type of structure chosen will depend on the span length of the bridge as well as the available depth for the superstructure. The depth is usually controlled by the deflection of superstructure due to live load. Since pedestrians will be sensitive to movements of the bridge, a maximum deflection of span length divided by 1,000 should be used. Based on this deflection, the required depth for any given span length can be determined.

AASHTO requires a design live load of 85 pounds per square foot. Some local building codes require a design live load of 100 pounds per square foot. Other loads, such as seismic, stream flow, and wind loads should also be considered in accordance with applicable codes. If the structure is to provide access for emergency or maintenance vehicles, the appropriate design loads should be used. With accessibility requirements resulting in ramped accessible bridges, all bridges must be assumed to provide service to both pedestrians and bicyclists. As a result, a railing to railing width of 12 feet is preferable. If a bridge is to accommodate emergency or maintenance vehicles, a 12-foot width is mandatory.

Bridges built over roadways must maintain 17.5 feet of clearance under the structure. Since pedestrian bridges are lighter than vehicular bridges and would sustain greater damages from vehicle impact, it is good practice to provide 18 to 22 feet of clearance to prevent damage. Clearance over railroad tracks is controlled by the railroad company, but is generally at least 23 feet. Bridges built over waterways should maintain a minimum clearance above the 100-year flood level.



Animated Eyes

Overpasses and bridges are more expensive than at-grade pedestrian facilities and not always conducive to pedestrian use, and thus should only be used in severe and/or dangerous locations, where at grade crossings are not appropriate.

Skywalks and Skyways

Skywalks or skyways are fully enclosed walkways between buildings, typically located at mid-block. They allow pedestrians to pass between buildings without going to street level or being exposed to weather. Design of skywalks will largely be determined by the buildings into which they are built and thus are not discussed in detail in this guidebook. One note of caution related to the use of skywalks: some communities have experienced a loss of pedestrian activity at the street level, negatively impacting the retail businesses and economic vitality of the area. When skywalks are being considered, ways to ensure that street level retail will still be fully accessible and inviting to pedestrians need to be identified. Also, development of skywalks does not preclude the need to provide a full system of pedestrian facilities and ADA compliance at street level.

Underpasses and Tunnels

Underpasses and tunnels provide walkways for pedestrians underneath the roadway or other features. Overpasses are generally easier to supervise and maintain than underpasses. Tunnels may pose greater potential costs and the possibility of drainage problems causing increased maintenance under certain conditions. Before choosing to install a tunnel, soil exploration is required to determine whether a tunnel can be feasibly constructed and whether drainage will be a problem. Tunnels can be designed to let more natural light in and with wide openings to be more inviting to pedestrians. To encourage maximum pedestrian use, tunnels should be easy to access and should be as short as possible. Often, tunnels and underpasses can be designed to be more convenient and desirable for pedestrians to use than overpasses and bridges (typically due to the need for less vertical grade change). Figure 6.14 illustrates a tunnel.

Existing pedestrian overpass in Tempe

Underpasses and tunnels are more expensive then at-grade pedestrian facilities and are not always conducive to pedestrian use, and thus, should only be used in severe or dangerous locations, where at-grade crossings are not appropriate.

Railroad Crossings

Crossing Design Options

At-grade railroad crossings can be difficult for pedestrians to negotiate. They differ from roadway crossings in that when a train reaches a crossing it always has the right-of-way and cannot stop to avoid a pedestrian. There are three types of railroad crossing designs: those with crossbuck signs, those with crossbucks and flashing light signals, and those featuring automatic gates in addition to the crossbucks and flashing lights.

Pedestrian safety improvement options are limited at these locations, since stopping the train is not a viable option. The only recourse to improving conditions for pedestrians is to improve the method of stopping pedestrians or to grade separate pedestrians from the tracks. A warrant analysis should be completed to determine if grade separation is a suitable solution. If the crossing is heavily used by pedestrians on a daily basis (located on a school walk route, or near pedestrian origins and destinations) and grade separation is not an option, it is recommended that it be designed to include the crossbuck sign, flashing light signals, and automatic gates. Another lower cost solution for crossings located on school walk routes is to assign a crossing guard to that location.

Surface Smoothness

The smoothness and slip-resistance of the surface is an important consideration, especially when providing crossings that are part of an accessible route of travel. Concrete used at the crossing area provides smoothness and performs best under wet conditions. Rubberized material can provide a durable, smooth crossing, but can become slippery when wet. If asphalt pavement is used, it must be regularly maintained to prevent ridge buildup next to the rail lines. Timber crossings wear down rapidly and are slippery when wet. The ADA requires smooth surfaces and a maximum lift tolerance between surfaces or at pavement joints of 0.5 inches.

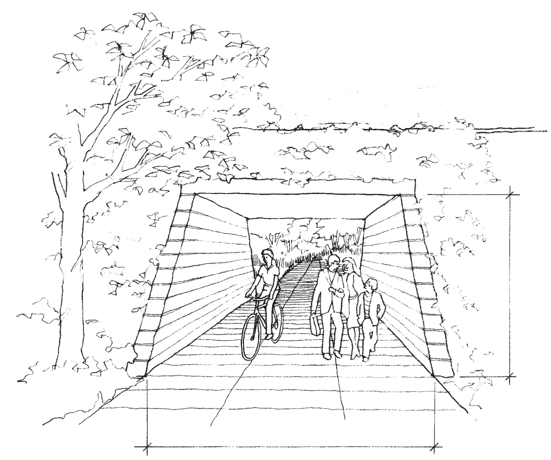
Signing and Marking

It is desirable for stencils and signs to be placed prior to railroad crossings to warn oncoming pedestrians, bicyclists, and motor vehicles, particularly at locations with heavy pedestrian activity.

Angle of Crossing

Figure 6.14

Tunnel



Since trains may be coming in either direction, the optimum condition for pedestrians to cross is at a 90 degree angle to the rail line.

Other Sources of Information

The following sources of information are recommended for design of intersections. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

A Policy on Geometric Design of Highways and Streets, 2004, American Association of State Highway and Transportation Officials

An Analysis of Pedestrian Conflicts with Left-Turning Traffic, Dominique Lord

Flashing Beacons, Association of Washington Cities and the County Road Administration Board

Curb Ramps for Accessible Pathways, Bureau of Transportation Engineering and Development, Office of Transportation, City of Portland

Railroad crossing with automatic gate

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Design Manual, Washington State Department of Transportation

Field Studies of Pedestrian Walking Speed and Start-Up Time, Richard L. Knoblauch, Martin T. Pietrucha, and Marsha Nitzburg

Florida Pedestrian Planning and Design Guidelines, University of North Carolina

Guidelines for the Installation of Crosswalk Markings, Steven A. Smith and Richard L. Knoblauch

Handbook for Walkable Communities, Washington State Pedestrian Facilities Planning and Design Courses, Dan Burden and Michael Wallwork, PE

Manual on Uniform Traffic Control Devices for Streets and Highways, 1988 Edition, US Department of Transportation

Oregon Bicycle and Pedestrian Plan, An Element of the Oregon Transportation Plan, Oregon Department of Transportation Bicycle and Pedestrian Program

"Pedestrian Actuated Crosswalk Flashing Beacons," John W. VanWinkle

Pedestrian Crossing Study, Final Submittal, Pedestrian Traffic Control Measures, Arctic Slope Consulting Group, Inc.

Pedestrian Improvements Demonstration Project, Kirkland Avenue at Main Street, Kirkland Avenue at Third Street, Lake Street South, Specifications and Contract Documents, KPG, Inc.

Pedestrian Signal Installation Policy, David I. Hamlin and Associates

"Pedestrian Signs at Crosswalks Spark Controversy in New Jersey," *The Urban Transportation Monitor*, Volume 10, Number 19

PUFFIN and PELICAN Crossings to Reduce Delays, Office of the Minister for Roads and Ports

Unsignalized Pedestrian Crossings, New Zealand's Technical Recommendation, Roger C.M. Dunn

MULTI-USE PATHS  7

This Section Addresses:

- *Overview*
- *Location Guidelines*
- *Accessibility of Multi-use Paths*
- *Local and Regional Connectivity*
- *Recommendations for Path Design*
- *Recommendations for Trail Design*
- *Multi-use Paths Next to Roadways*
- *Paving and Surfacing*
- *Longitudinal Grades*
- *Shoulders, Side Slopes, and Railings*
- *Connections and Crossings*
- *Managing Motor Vehicle Access*
- *Vegetation and Landscaping*
- *Signage*
- *Seasonal and Nighttime Use*
- *Maintenance*
- *Other Sources of Information*

This section provides design recommendations related to various types of multi-use paths that are independently aligned and not typically located parallel to streets or within road rights-of-way. These types of facilities are generally found along canals and rivers (Rio Salado), and within open spaces, railroad rights-of-way, utility easements, and parks.

Multi-use paths commonly serve a variety of bicyclists and pedestrians, including commuters, school children, neighborhood residents, and recreational users such as joggers and skaters. Multi-use paths are designed for transportation and recreation purposes.

Tempe's *Multi-use Path System Detailed Plan,* created in August 2000, identifies and recommends specific alignments for multi-use path locations and cross-sections for paths already identified in the 1995 Bicycle Plan. The plan shows path connections to areas in Tempe including activity centers, parks, mid-block crossings, and bridges. It also identifies design standards and funding priorites.

Location Guidelines

The *Multi-use Path System Detailed Plan* has outlined criteria that were used to determine where paths would be located throughout Tempe. Table 7.1 provides a list of those factors. Refer to this plan for specific path locations throughout the city. The plan identifies 14 locations as destinations for multi-use paths, including all canal banks, the Rio Salado, and railroad right-of-way.

Multi-use paths provide recreation and transportation choices.

Table 7.1

Path Location Guidelines

- *Improve safety.*
- *Maximize the distance from the edge of the canal to provide access for Salt River Project maintenance vehicles.*
- *Maximize the distance from the railroad tracks.*
- *Maintain a minimum of four feet from the edges of the available space, allowing room for light poles located two feet from the edge of the light path.*
- *Create access to adjoining significant activity centers.*
- *Avoid conflicts with utility poles or railroad spurs.*
- *Provide connectivity to existing bike lanes and paths.*
- *Provide connectivity to transit service.*
- *Locate trees on the south or west side of the path to provide maximum shade.*

Source: Multi-use Path System Detailed Plan

Accessibility of Multi-use Paths

Multi-use paths provide important outdoor recreational opportunities and transportation alternatives for everyone. It is the best design practice to provide pedestrian and bicycle facilities that are accessible. Multi-use paths should meet all Americans with Disabilities Act (ADA) standards.

Local and Regional Connectivity

Multi-use paths enhance transportation mobility and regional connectivity. When well planned, designed, and maintained, multi-use paths can provide convenient routes of travel within communities, linking popular destinations such as parks, schools, and community centers. Paths are not typically an adequate substitute for a full system of on-street transportation improvements, such as bike lanes and sidewalks. Rather, they serve as important linkages in the overall transportation system.

Recommendations for Multi-use Path Design

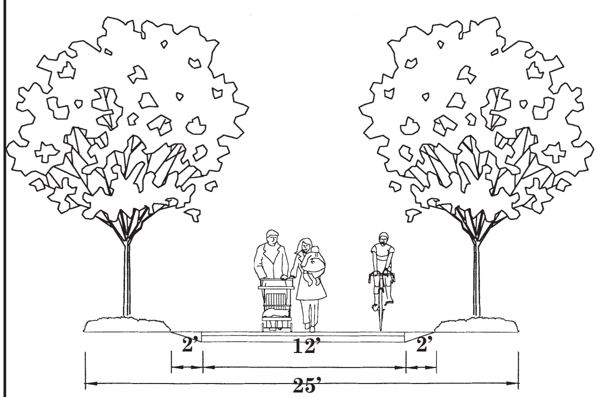
Tempe's *Multi-use Path System Detailed Plan* outlines design standards for multi-use paths. Design dimensions for paths can vary depending on the type of facility, levels of use they receive, and the setting in which they are located. The recommended width for paths is 12 feet. A minimum 10-foot width is acceptable under certain conditions. A 25-foot right-of-way is recommended to accommodate landscape and lighting around the path. If this not available, the easement should at least accommodate a 10-foot path and lighting until additional right-of-way can be acquired.

If a multi-use path must accommodate a higher number of users, it needs to be as wide as possible with a paved width of 12 feet desirable or 10 feet minimum, and with 2-foot wide shoulders on both sides (see *Tempe Guidelines and Standard Details*.) Figure 7.1 illustrates a typical multi-use path shared by pedestrians and bicyclists.

The mix of pedestrians and bicycles on multi-use paths is not always a desirable situation because the potential for conflicts is high. Paths heavily used by commuting bicyclists present problems for families on recreational strolls. Children are particularly at risk on multi-use paths because they tend to travel at slower speeds than average bicyclists and their

Figure 7.1

Multi-use Path



movements are unpredictable. They may change direction unexpectedly in front of an approaching bicyclist. Conflicts between bicyclists and pedestrians can be avoided by designing the path to separate them and/or with adequate width for shared use.

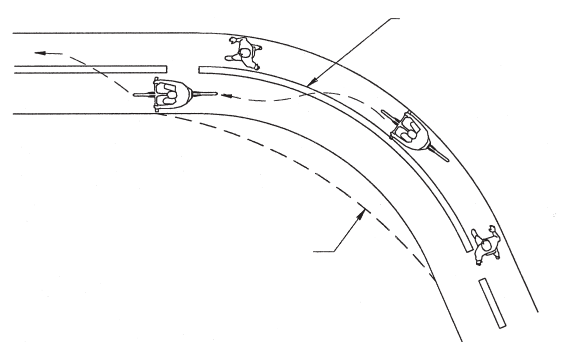
Multi-use paths need to be designed in accordance with applicable standards (refer to ADOT, MUTCD, AASHTO, and Tempe standard design requirements). Adequate visibility and sight distance is crucial. Design treatments that help to improve multi-use paths so that they are safer for use by everyone include the following:

- proper horizontal and vertical alignment to ensure clear lines of sight for pedestrians and bicyclists;
- wide shoulders, 2 feet minimum on each side, to provide stopping and resting areas and allow for passing, and widening at curves;
- avoidance of view obstructions at edges of the path by placing signs, poles, utility boxes, garbage cans, benches, and other elements away from the edge of the path and using low-growing landscaping or high-branching trees;
- use of bicycle speed limits;
- use of delineation and separation treatments; and
- use of directional signing and marking (refer to the *Manual on Uniform Traffic Control Devices*).

A 4-inch wide centerline stripe may be considered for multi-use paths with heavy volumes of pedestrians and bicyclists, on curves with restricted sight distance, and on paths where nighttime use is expected (see Figure 7.2). Edge lines can also be beneficial on paths experiencing nighttime use.

Figure 7.2

Multi-use Path Striping



Recommendations for Trail Design

"Recreation trails" include to trails that are designed primarily for a recreation experience and for walking speeds. The book *Universal Access to Outdoor Recreation: A Design Guide*, developed by the PLAE, Inc. and the USDA Forest Service, provides extensive design guidance related to outdoor recreation trails. It includes a recreation trail rating system and suggests that trails be signed to indicate the level of accessibility: easy, moderate, and difficult.

There are several other sources of information available for trail design. See the list at the end of this toolbox section for other sources.

Unpaved paths are best used for areas with low use and limited purposes or as interim solutions until they can be fully improved (see Figures 7.3 and 7.4).

A separated, soft-surface jogging path may be constructed parallel to multi-use paths using wood chips, compacted crushed rock, or other suitable material.

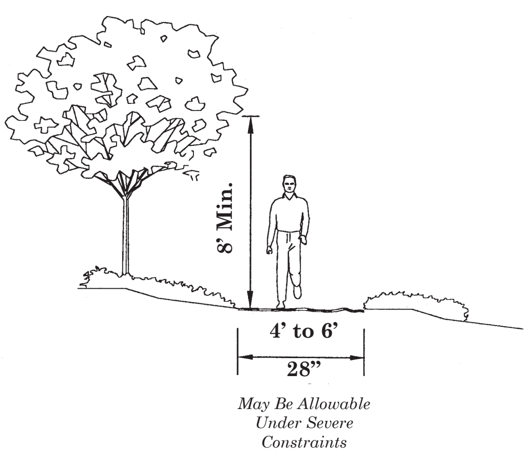
Multi-use Paths Next to Roadways

Multi-use paths aligned along a street often do not function well due to problems related to bicycle use. For example, on a multi-use two-way path, some of the bicyclists will be travelling against the normal flow of motor

Figure 7.3

Unpaved Pedestrian-Only Trail

(Limited Purpose/Interim Solution)



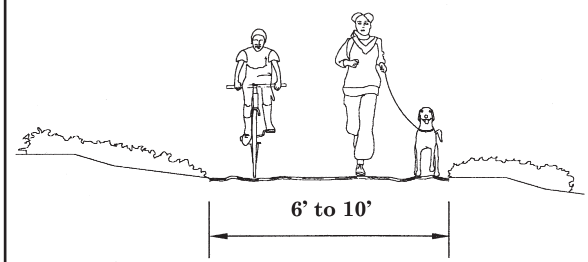
Suggested surfacing options — compacted gravel .25 in. minus, wood chips, grass/grasscrete, boardwalk or trestle.

Source: 2001 City of Kirkland Non-Motorized Transportation Plan

Figure 7.4

Unpaved Trail Section

(Interim Solution)



Suggested surfacing options — compacted crushed rock, 5/8 in. minus; other compacted crushed material or stabilized earth.

Source: 2001 City of Kirkland Non-Motorized Transportation Plan

vehicle traffic, which is contrary to the rules of the road. Conflicts at intersections and driveways are a major concern on paths adjacent to roadways. Motorists will often not notice bicyclists coming toward them on the right, since they do not expect to see them travelling against the flow of traffic. Additional problems are listed in the AASHTO *Guide for the Development of Bicycle Facilities.*

The feasibility of developing a multi-use pedestrian and bicycle path within the right-of-way and adjacent to a roadway should be carefully considered. The following conditions should exist before determining that a multi-use path within the right-of-way is necessary.

- The path can be separated from motor vehicle traffic. AASHTO standards require a minimum horizontal separation of 5 feet or a physical barrier, as illustrated in Figure 7.5.
- Development of bike lanes and sidewalks as an alternative to the multi-use path

Figure 7.5

Path Separation From Roadway

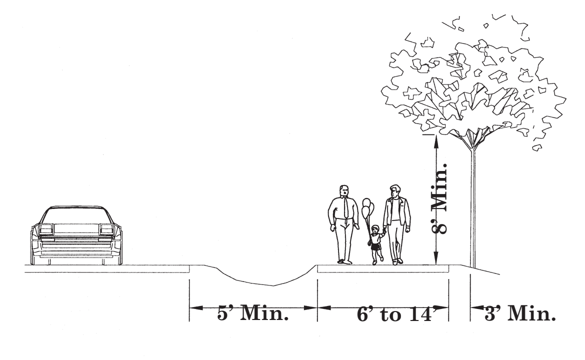
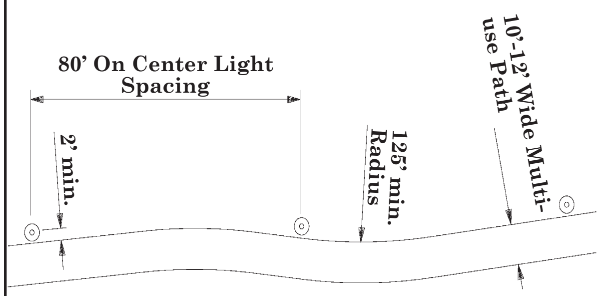


Figure 7.6

Path Guidelines



City of Tempe Multi-Use Path Detail T-656

is not a feasible alternative, because the multi-use path typically is being provided for specific reasons (i.e. safety, connectivity, etc.) in addition to the on-street system.

- There are no reasonable alternative alignments for bikeways and sidewalks on nearby parallel routes.
- There is a commitment to provide a continuous nonmotorized system throughout the corridor.
- Bicycle and pedestrian use is anticipated to be high.
- The path can be terminated onto streets with good bicycle and pedestrian facilities, or onto another safe, well designed path at each end.
- Potential driveway and intersection conflicts can be minimized or mitigated.
- There are popular origins and destinations throughout the corridor (schools, parks, and neighborhoods).
- The path can be constructed wide enough to accommodate all types of users, with delineation and separation techniques to minimize conflicts between users — 12 feet desirable, 10 feet minimum, as shown in Figure 7.6.

When there is no feasible alternative to locating a two-way multi-use path within the roadway right-of-way, adequate separation is required. The wider the separation dimension, the better.

Paving and Surfacing

When selecting paving and surfacing materials, long-term durability, safety, accessibility, cost, and maintenance are usually the most important criteria.

In general, surfacing materials for paths in urban areas should be paved or consist of other hard-surfaced materials. Recreational trails in rural or semi-primitive settings can be constructed of materials that blend with the natural setting but should provide a firm, stable surface.

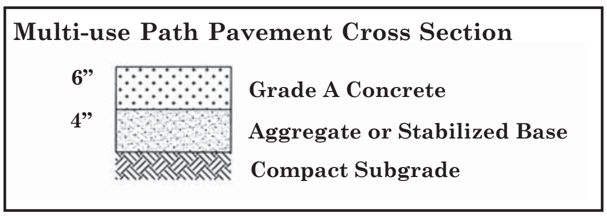
Multi-use paths shared by pedestrians and bicyclists function best when constructed of a smooth, paved, all-weather surface such as asphalt or concrete, regardless of the setting. Paths highlighted in the *Multi-use Path System Detailed Plan* are recommended to be concrete.

All path materials need to provide a firm, stable, and slip-resistant surface throughout the primary seasons of use. A good sub-base, such as compacted aggregate material or fully compacted native soil (if structurally suitable), is also important for structural support of multi-use paths. Tempe recommends 6 inches of concrete over a 4-inch base.

Recommended pavement cross sections are illustrated in Figure 7.7. Pavement conditions should be checked periodically for potholes or cracks, with repairs when necessary to maintain a smooth surface.

Longitudinal Grades

Figure 7.7



Longitudinal grades on paths should be kept to a minimum, especially on long inclines. If a multi-use path serves as an accessible route of travel, it must meet gradient requirements of the Americans with Disabilities Act. On all mult-use paths, grades greater than 5 percent are typically undesirable. If steeper grades are unavoidable on a certain path or trail segment, the design speed should be increased and additional width of 3 feet should be provided for maneuverability on grades exceeding 5 percent. Providing signs alerting users to the maximum slope and advising on a maximum speed are also good measures.

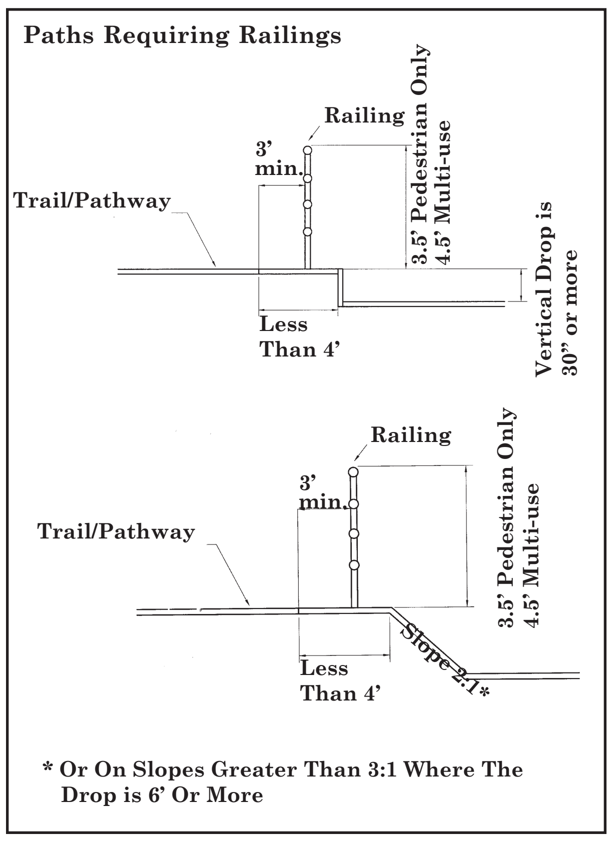
Shoulders, Side Slopes, and Railings

In areas where there are side slopes or ditches, a minimum of 4 feet of clear, level area (including shoulder) is needed before the up slope or down slope (or ditch) begins.

Maximum side slopes of 3:1 are recommended. When the grade drops severely from the shoulder of a pedestrian or bike travel way, railings are required by most jurisdictions. When a vertical drop is more than 30 inches, exceeds a down slope grade of 2:1, and is located less than 4 feet from the edge of the trail, path, walkway, or sidewalk, railing needs to be installed along the extent of the grade drop. Figure 7.8 illustrates conditions where railing is required.

Railings are required by AASHTO to be a

Figure 7.8



minimum of 3.5 feet in height adjacent to multi-use paths. On paths, walkways, and sidewalks used exclusively by pedestrians, the railing can be a minimum of 3.5 feet high. Railings are required to be designed with vertical posts, bars, and top and bottom rails spaced so that a 4-inch sphere cannot be passed through the bars (*Uniform Building Code*, Section 509.3).

A maximum 3:1 slope is also recommended for steep side slopes on the uphill side of paths. Its best to avoid high retaining walls immediately adjacent to paths since they may be out of scale with creating a pedestrian-friendly environment. High walls should be terraced back from the edge of the trail shoulder. Blank walls should be screened with landscaping or designed with an attractive face or artwork.

Connections and Crossings

Initial planning of the routes of paths and trails should minimize crossing points with roads and driveways as much as possible. Paths should connect to street systems and destination sites in a safe and convenient manner. Connections should be clearly identified with destination and directional signing. Where a path or trail that follows a given street encounters a cross street, the crossing should utilize the normal pedestrian crosswalk at the intersection of the streets. Where an intersecting path and street have orientations are skewed, a realignment should be made that brings the angle at the intersection as close to 90 degrees as possible.

Managing Motor Vehicle Access

As a general rule, separated paths function best when motor vehicle access is prohibited or limited to maintenance vehicles for periodic inspection, sweeping, and repairs, utility vehicles, and emergency vehicles. The following design treatments are suggested for managing motor vehicle access on paths.

- Pavement cross-sections with sufficient base and thickness are necessary to support maintenance vehicles while minimizing deterioration. A 6-inch concrete or asphalt thickness over a 4-inch aggregate base is recommended.
- Access points can be provided from roadways for use by maintenance and emergency vehicles, but blocked from use by other motor vehicles with removable bollards or special gates.
- Gates or fencing at side entrances to the path can be specially designed to allow passage for pedestrians, wheelchairs, and bicyclists without providing an access point for motor vehicles.
- Signing can be installed to notify trail and path users that maintenance vehicles may be entering the system at the identified locations; temporary signs and markers need to be carried and placed at appropriate locations as warning devices during maintenance activities.

Bollard Design and Placement

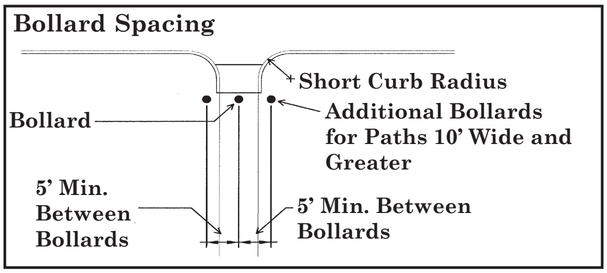
When bollards are placed at path entrances, marking them with bright colored reflective paint or emblems increases their visibility to pedestrians and bicyclists. The recommended minimum height for bollards is 30 inches.

Bollards need to be adequately spaced to allow easy passage by bicyclists, bicycle trailers, and wheelchair users with one bollard in the center of the trail dividing the two-way traffic flow. If more than the center bollard is needed, other bollards should be placed outside the paved area at path edges. Figure 7.9 illustrates suggested bollard placement for various trail widths.

Entrance Design to Restrict Motor Vehicles

Motor vehicles can be restricted from entering paths through the use of special design techniques, such as short curb radii or a split path configuration. Figure 7.10 shows Tempe's standard details (detail T-656) for a split path and intersections with a street or multi-use path. These techniques are most appropriate at locations where maintenance and emergency vehicles do not require access to the trail.

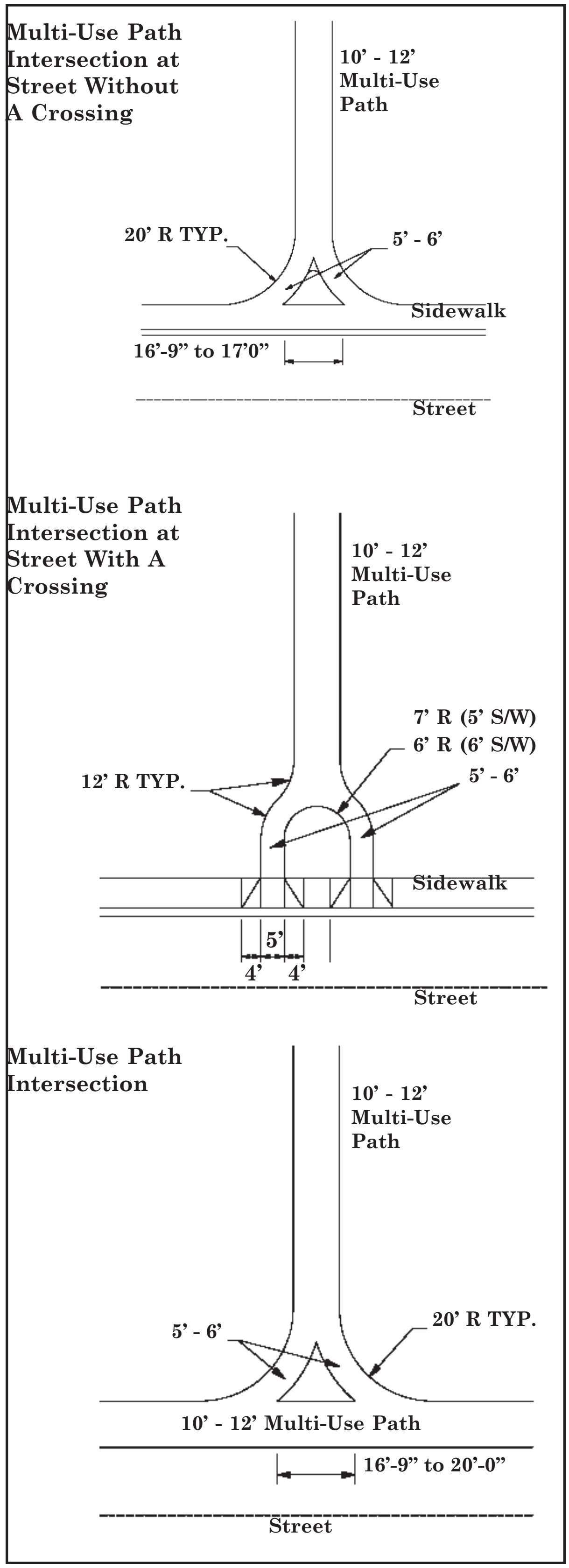
Figure 7.9



Vegetation and Landscaping

The primary objective of landscaping a path area should be identified initially. The *Multi-use Path Detailed Plan* outlines landscape requirements for paths. Table 7.2 shows some these general guidelines. The plan states that "the landscape theme for the path should have consistent elements that visually integrate all paths in the system." Xeriscape treatment is also recommended. Xeriscape is a way to design landscaped areas with minimal water usage. This would include the use of native, desert vegetation along the paths. Landscaping placed along paths need to

Figure 7.10



be carefully selected to avoid the need for excessive pruning, cleanup of fallen debris, and watering. See Toolbox Section 10, Desert Vegetation for more information.

Table 7.2

Landscaping Guidelines for Multi-use Paths

- *Low maintenance, low water use plant material should be used.*
- *Planting design should maximize safety by using low growing shrubs adjacent to the path, in accordance with Tempe's Crime Prevention (CPTED) guidelines.*
- *The use of turf should be avoided except where deemed absolutely necessary.*
- *Plants should not encroach on the path or impede movement along the path.*

Signage

Signage is an important element in the design process. Signs and wayfinding elements will help users identify paths. Sign designs should be consistent throughout the entire pathway system. Sign guidelines are outlined in the *Multi-Use Path Detailed Plan* and summerized in Table 7.3.

Seasonal and Nighttime Use

When paths are frequently used during nighttime hours or during the late fall and winter when darkness occurs earlier, lighting is an important consideration. Lighting should be designed according to applicable local standards, with consideration toward maximizing pedestrian safety and security while minimizing glare and obtrusiveness to surrounding neighborhoods. All lighting should comply with city standards.

Table 7.3

Signing Guidelines for Multi-use Paths

- *Signs should be low maintenance.*
- *Signs should be vandal proof.*
- *Signs must confirm to Tempe's sign ordinance details.*
- *Graphic elements and their placement on signs should be consistent.*

Maintenance

Several suggestions have been provided throughout this section related to maintenance. It is important to establish a maintenance program at the time a project is developed to ensure that the path will function properly over the long term. Maintenance activities should be scheduled during times of typically low path use, if possible. Proper work zone signing should be used when maintenance occurs on or adjacent to pedestrian travel ways.

Other Sources of Information

The following sources of information are recommended for design of multi-use paths. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

Paths should be well maintained for the enjoyment of all users.

1995 Bicycle Plan, City of Tempe

Designing Sidewalks and Trails for Access: Part Two — Best Practices Design Guide, Beneficial Designs, Inc. for U.S. Department of Transportation

Development Manual, Transportation Department, Parks & Community Services Department, City of Bellevue

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CHILDREN AND SCHOOL ZONES 8

This Section Addresses:

- *Special Considerations Related to Children*
- *Improving Student Pedestrian Safety*
- *School Related Pedestrian Improvements*
- *The School as a Community Focal Point*
- *Pedestrian-Friendly Schools and School Zones*
- *Traffic Control and Crossings Near Schools*
- *School Walk Routes and Safety Programs*
- *Education Tools and Programs for Child Safety*
- *Ongoing Maintenance*
- *Other Sources of Information*

The potentially severe, and often fatal, consequences of a collision between a moving vehicle and a child raises high emotions whenever the topic is discussed. Children are more vulnerable than adults to collisions with motor vehicles, because their movements are often unpredictable. Traffic engineering approaches must fully address concerns about the safety of young children walking along or crossing busy streets and highways to schools, parks, neighbors' houses, or between other origins and destinations in our communities.

This sign is used at a school crossing to get the driver's attention.

Special Considerations Related to Children

As pedestrians, children are exposed to more accidents for several reasons. One of the most problematic characteristics of child pedestrians is that their movements are less predictable than adults. Young children tend to dart out into traffic or cross the street without looking for oncoming traffic more often than adults. Young children also lack the visual acuity and peripheral vision to judge speeds of oncoming traffic and adequacy of gaps in the flow of traffic (Knoblauch, et al). Since children do not drive, they lack the understanding of what a driver's intentions

Table 8.1

Some Special Limitations of Children Aged 5 to 9

- *Children are shorter than adults; typical eye height is 3 feet above ground; their field of vision is different.*
- *Children have one-third narrower side vision than adults and are less able to determine the direction of sounds.*
- *Children have trouble judging speeds and distances of moving cars.*
- *Children are sometimes too small to be seen by fast moving or inattentive drivers.*
- *The movements of children are less predictable than adults.*
- *Children have shorter attention spans and may grow impatient at crossings.*
- *Children have less experience as pedestrians and may not be fully aware of dangerous conditions.*

Source: A guidebook for Student Pedestrian Safety; adapted and revised for this toolbox

might be at an intersection or crossing point. Table 8.1 lists the special limitations of children aged five to nine.

Pedestrian collisions occur on all types of streets and under all types of conditions, and unfortunately, child pedestrian injuries even occur on local, residential, and neighborhood streets that are straight, paved, and dry. According to *the National Safe Kids Campaign*, in 1999, almost half of all child pedestrian deaths occurred after school in the late afternoon and early evening. Most of these occurred at non-intersection locations. Driveways also present a danger to young children. Nearly half of all toddler accidents occur when drivers are backing out of a driveway and do not see young children.

It is important to remember the special limitations of this age group when designing for them. Research has shown that adults uniformly tend to overestimate a child's capabilities to deal with traffic, particularly when crossing the street. Adults sometimes fail to realize that many children under age nine lack the developmental skills to safely and consistently cope with moving traffic.

Children have the right to travel safely as pedestrians, just as we all do.

Improving Student Pedestrian Safety

The safety of students walking to and from school is a major concern for parents, teachers, schools, public works, law enforcement, and the general community. One of the most important tools for communities to develop is a safe walking route plan for children. It is also important to develop a plan to determine which students walk to schools and which ride the school bus. The basics about developing school walk routes are described later in this toolbox section. The responsibility for student pedestrian safety goes beyond development of "safe walk routes" by school districts. Preparing walk route plans is only part of the overall process (see Table 8.2).

Table 8.2

Process for Improving Student Pedestrian Safety

- *Prepare school walk route plans.*
- *Provide school walk route maps and information to parents and students.*
- *Identify pedestrian safe deficiencies.*
- *Implement remedial actions and improvements to address pedestrian safety concerns.*

Identifying problems and implementing improvements to address these problems in school zones and along school walk routes should be accomplished through a cooperative effort among public agencies (capital investments and public works funding programs), school districts, private developers, and others in the community to ensure maximum success.

All of these entities must work together and coordinate with each other to develop pedestrian improvement programs that provide better opportunities for children to walk to school. Additional traffic and pedestrian studies may be needed to identify deficiencies in walking routes. These are identified later in this section.

Tempe school districts should work with the Public Works Department and traffic engineers to mitigate walk route deficiencies. If hazardous walking conditions are improved, more students will walk to school, reducing ever-escalating transportation costs, while at the same time making walkways safer for the community-at-large. Refer to ADOT's *Traffic Safety for School Areas* for more details on student safety.

School Related Pedestrian Improvements

There are two key components of a pedestrian improvement program that ensure safer conditions for school children:

- a sufficient level of physical facilities provided along the school walking route and adjacent to the school; and
- effective operation plans and safety programs, consisting of supervisory control elements and student/adult education for school trip safety.

This toolbox section focuses on design recommendations for physical facilities surrounding schools and along school walk routes. Information related to school walk route safety programs is provided at the end of this section.

The School as a Community Focal Point

A broader consideration related to the design of pedestrian access to schools is how the school is oriented within the community and connected to surrounding neighborhoods. Schools are often a focal point of the community, serving as much more than a place of education, by providing outdoor fields and facilities for play, recreation, meeting, voting, and other community services. Siting a school so it can be easily reached from all directions and providing a sufficient level of pedestrian facilities in the vicinity of the school further help to establish it as a strong component of the community.

School sites should be centered in the community and accessible to pedestrians from all sides. Schools can function both as neighborhood parks and school playgrounds. Streets leading to the school site should be designed to include full sidewalks or walkways and other elements that contribute to pedestrian safety and comfort (traffic calming to slow traffic, good lighting, clear visibility, and trees for shelter and shade).

Intersections and crossings within the vicinity of schools need to be well designed, with a focus on the needs of student pedestrians. Schools should be located where major street crossings are minimized. When possible, older schools should be refurbished instead of building new ones. Older schools are typically located in established residential neighborhoods and can serve as an important community focal point. Table 8.3 lists important elements of a school as a focal point within the community.

Table 8.3

The School as a Community Focal Point

- *The school site is centrally located in the community; most children live within one mile.*
- *Pedestrian and bicycle access is available from all directions.*
- *Sidewalks, bike lanes, and trails on adjacent streets or through neighborhoods connect to the school property.*
- *Linkages between surrounding neighborhoods, such as access between cul-de-sacs, provide enhanced pedestrian connections to the school.*
- *Effective traffic control devices are provided within the surrounding vicinity.*
- *School facilities, including playgrounds, fields, and meeting rooms, are available for community use.*
- *Because of the level of pedestrian improvements in the area and the design of the school site, children and adults feel comfortable walking to the school rather than riding the school bus or driving cars.*

Pedestrian-Friendly Schools and School Zones

School sites and surrounding areas should be designed to invite pedestrian travel while also improving pedestrian safety.

School Site Design

Design and retrofit of schools and school grounds requires consideration of many factors, too numerous to list in this toolbox, but some of the basic principles of good school site design related to pedestrian travel are provided. Specific sites may have unique conditions that require special design treatments. Good design solutions are typically based on the adopted standards and practices of the local jurisdiction, but design solutions can also exceed established standards where desired or necessary to provide a more effective pedestrian system.

Table 8.4, on the following page, lists typical elements on and adjacent to school sites that function well for pedestrians and encourage pedestrian travel.

Figure 8.1 illustrates a typical school site design that includes many of these features. Design will differ, however, when designing for an elementary school as opposed to a high school or middle school. ADOT's *Traffic Safety for School Areas* discusses design standards for each school type including elementary, middle, and high schools.

Pedestrian Access Routes to Schools

Sidewalks and walkways that clearly define the routes of access to and from schools should be provided in all areas surrounding the school and on the school site. Vertical separation (with curbs) and horizontal separation (planting buffers, ditches, or swales) from motor vehicle traffic are strongly encouraged to improve the safety of pedestrians walking along streets.

On roads without sidewalks, widened roadway shoulders can accommodate pedestrians. Shoulders may be paved or unpaved, but if unpaved, a well compacted stable surface of crushed rock or other material is highly recommended. At a minimum, *A Guidebook for Student Pedestrian Safety* recommends that shoulders that are part of a designated school walk route be minimum 5 feet wide

Table 8.4

Elements of Good School Site Design

- *Surrounding streets are equipped with sidewalks and bike lanes.*
- *The building is accessible to pedestrians from all sides (or at least, from all sides with entries/ exits).*
- *Trails and pathways provide direct links between the school site and the surrounding neighborhoods.*
- *Bus drop-off zones are separated from auto drop-off zones to minimize confusion and conflicts.*
- *Buses, cars, bicycles and pedestrians are separated and provided with their own designated areas for traveling.*
- *Pedestrian travel zones (sidewalks, etc.) are clearly delineated from other modes of traffic (through the use of striping, colored and/or textured pavement, signing and other methods).*
- *Parking is minimized; people are encouraged to walk to school.*
- *Pedestrians are clearly directed to crossing points and pedestrian access ways by directional signing, fencing, bollards or other elements.*
- *Strategically located, well-delineated crossing opportunities are provided, including marked crosswalks at controlled intersections and mid-block crossings (signalized if warranted).*
- *Traffic calming devices (raised crossings, refuge islands, bulb-outs at crossings, on-street parking, traffic circles, landscaping, etc.) are installed in the vicinity to slow vehicles.*
- *View obstructions are avoided so there is clear visibility of pedestrians throughout the area.*
- *Parking restrictions are required in areas close to school walk routes.*
- *Bus unloading zones should be separated from vehicular traffic.*
- *Student crossings and bus loading zones should provide adequate light.*

(8 feet preferred) and be provided on both sides. If a shoulder can only be provided on one side, provide a minimum of 8 feet in width to allow students to walk off the roadway in either direction. Although this is not the most desirable solution (shoulder on only one side), it is better than a scenario where there are no pedestrian travel areas at the roadside.

School Bus Stop Design

Bus stops need to be adequately designed to provide sufficient waiting area away from the roadway for the number children using the stop. Bus stops are often designed and constructed as part of private development projects. Figures 8.2 and 8.3 illustrate two typical designs for school bus stops on residential streets — one for areas where sidewalk either exists or can be constructed, and one for areas where roadside walkways or widened shoulders function as the pedestrian travel zone.

Visibility at Crossings and Along School Walk Routes

Children are smaller than adults and more difficult for motorists to see at crossings. To function safely, crossings should provide an unobstructed visual field between motorists and pedestrians. Street furniture, such as utility poles, mailboxes, and telephone booths should not hide the pedestrian from view. Landscaping can enhance the pedestrian environment and trees can provide shade and shelter from hot weather. However, care must be taken to select lower growing plants and shrubs that won't block views of pedestrian. A maximum shrub height of 2 feet is suggested for

Figure 8.1

School Site Design

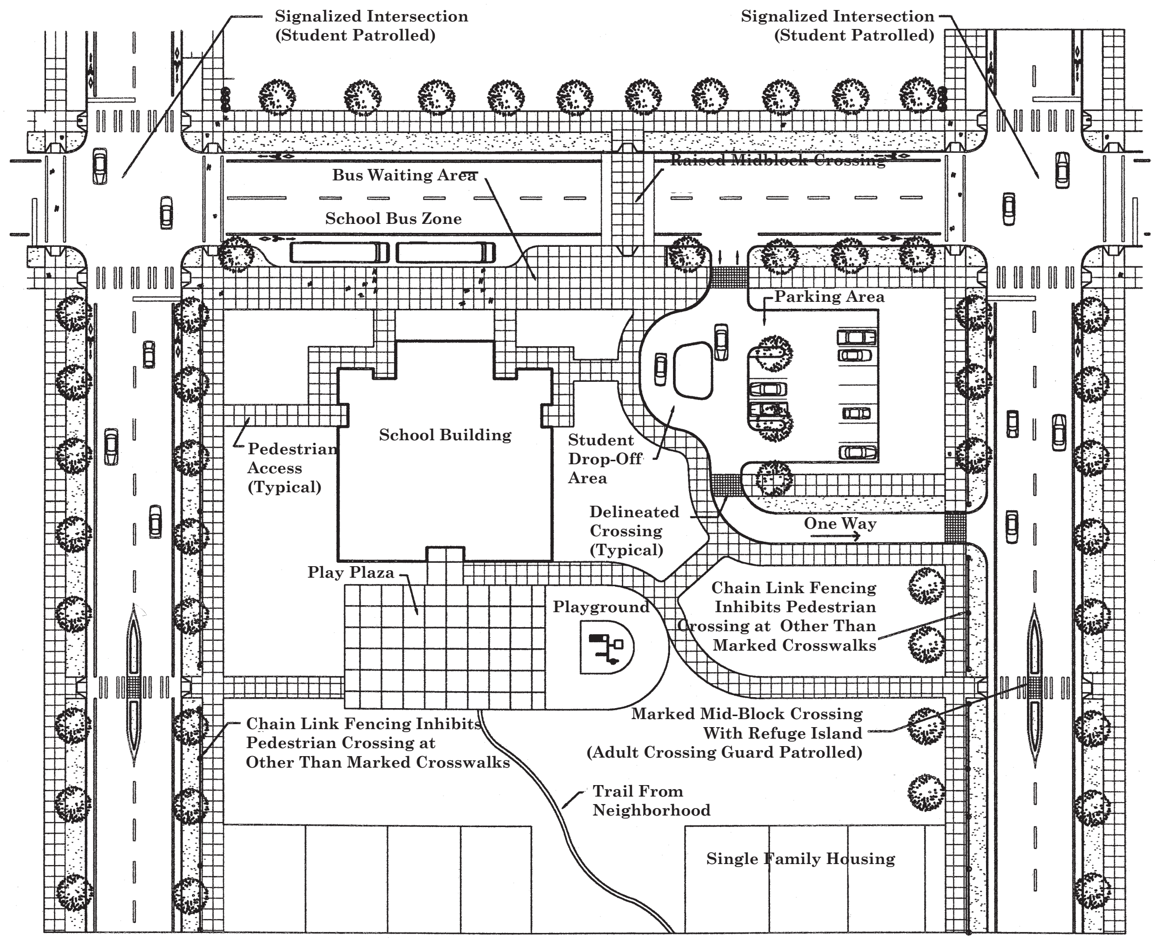


Figure 8.2

Typical Bus Stop Design for Sidewalk

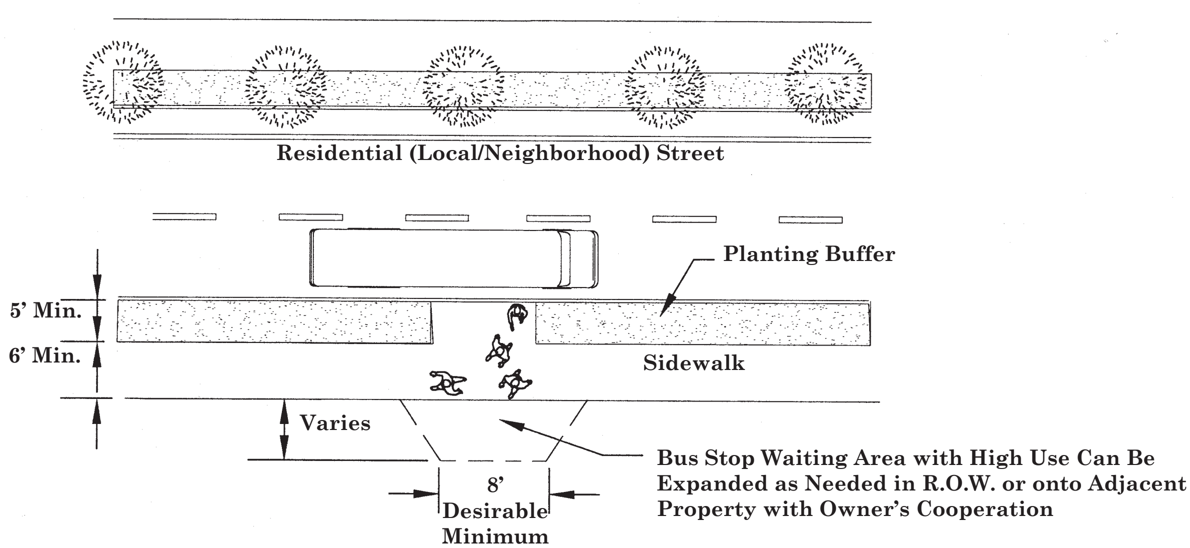
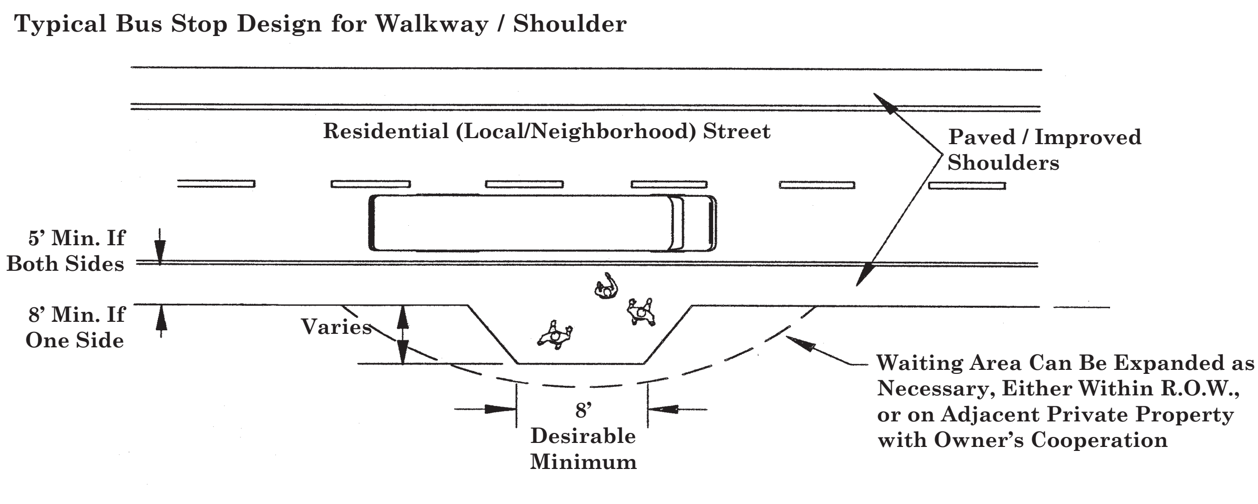


Figure 8.3



school zones. Trees along streets should be upward branching, with lower branches located at least 6 feet above ground. See Toolbox Section 10, Desert Vegetation for recommended plantings.

Parked vehicles (even momentarily) are also visual obstructions, especially for children, wheelchair users, and people of small stature. For recommended setbacks for parked vehicles near pedestrian crossing points, refer to Toolbox Section 3, Pedestrian and Bicycle Friendly Streets.

Traffic Control and Crossings Near Schools

Special considerations related to various types of crossings and traffic control methods used near schools are described in the next part of this section of the toolbox.

General Considerations

Traffic control related to schools is a sensitive and controversial subject. The methods used to protect children as they walk to school need to be carefully considered and analyzed by traffic engineering professionals on a case-by-case basis before solutions are implemented.

According to the Institute of Transportation Engineers (ITE) manual, *Design and Safety of Pedestrian Facilities*, the majority of drivers do not typically reduce their speeds in school zones unless they perceive a potential risk, such as the presence of police or crossing guards, or clearly visible children. Overuse of signs and other devices can cause drivers to be less responsive and attentive. Unnecessary installation of traffic controls lessens the respect for traffic controls that are warranted. Placement of signs, crossing treatments, and traffic control devices need careful consideration.

According to the ITE's *School Trip Safety Program Guidelines*, a number of elements should be studied to determine the appropriate types of crossing treatments and traffic control in school zones or along school walk routes, including, but not limited to:

- existing and potential traffic volumes and speeds,

- inventory of existing traffic control devices and roadway facilities,
- adequacy of gaps in the stream of traffic,
- numbers and ages of children crossing (pedestrian volumes and characteristics),
- adequacy of sight distance,
- collision statistics, and
- location of the school and relationship to surrounding land uses (both existing and planned).

These elements should be considered under the direction of a professional traffic engineer and the results reviewed with Tempe's Public Works Department, as well as a safety advisory committee established by the school district. There are many variables related to these elements and how they might influence design treatments.

Types of Traffic Control and Crossing Treatments

There are several types of crossing treatments and traffic control devices that may be appropriate in school zones and along school walk routes under varying conditions. Crossing treatments are usually necessary at locations where adequate gaps are not currently available in vehicular flow to allow school children to cross safely. Below are potential types of traffic control and crossing treatments that may be implemented near schools. More detailed design information for many of these can be found in other sections of this toolbox.

Reduced Speed Zones

The maximum speed limit is typically 20 mph for school zones (inside or outside incorporated cities or towns). This speed limit is usually required to extend 300 feet in either direction from the school and from marked crosswalks near the school. A lower maximum speed limit may be established within a school zone or other area if determined that on the basis of an engineering and traffic investigation, the maximum speed permitted is more than reasonable and safe under existing conditions. Consider reducing the speed limit to lower than 20 mph in school zones where special hazards exist and a traffic engineering study determines that such a speed reduction is warranted.

Speed limits need to be reduced in school zones, and special signing can enhance safety.

Traffic Calming

Traffic calming techniques are used to slow vehicles and to reduce non-local through-traffic. Various techniques can be used on all classifications of roadways, but traffic calming is generally very effective on local access streets in residential areas.

On street systems surrounding schools and in school zones, traffic calming can be an effective means to create a safer and more comfortable environment for children walking to school. Some examples of traffic calming techniques that may be appropriate include raised crossings, refuge islands at crossings, traffic circles, chicanes, bulb-outs, speed humps, narrower streets, on-street parking, trees and landscaping along rights-of-way, and at gateways. Speed enforcement and speed watch programs are also good methods for calming neighborhood traffic in school zones, although their effectiveness may only last for a limited time, unless consistently implemented. Refer to Toolbox Section 5 for more specific design recommendations related to traffic calming.

Marked Crosswalks

The issue of providing marked versus unmarked crosswalks at intersections is often debated. For a discussion on studies related to the effectiveness of marked and unmarked crosswalks, refer to Toolbox Section 6, Intersections and Crossings.

All crossing points within school zones and along school walk routes, typically within one mile of a school site (but may include intersections and crossings outside of this distance), should be evaluated to determine where to mark crosswalks. The *Manual on Uniform Traffic Control Devices* (MUTCD) requires crosswalks to be marked at all intersections on established routes to schools:

- where there is measurable conflict between vehicles and kindergarten or elementary students (while crossing);
- where students are permitted to cross between intersections; or
- where students could not otherwise recognize the proper place to cross.

Marked crosswalks are often located at signalized and stop-controlled intersections or mid-block crossings, or at intersections or locations where traffic volumes meet warrants for pedestrian signals using the MUTCD guidelines. Marked crosswalks may be provided at other locations when a traffic engineering analysis determines the need.

School patrolled crossings (with either student patrollers or adult crossing guards) should not be operated unless proper traffic control devices are in place. At a minimum, these devices shall consist of school crossing warning signs (S1-1 and S2-1), marked crosswalks, and school speed limit signs.

Stop Controlled Crosswalks

Stop controlled crosswalks, consisting of stop signs and stop bars, with or without actual crosswalk markings, provide the added protection of having all vehicles stop at the crossing. Since vehicles must stop at the stop signs in these locations, there is typically less need for paid adult crossing guards or student patrols. Additional protection with crossing guards and/or student patrols may be necessary at intersections where pedestrian volumes are high and traffic volumes are moderate or higher.

A school-patrolled marked crosswalk

Signalized Crossings (With Pedestrian Actuators)

New traffic signals should provide marked pedestrian actuation buttons and symbolic “walk/don’t walk” indications. It is appropriate to install signals at locations other than intersections for pedestrian crossings, under certain conditions. Examples include frequently used mid-block crossings and crossings to school sites.

The MUTCD defines warrants for installation of traffic signals at school crossings. The MUTCD recommends that a traffic engineering study be conducted to determine the frequency of gaps in the vehicular traffic stream that allow pedestrians to cross. When crossing gaps are less than one per minute and of insufficient duration to allow the size of group to cross, a signalized crossing may be needed.

Provide pedestrian signal indications and push buttons at signalized school crossings and mark the designated crosswalks. For a complete discussion on signal placement and design, refer to the MUTCD.

The services of a school patrol program (adult crossing guard or student patroller) may not be necessary at all signalized intersections near the school unless special problems exist. School patrol services can provide additional protection at intersections where pedestrian volumes are high and traffic volumes are moderate to high. See the discussion under School Patrolled Crossings for appropriate locations for adult crossing guards versus student safety patrollers.

More information related to intersections, crossings and signalization can be found in Toolbox Section 6, Intersections and Crossings.

Flashing Beacons

Flashing beacons are common devices used in school zones, and they come in varying styles such as mounted to school speed limit signs, and overhead crosswalk signs. The effectiveness of flashing beacons is an often debated issue. The flashing light alerts drivers in advance to the potential of pedestrians without forcing them to stop. Some studies indicate that after drivers have become accustomed to seeing the beacons in advance of conditions that do not appear to be truly unusual, they stop paying attention the flashing light. This can result in a disregard for all beacons, even those that are truly needed (*Flashing Beacons*, Association of Washington Cities and County Road Administration Board).

Flashing beacons are most effective when used as a warning of truly unusual or hazardous conditions not readily visible to the driver, such as a stop sign located just beyond a curve that is hidden from view of the driver. It is a common practice for flashing beacons to be attached to school speed limit signs. These beacons are only activated during hours that students are present in the school zone. Flashing beacons are discussed under section 4E of the MUTCD relating to hazard identification beacons, and a mid-block crosswalk is one of the specific applications noted for this device. Please refer to the MUTCD for more specific guidance related to the use of flashing beacons.

Grade Separated Crossings

Grade separated crossings may be necessary to physically separate the crossing of a very heavy volume of school pedestrian traffic and a heavy vehicular flow, or where the roadway’s cross section is exceptionally wide, such as freeways and principal arterials. Typical types of grade separated crossings include overpasses and underpasses. Because these facilities are costly in comparison to other crossing solutions, they should be considered only in areas where large numbers of pedestrians will benefit. Grade separated crossings need to be easily accessible and convenient to use or they may lose their effectiveness. Pedestrians may be tempted to try crossing at grade instead of using the overpass or underpass.

Crossing Guard and Student Patrol Controlled Crosswalks

Some specific design considerations related to school patrolled crosswalks (adult crossing guard or student patrolled) have already been discussed under the various traffic control and crossing treatments in this section. Traffic engineering studies can determine the need for and placement of school patrols at crosswalks on a case-by-case basis.

The use of well-trained adult crossing guards is considered to be one of the most effective methods of school zone traffic control. Student safety patrollers, who are most often students at the school, can also provide supervision and direction at crosswalks near schools. Adult crossing guards can be appointed as members of the school patrol under certain conditions (see Table 8.5).

Adult crossing guard at busy intersection near an elementary school.

Crossing guards should be hired employees, trained to work with children. Untrained or volunteer crossing guards may not be adequately prepared to assist children in emergency situations.

Training for crossing guards includes making sure guards are in the proper location for maximum supervision of children and making sure guards interact with children to teach them the right techniques for crossing streets. Crossing guards should wear an easily identified uniform and carry identification and phone numbers for authority in case of emergencies.

Sometimes vehicular traffic is such that control by a police officer or adult school patrol member or a traffic signal is required. In this case, student school patrol members can assist by directing students

Table 8.5

When to Utilize Adult Crossing Guards

- *When there is a lack of adequate gaps due to high volume of traffic*
- *When 85 percent of the traffic exceeds the speed limit by 5 mph*
- *When there is restricted sight distance*
- *When the location or distance from the school building is such that poor supervision of students would otherwise result*
- *When there is a high volume of traffic in a crosswalk*
- *When the location has been determined by either school or law enforcement authorities to be beyond the capacity of a student to make rational decisions concerning safety*
- *When there is a high volume of pedestrian traffic over a highway*
- *When any of the above criteria exists and there is no alternative school route plan*

to cross in conformance with the direction given by the police officer or adult patrol member, or in conformance with the time cycle of the signal. Student safety patrol members should typically be selected from upper grade levels, preferably not below the fifth grade. Student safety patrollers should not be directed or authorized to halt or direct vehicular traffic. Their purpose is to supervise and assist children, not to control vehicular traffic.

Signing and Marking

The types of school signs authorized by the MUTCD are shown in Figure 8.4. The sign placement requirements discussed below are from the MUTCD. Arizona Revised Statute 28-641 states that Arizona traffic control devices shall correlate with the MUTCD guidelines as much as possible.

School Advance Sign (S1-1)

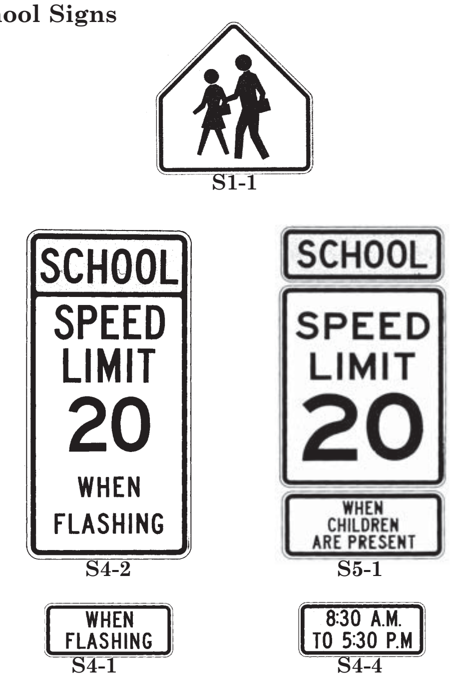
The school advance sign is intended for use in advance of locations where school buildings or grounds are adjacent to the roadway. This sign is also placed in advance of any school crossing sign (S2-1). The school advance sign is placed not less than 150 feet in advance and not more than 700 feet in advance of the school grounds or school crossing.

School Bus Stop Ahead (S3-1)

"School Bus Stop Ahead" signs are intended for use in advance of locations where a school bus stop is not visible for a distance of 500 feet in advance. It is not intended for these signs to be placed everywhere a school bus stops, but only in locations where terrain or other features limit sight distance and there is no opportunity to relocate the stop to a more visible location.

Figure 8.4

School Signs



Source: Manual on Uniform Traffic Control Devices

School Speed Limit Signs (S4-1, S4-2, S4-3, S4-4)

School speed limit signs are used to indicate the speed limit within the school zone. School speed limit signs may be accompanied by signs that indicate applicable hours or conditions of speed limit reduction ("when children are present"). A flashing beacon along with a sign "When Flashing" may also be used to identify the periods when the school speed limit is in force.

Overhead Crossing Signs

Overhead school crossing signs are sometimes used at school crossings, but are not contained within the MUTCD and are considered to be extraordinary traffic control devices. These devices are only installed at locations where school authorities request supplemental traffic control for marked school crosswalks and only after a traffic engineering analysis considers other traffic control measures. When such signs are installed, they should include flashing lights that are on only at the time school children use the crosswalk. The school district should be responsible for ensuring that the flashing lights are on at the appropriate times. Flashing lights may be similarly used on school speed limit signs if installed in accordance with the MUTCD requirements.

School Sign Program
Tempe is currently using a technique of different colored school area signs. This is a program conducted by the Federal Highway Administration (FHWA). A new florescent yellow-green color is used on school zone signs. This color of sign is used only in school zones, and heightens driver awareness by placing an unexpected element (sign color) in their environment. Drivers who see the different colored signs then come to know that the different color represents a school zone, prompting them to look carefully for children as they are driving through.

"School" Markings
The MUTCD allows word and symbol markings on the pavement for the purpose of guiding, warning, or regulating traffic. They are typically limited to not more than a total of three lines of words or symbols

Figure 8.5

One Lane School Marking

Source: Manual on Uniform Traffic Control Devices

and are white in color. These types of markings are not used for mandatory messages except in support of standard signs. Figure 8.5 illustrates the school pavement marking design standard.

Other types of street crossing marking devices are discussed in Toolbox Section 6, Intersections and Crossings.

School Walk Routes and Safety Programs

School walk route plans are required in some parts of the country. Most elementary schools have a school walk route program. Many children are still bused to and from school. Participants in public meetings during the Comprehensive Transportation Plan process felt that more children would walk if better pedestrian facilities and safe walking routes were available.

Procedures for developing school walk routes are listed in Table 8.6. School walk route plans can be an important tool for communities. Such plans can give parents and teachers assurance that the specified routes are safe for children's travel.

Once a school walk route has been established, pedestrian safety deficiencies along the walk route need to be identified. Then, remedial actions can be considered and implemented as funding becomes available. Refer to *Traffic Safety for School Areas* produced by the Arizona State Department of Transportation for guidelines for identifying pedestrian safety deficiencies and developing remedial actions.

Table 8.6

Procedures for Developing School Walk Routes
• *Form Safety Advisory Committee (SAC)*
• *Prepare base maps*
• *Inventory existing walking conditions*
• *Inventory traffic characteristics*
• *Design the walk routes*
• *Prepare the draft walk route maps*
• *Review the route maps with the SAC*
• *Have route maps approved by the school board*
• *Distribute and explain the maps*
• *Continually evaluate the program*

Educational Tools and Programs for Child Safety

Many tools currently exist that can help parents, teachers, and school officials provide safer travel for children. These tools demonstrate that child pedestrian travel is a national issue. Below are some of the tools available.

- *Kids Walk-to-School, A Guide to Promote Walking to School* – a document to promote walking to school produced by the U.S. Department of Health and Human Services

Walk to School Day at Wood Elementary School in Tempe.

- Walk to School Day – an organization devoted to encouraging walking to school and recognizing the need to create safe walking communities for children.
- National Kids Safety Campaign – a resource available to the community to help prevent child injuries, including pedestrian collisions. Brochures such as "Safe Kids are No Accident" are available to teach children how to become responsible pedestrians.
- Way to Go School Program – an organization committed to providing resources to school communities to develop traffic safety awareness programs and to increase the opportunities for children to walk, bike, or rideshare to school.

Ongoing Maintenance

The school district and school site officials are responsible for providing ongoing maintenance of pedestrian facilities and traffic control elements on the school site. This includes sidewalks within the right-of-way adjacent to the school site. Public and private property owners are typically responsible for repairs and reconstruction of the sidewalk within the street right-of-way adjacent to their property. The City of Tempe is responsible for maintaining facilities and traffic control elements at intersections and mid-block crossings. On an annual basis, before the opening of school each year, elements that affect pedestrian travel in the area of the school should be inspected. Some of the things to look for include the following.

- Signs should be clearly visible and easy to read (paint has not worn off; tree branches are not in the way).
- Traffic control devices, signals, and

actuators should function properly.

- Sidewalks and walkways should be clear of obstruction; pavement should be smooth.
- Crosswalks and pavement markings should be clearly visible.
- Pedestrians visibility should not be compromised by overgrown landscaping, parking, signs, fencing, or other obstacles at intersections, crossings, and along walkways.

Other Sources of Information

For more specific design guidelines related to various pedestrian facilities that may be developed within the vicinity of schools, refer to the other toolbox sections.

The following sources are recommended for additional information related to pedestrian facilities for children and school zones. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

School Zone Safety Guidelines, ADOT

A Guidebook for Student Pedestrian Safety, Final Report, KJS Associates Inc., MacLeod Reckord, and Educational Management Consultants

Childhood Injury Prevention, A Directory of Resources and Program in Washington State, Washington State Department of Health

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Elementary School Catalog, AAA Foundation for Traffic Safety

Florida Pedestrian Planning and Design Guidelines, University of North Carolina

Guidelines for the Installation of Crosswalk Markings, Steven A. Smith and Richard L. Knoblauch

Handbook for Walkable Communities, Washington State Pedestrian Facilities Planning and Design Courses, Dan Burden and Michael Wallwork, PE

Kids and Cars Don't Mix, Seattle Engineering Department

"Make Their First Steps Safe Ones," Robert B. Overend

Manual on Uniform Traffic Control Devices for Streets and Highways, US Department of Transportation

SITE DESIGN 9

This Section Addresses:

- *All Modes of Transportation as Part of Site Development*
- *Pedestrian-Friendly Site Design*
- *Bicycle-Friendly Site Design*
- *Transit-Friendly Site Design*
- *The Benefits of Mixed-use Site Development*
- *Building Location and Design*
- *Walkways and Accessible Routes*
- *Site Access and Driveway Design*
- *On-Site Circulation and Parking*
- *Ramps, Stairways, and Steps*
- *Landscaping and Furnishings*
- *Public Art*
- *Open Space*
- *Sites Used Exclusively by Pedestrians*
- *Other Sources of Information*

Good site design accomplishes many important objectives related to pedestrians and bicyclists, including safer conditions and more convenient access. When sites are designed with the pedestrian in mind at the onset, rather than as an afterthought, a more pedestrian-friendly environment can be created. Pedestrians can easily tell whether or not their needs are being adequately considered at the businesses, shopping centers, community buildings, and other sites they frequent.

This toolbox section provides site design and development recommendations intended to make designers of private and public sites more aware of the needs of pedestrians. When pedestrian conditions are improved, pedestrian travel and activity in the area increases. Well-designed sites that invite pedestrians and provide convenient facilities for them are also often successful businesses and vital areas within the community.

All Modes of Transportation as Part of Site Development

Integrating all modes of transportation into site development is important. Increased pedestrian, bicycle, and transit activity can be beneficial to business and improve the safety and character of the community.

Often, site development is oriented more toward creating convenient and efficient access and circulation for motor vehicles, rather than other modes. In order to fully integrate all modes into the overall transportation system, all places need to be designed for safety, convenience, and comfort, not just public rights-of-way.

Perhaps one of the most important things that can be done to accommodate all transportation modes in site design and development is for design professionals and developers to be more conscious of user needs at the onset of the planning and design process.

Pedestrian-Friendly Site Design

Designing sites to meet the needs of pedestrians does not have to be complicated. A simple approach can help designers envision a good pedestrian environment.

When reviewing a site for the first time, designers and developers should consider the point-of-view of a pedestrian walking through the site. By considering the needs of pedestrians as part of the overall site design process, site planners and designers can begin to consider how various site elements can be specifically designed to improve conditions for pedestrians. To create a better walking environment, buildings, architectural elements, and landscape should be used to maximize shade and cooling during the hot season.

Table 9.1 provides an overview of basic site design solutions that improve conditions for pedestrians. Often, existing shopping centers, office parks, and public and private developments can be upgraded and improved for better pedestrian access. Figure 9.1 illustrates a good example of a retro-fitted design of an existing shopping center to enhance pedestrian access.

Neighborhood residents often walk to work to connect to transportation, as well as for exercise or pleasure. Children need to be able to walk or bike to neighborhood services. Many suburban developments are not conducive to pedestrians. Low-density single family development and cul-de-sacs often make it difficult to get around neighborhoods or to link to transportation. Traditional and neotraditional neighborhood designs offer an alternative to suburban street patterns.

Table 9.1

Pedestrian-friendly Site Design Checklist

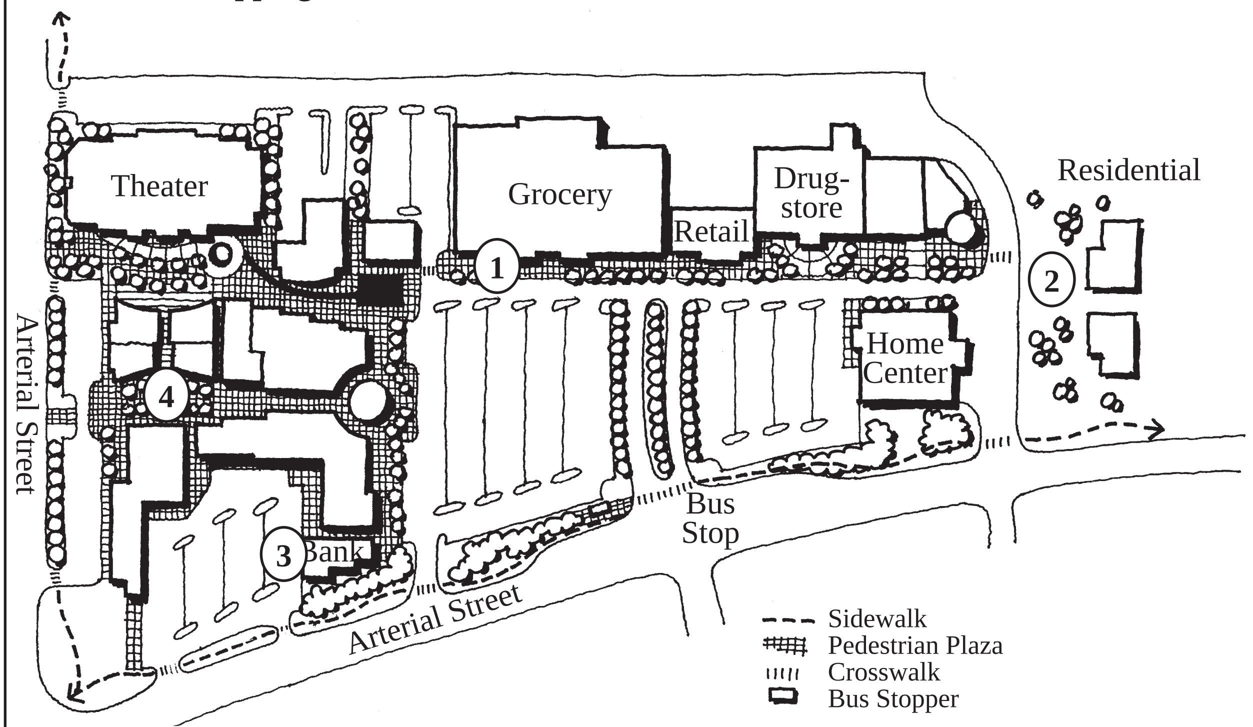
- *Delineated walkways through parking lots*
- *Connections to neighborhoods and surrounding areas*
- *Easy to identify building entrances and building frontages located along the streets rather than across parking lots*
- *Convenient and safe access to transit and adjacent sidewalks*
- *Alignment of walkways for convenience and reduced travel distances*
- *Accessible routes of travel to and from the site, as well as throughout the site*
- *No barriers (walls, ditches, landscaping, or roads without safe crossings) to pedestrian travel*

These designs are characterized by a mix of housing options and land uses, a connected or grid system street network, narrow streets, and a connection to transit options. If pedestrian connections are not present in existing housing development, pedestrian cut-throughs and linkages should be provided and maintained by homeowner associations and private owners. Upkeep of cut-throughs and linkages is important to encourage their use as viable transportation routes.

Pavement texture or scoring can be used to delineate the pedestrian travel area in a parking lot.

Figure 9.1

Retro-fitted Shopping Center for Pedestrian Access



1 Walkways added and located for safer and easier pedestrian access

2 Pedestrian access provided from neighboring residences

3 New buildings added to reinforce better street access for pedestrians

4 Interior walkways connected with perimeter sidewalks

Bicycle-friendly Site Design

It is important to include bicycle facilities and amenities when designing or retrofitting a site. Bicycle access from the street to the business or office should be provided via a separate path or along the roadway. Bicycle travel on sidewalks or pedestrian paths is discouraged. If possible, bicycle lane striping or signing is recommended. Most importantly, site access and circulation should be designed carefully to avoid conflicts between bicyclists, pedestrian, and motorists.

One bicycle parking space per every ten vehicle parking space is recommended. If businesses are located close together, a shared bicycle rack should be encouraged. To encourage bicycle commute trips, employers should provide showers and changing facilities for their bicycle commuters.

Transit-friendly Site Design

When designing a site, designers and developers should consider existing transit service and the potential for additional transit access to the site. If site is along an existing designated transit route, check into the possible need for an additional bus stop. This would depend on the number of employees and customers who may come

Table 9.2

Checklist for Successful Mixed-use Site Developments
• *Are the uses complimentary?*
• *Are the uses located within convenient walking distance of each other?*
• *Are the uses linked by sidewalks or paved paths?*
• *Are the walking routes short, direct, safe, and comfortable?*
• *Do the buildings fit with and compliment each other?*
• *Do the uses create activity at different times of the day?*
• *Is parking kept out of the pedestrian's path of travel?*
• *Do the uses support one another economically?*
Source: A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts, The Snohomish County Transportation Authority

to the site by bus. If a bus stop is installed internal to the site, the pulloff area should meet local transit design requirements, with adequate turning radii, bay length, platform and waiting area widths. See Section 4, Access to Transit for design requirements.

Sites should provide pedestrian-scale lighting and accessible access ways between buildings and the bus stop location along the street. Access ways in parking lots or between buildings, should be delineated and striped. Directional signing is encouraged. Employers should provide incentives to commuters who take transit.

Pedestrian scale architecture along access ways invites pedestrians into businesses.

The Benefits of Mixed-use Site Development

Over the past 50 years, arrangement and design of land uses was scaled and oriented to driving rather than walking. Many communities are now encouraging mixed-use site development, where compatible land uses are developed on a single site or within a specific district. Mixed-use development was an integral component of traditional towns built before the automobile became the focus. Tempe could encourage mixed-use development through local zoning ordinances. Mixed-use development should be allowed within or near single-family residential districts.

Examples of mixed-use development include housing located over retail shops or studios, local services, and shopping opportunities within a convenient walking distance (0.25 miles or less); and employment/offices located near residential housing. Below are three basic criteria of successful mixed-use developments:

- Complementary land uses
- Located within convenient walking distance of each other
- Connected by safe, direct walkways
- Shared Parking

Table 9.2 provides a checklist for successful mixed-use site developments.

Building Location and Design

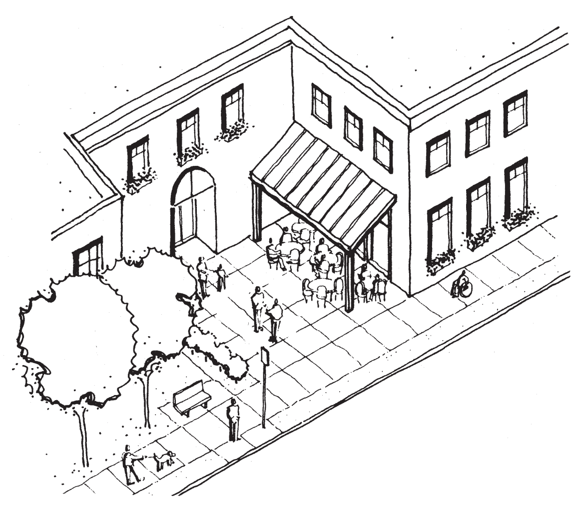
Pedestrian access is enhanced by an attractive and welcoming environment.

- Locate buildings directly adjacent to the sidewalk and street environment, avoiding placement of parking lots between the street and buildings. This allows pedestrians to access the buildings directly from the sidewalk, encouraging a friendly street atmosphere, and eliminating the need to cross parking lots to get to building entrances.
- Create a pedestrian-friendly atmosphere by laying out buildings and other site elements in configurations that define spaces for people to walk and gather.
- Create plazas, seating areas, displays and exhibits that draw pedestrians to the building.
- Design buildings that reflect the character of the surrounding neighborhood and respond to the preferences of the community.
- Design walls that relate to pedestrian scale. Architectural elements such as windows, balconies, and entries should be encouraged.
- Utilize color, texture, landscaping (climbing vines), and other techniques to soften hard surfaces and bring human scale to building frontages. Blank walls are not desirable.
- Use special paving to direct pedestrians to the building entrances, especially on sites where there are high volumes of pedestrians entering the building and traveling across vehicle circulation (at shopping centers and grocery stores). Areas in front of buildings can be striped

Site access should be well delineated to minimize conflict between pedestrians and vehicles.

Figure 9.2

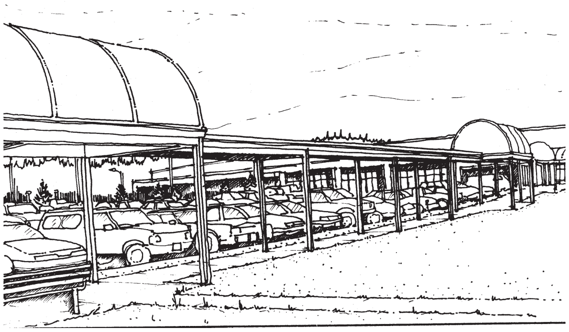
Accessible Building Entrance



Source: Accessibility Design for All, An Illustrated Handbook, Barbara Allan et. al., and A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts, The Snohomish County Transportation Authority

Figure 9.3

Covered walkways provide shelter for pedestrians.



Source: A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts, The Snohomish County Transportation Authority

or delineated.

- Include displays, signs, retail features and outdoor seating areas combined with wide storefront walkways to welcome pedestrians.

Walkways and Accessible Routes

Layout of walkways as part of site design is a key ingredient in making the site efficient for pedestrian travel. Pedestrians will walk more frequently along routes that are the most convenient and direct to their destinations.

Walkways should be aligned along the most direct routes in urban areas and on sites where the priority for pedestrians is placed on efficient access to and from buildings, parking, bus stops, and other site elements. Meandering walkways may look nice in certain settings, but are not the most efficient way of getting people from one place to another. People may not use a walkway if it does not provide the most direct route, especially during times of inclement weather or when they are in a hurry.

The Americans with Disabilities Act (ADA) design guidelines require all sites to provide an accessible route of travel between accessible site elements such as parking areas, buildings, transit stops, perimeter sidewalks, and other facilities. An accessible route is a clear level walkway that provides access for all pedestrians, including people with disabilities. Specific design requirements related to accessible routes of travel are provided in Toolbox Section 2 — Accessibility.

Figure 9.2 illustrates a building entrance directly accessible from the street.

Other walkway design treatments that can help to improve conditions for pedestrians include the following.

- Covered walkways and shelters provide pedestrian comfort and provide protection from direct sun and rain.
- Illuminating walkways and corridors increases pedestrian security.
- Raised walkways through parking areas (with curb cuts to provide accessibility) clearly define the pedestrian travel way (see Figure 9.3).

For more information related to walkway and pathway design, including dimensional guidelines, suggested surfacing materials, and other treatments, refer to Toolbox Section 7 — Multi-use Paths and Section 3 — Friendly Streets and Sidewalks.

Site Access and Driveway Design

Much can be done through access management and driveway design to improve pedestrian mobility and safety. Access management suggestions include the following.

- Limit the quantity and frequency of driveway access points and entrances to sites from streets to minimize interruption of pedestrian travel on adjacent sidewalks and walkways.
- Design sites so that adjacent properties can share access points where possible.
- Separate pedestrian and vehicle access to the site to minimize conflicts.
- Design emergency vehicle access to allow quick access and minimum conflict with pedestrians.

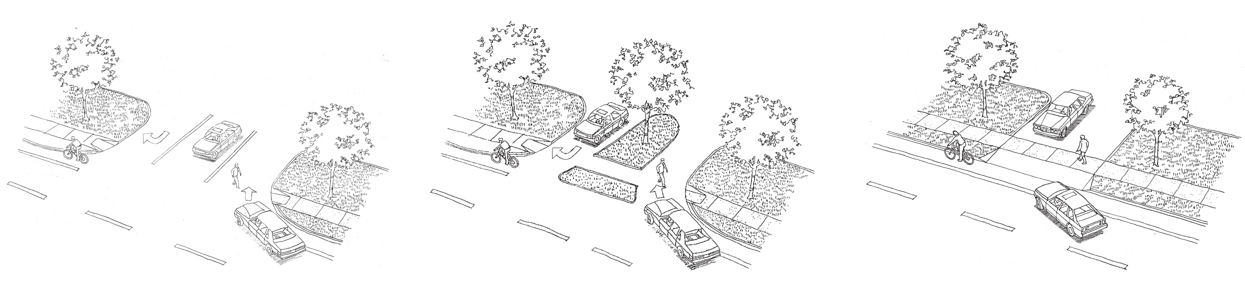
Driveways can be designed or retrofitted so that they are easier for pedestrians to cross. Generally, the narrower the driveway width, the better. The shorter the crossing distance, the less likelihood of conflict with a motor vehicle. The provision of clear sight lines between pedestrians and motorists pulling out of or into driveways is very important.

Driveways that provide access to businesses, offices, or other commercial buildings can be built as conventional driveways or with designs that resemble street intersections (with right-in/right-out access control). For pedestrian safety and comfort, the conventional driveway design is more desirable, because motorists are forced to slow down when turning into the driveway and the pedestrian right-of-way is more clearly established. Most residential driveways are designed in the conventional style. This design is also safer for bicyclists. When crossing distances are shorter, bicycles have less driveway to cross.

Figure 9.4 illustrates three common driveway designs. The least desirable of the three is the first design, which shows a very wide driveway with undelineated crossing area and no refuge for pedestrians. The driveway is designed to resemble a street intersection, which may encourage higher speed turns and discourage stopping for pedestrians since their right-of-way is not clearly delineated. In this design, the movement of the vehicle clearly takes priority over crossing pedestrians.

Figure 9.4

Driveway Design Comparisons



1. Least Desirable

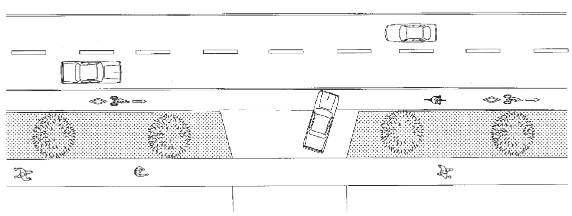
2. Better Design for Some Commercial Driveways

3. Most Desirable Design for all Driveways

The second design is more desirable and is suggested for commercial driveways when it is not feasible to provide a conventional driveway apron design. The second design still treats the driveway like a street intersection, but it limits the driveway width to two lanes and provides a refuge island in the middle for crossing pedestrians. One additional element that would make this design better would be a clearly delineated pedestrian travel way across the lanes.

Figure 9.5

Wide Planting Areas at Driveway



Source: Adapted from Oregon Bicycle and Pedestrian Plan

The third drawing is the most desirable solution. This design provides a delineated walkway across the driveway neck. In this conventional driveway design the pedestrian travel way is clear to the driver, the crossing distance is narrow, and the walkway stays at a constant grade.

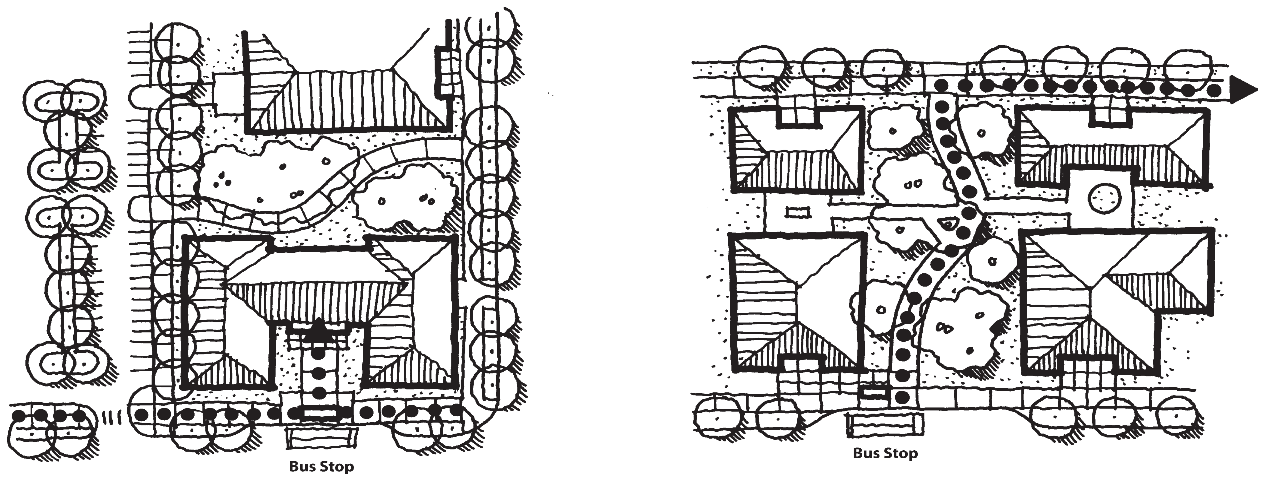
Sidewalks that cross driveways and alleys can be problematic if sight distance is limited by adjacent buildings, landscaping, or other elements. Often drivers pulling into or out of the driveways are concentrating on the flow of vehicular traffic and may not notice oncoming pedestrians. Several measures can be applied to improve pedestrian visibility and make these crossings easier for pedestrians.

- Unit pavers or colored pavement bands in the sidewalks prior to driveway entrances provide a visual and tactile forewarning of the upcoming driveway crossing. An alternative texture or pavement color across the entire pedestrian travel way at the driveway or alley access point helps motorists identify a pedestrian crossing zone.
- Signs located to the side of the pedestrian travel way help to identify upcoming driveways and alleys.
- Stop signs should be provided at an access point used by multiple drivers.
- Curb stops at the access point keep the front of the vehicle from protruding onto the sidewalk.
- Auditory warnings can be provided when vehicles are entering and exiting (often used in downtown areas where vehicles are exiting from parking garages).
- Mirrors placed in strategic locations help exiting drivers see approaching pedestrians (Mirrors need to be placed carefully to avoid glare and obstruction to pedestrian travel.)
- Planting buffers that separate the walkway from the street allow some extra space between pedestrians crossing the driveway and vehicles pulling into the driveway. Buffers also provide room for the driveway apron to ramp up before the walkway, creating a more constant grade on the walkway.

Wide planting areas at the perimeter of sites provide sufficient space for vehicles pulling out of driveways, eliminating the problem of blocking the sidewalk used by pedestrians (see Figure 9.5). Note that when trees are planted in planting buffers near driveways, they should be placed to avoid affecting sight distance. Typically, tree trunks don't create a sight obstruction, but upward branching species should be selected. It is important to ensure that

Figure 9.6

Access to Transit

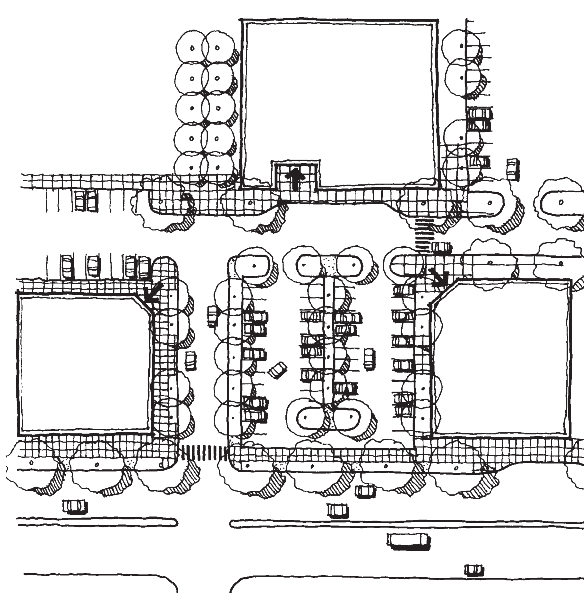


Building entrance oriented to street and transit stop.

Pedestrian path running through the site to connect to transit stop.

Figure 9.7

Shared Parking Lot



any landscaping placed within proximity to driveways does not block visibility. Designers should consult Tempe's plant list recommendations (See Section 10) for appropriate species to use within the sight distance triangles adjacent to driveways.

On-site Circulation and Parking

One of the biggest concerns for pedestrians in site design is conflict with motor vehicles. The following design strategies can minimize conflicts and help clarify pedestrian circulation.

- Develop clearly defined pedestrian access ways. Striping, delineation of walking zones with curbs and landscaping, centralized walkway medians and islands, and textured paving are all good examples of ways to provide defined walking spaces within parking areas and adjacent to vehicular circulation.
- Provide direct access to the building entrance from the street and sidewalk where pedestrians, bicyclists, and transit riders are traveling.
- Locate transit stops adjacent to or on the site, and provide direct access to all major origins and destinations on the site. Figure 9.6 illustrates two site designs that provide good transit access.

- Provide well delineated and marked drop-off and pick-up zones for pedestrians that are separated from the flow of vehicle traffic. These areas, as well as all areas in front of building entrances, should be designated as "no parking" zones.
- Minimize pedestrian crossings in vehicle circulation zones and design motor vehicle circulation aisles so that crossings of pedestrian travel ways are minimized.
- Consider the use of raised crossings, speed humps, and speed tables to discourage high traffic speeds in parking lots where pedestrian volumes are high.
- Design parking lots so they can be shared by more than one building on the site or by buildings on neighboring sites; limit parking in certain areas to help increase pedestrian trips and transit use, and decrease motor vehicle use. Figure 9.7 illustrates an example of a site design where three buildings share a single parking area.
- Locate parking areas behind or at the side of buildings, or underneath buildings, rather than between the building and the street.
- Provide one-way traffic flow through parking lots, where appropriate, to minimize pedestrian confusion and conflicts with automobiles.
- Fully illuminate pedestrian walking areas through parking lots.
- Provide good drainage to avoid puddles and concentrated runoff areas across pedestrian walking routes.
- Provide separate access to parking garages and structures for pedestrians.
- Avoid locating pedestrian walking areas near truck and freight delivery zones and keep sight lines clear. Trucks backing up without being able to see pedestrians is a common cause of collisions.

Ramps, Stairways, and Steps

Pedestrian routes with stairways and steps should be avoided where possible. Ramps should be provided to maximize access for all. More information about ramp design is provided in Toolbox Section 2 — Accessibility.

When stairways and steps must be installed in pedestrian environments, several design guidelines should be followed, including the following.

Stairway Width

The recommended minimum width of public stairways is 5 feet, and for private stairways it is 4.5 feet.

Step Dimensions

Treads and risers should be uniform in height and depth, with treads no less than 11 inches wide and risers no deeper than 7.5 inches. It is generally preferred that risers for outdoor stairways be a minimum of 4.5 inches and a maximum of 7 inches in depth.

Stairs are often necessary in areas of significant grade changes.

Figure 9.8

Landing Placement for Stairways

A minimum of two steps should be provided.

Three steps are preferred to ensure clear legibility of the grade change.

Landings should be long enough to allow an easy cadence with a minimum of three strides on the landing.

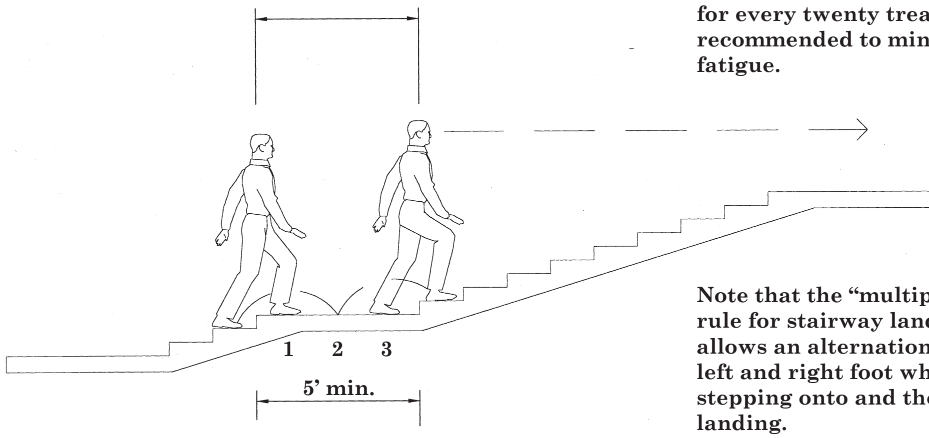
A 5' length landing is a typical minimum.

Longer landings are typically multiples of 5', i.e., 5', 10',15' etc.

The height between landings should be kept to a maximum height of 5' to allow a view of the next higher landing.

Heights greater than 5' are psychologically less inviting.

Where this is not possible, a minimum of one landing for every twenty treads is recommended to minimize fatigue.

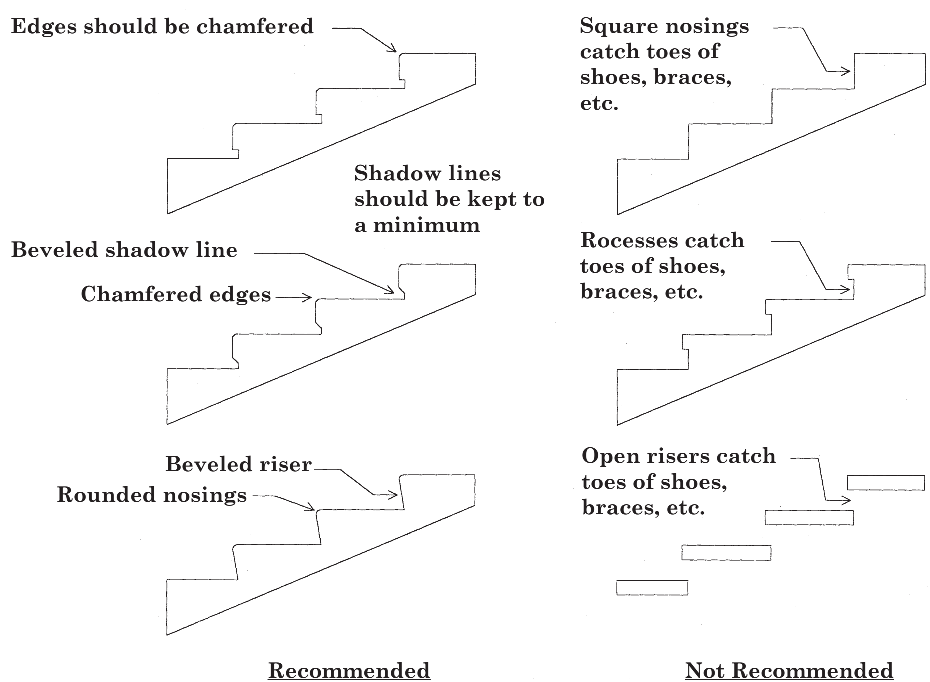


Note that the "multiple of five" rule for stairway landings allows an alternation between left and right foot when stepping onto and then off of a landing.

Source: Time-Saver Standards for Landscape Architecture

Figure 9.9

Stair/Step Nosing Design



Source: Time-Saver Standards for Landscape Architecture

Tread to Riser Ratio

The tread to riser ratio should be consistent. A typical formula for tread to riser ratio is:

2R + T = 26 to 27 inches
where R = riser and T = tread

Height between Landings

Typical height between landings can vary. The *Uniform Building Code* allows up to a maximum height of 12 feet. Lesser heights are generally recommended to provide more frequent resting opportunities for pedestrians and to breakup the visual expanse of the stairway.

Landing Dimensions

Landings should be long enough to allow a minimum of three strides on the landing before proceeding onto the next set of steps. A 5-foot landing is a typical minimum length. Longer landings are typically dimensioned in multiples of 5 feet. The width of the landing should be at least the width of the stairway. Landing placement for stairways is illustrated in Figure 9.8.

Tread Design

Nosings (the outer exposed corners of steps or stairs) should not be abrupt. Nosings should be easy to see and not obscured by confusing surface patterns. Nosing edges should be chamfered or rounded corners. Beveled shadow lines help to create a visual distinction between steps. The heights of the bevels should be kept to a minimum to avoid tripping, with nosing undersides not exceeding 0.5 inches. Closed, beveled risers are preferred over 90-degree square risers, risers with recesses, or open steps. Figure 9.9 illustrates recommended nosing configurations. Treads should be pitched downgrade at a two percent slope for proper drainage.

Landscaping provides an attractive and shaded pedestrian environment.

Landscaping and Furnishings

Successful pedestrian environments provide furnishings and create attractive settings for pedestrians to gather, rest, socialize, and orient themselves. While these furnishings are good for pedestrian environments, they should not protrude into the pathway of pedestrians. Examples of complementary elements on pedestrian oriented sites include the following.

- Trees of heights and patterns complementary to human scale should be provided, with high branches and upward branching habits along walking areas, and with the capability to provide shade and shelter. Trees should be installed to avoid buckling of adjacent pavement by root systems.
- Perimeter landscaping buffers with defined edges help to reduce the impact of parked vehicles and enhance the streetscape.

- Shrubs and ground covers should not intrude into or block walkways or interfere with visibility and security.
- Shopping cart storage should be installed in several convenient and easy to find locations.
- Benches or seating areas outdoors or in building alcoves should be provided to allow pedestrians to stop and rest.
- Safe and convenient access to restrooms is important.
- Strategically located garbage receptacles and cigarette ash cans can help keep an area clean and attractive, along with fully screened garbage bins with self closing doors and landscaping.
- Public artwork creates interest in a place as a destination and enhances the pedestrian environment.

See Section 10 – Desert Vegetation for more information on recommended landscapes.

Signs help orient pedestrians and tourists.

Art helps to create an enjoyable pedestrian experience.

Public Art

Art is an integral component of pedestrian site design, whether public or private. Art creates a sense of place and provides a pleasurable experience for pedestrians. Tempe has one of the most innovative public art programs in the nation. There are several public art pieces in downtown Tempe that focus on transportation. These include bus shelters, bike racks, and bike lockers. Art can also be integrated into private developments. Art does not need to follow specific design guidelines. It should be noted that art is easily integrated in good pedestrian designs where the most people can enjoy the art. See Tempe's Comprehensive Transportation Plan, for more information on integrating public art in site design.

Open Space

Secure, attractive, and active spaces provide focal points in the community where people can gather and interact. Public spaces are an essential ingredient for making a pedestrian-friendly community. Successful walking/shopping districts have a variety of usable outdoor spaces interspersed with businesses, housing, and civic buildings. Well-designed public spaces encourage pedestrians to walk, explore, shop and stay for a while. Whether a large civic plaza or a small pocket park, it is the integration and interconnection of outdoor spaces that makes a community great.

All public open spaces should be visually linked to a street or other public space, easily accessible to pedestrians of all abilities, and be usable places for people to enjoy. These spaces range in scale from a simple expanded sidewalk for outdoor dining to a large plaza with public art and entertainment.

When designing public spaces, it is important to consider what shapes the edges. A blank building façade can make a public space uninviting. Building design should respond appropriately to existing or planned public spaces on or near the site (e.g., parks, sidewalks, transit stops, plazas). Architectural treatments such as windows, entrances, and balconies help to enliven public spaces. Public spaces should be comfortable. Where possible, buffer the sound and sight of traffic from a public space. A row of street trees, bollards or even a low wall can create a physical separation without compromising good security surveillance. Awnings, trellises, pergolas, tables with umbrellas, and trees provide shade for people. In addition, passive cooling elements such as pools and fountains can provide comfort and enjoyment, but attention to recycling of water and low-water use approaches is important in desert environment like Tempe.

Businesses benefit from pedestrian activity. This may be the greatest incentive for developers to incorporate public open spaces in their site plan.

Sites Used Exclusively by Pedestrians

Pedestrian malls, plazas, and special districts, including tourist and recreation sites, are often developed for exclusive use by pedestrians, or with the focus that pedestrians are the primary user group. These spaces provide important opportunities to increase pedestrian travel in our communities. Since these sites serve high numbers of pedestrians, they are usually designed with the specific needs of pedestrians in mind.

Many urban planning experts agree that the vitality of downtown areas is strengthened when streets serve a mix of transportation modes (pedestrians, bicyclists, transit, and motor vehicles) with the needs of all user groups being carefully considered and balanced in the planning and design process.

Design guidelines that can help to establish pedestrian malls, plazas and special districts as vibrant public gathering spaces are listed below.

- Special paving and accents enhance plazas and special districts and provide a clear message to tourists as to where they should walk.
- Tourist attractions and recreation areas located adjacent to busy highways require special attention to the needs of pedestrians, especially on sites with high visitation. Consider grade separated crossings in these areas, but only if their use will be convenient for pedestrians.
- Drop-off and pick-up zones for buses, trolleys, and other touring vehicles

should be clearly delineated and located to avoid interrupting pedestrian travel along sidewalks and impeding views of pedestrians and motorists.

- Signing is an important tool and can be used both to identify elements within the district and to clearly orient pedestrians.
- Maps engraved in sidewalks or on manhole covers provide a unique opportunity to direct pedestrians.
- Left-turns and free-right turns at intersections should be eliminated where high volumes of pedestrians cross.
- Pedestrian activity thrives by introducing special places for entertainment, music, concessions, seating, and outdoor cafes.

Other Sources of Information

The following sources of information are recommended for site design for pedestrians. Please see the Resource Guide included at the end of this toolbox for complete bibliography information.

A Guide to Land Use and Public Transportation, Volume II: Applying the Concepts, The Snohomish County Transportation Authority

Accessibility Design for All, An Illustrated Handbook, 1995 Washington State Regulations, Barbara L. Allan and Frank C. Moffett, AIA, PE

Accommodating the Pedestrian, Adapting Towns and Neighborhoods for Walking and Bicycling, Richard K. Untermann

Bus Stop Placement and Design, Tri-Met

City Comforts, How to Build An Urban Village, David Sucher

City, Rediscovering the Center, William H. Whyte

Design and Safety of Pedestrian Facilities, A Proposed Recommended Practice of the Institute of Transportation Engineers, ITE Technical Council Committee 5A-5

Designing Urban Corridors, Kirk R. Bishop

Developing Your Center: A Step-by-Step Approach, Puget Sound Regional Council

Effects of Site Design on Pedestrian Travel in Mixed-Use Medium Density Environments, Anne Vernez-Moudon, PhD

Handbook of Landscape Architectural Construction, Volume Two, Site Works, Maurice Nelischer

Pedestrian Corridor and Major Public Open Space Design Guidelines, Don Miles Associates/PPS

Pedestrian Malls, Streetscapes, and Urban Spaces, Harvey M. Rubenstein

Site Planning, Kevin Lynch

Site Planning and Community Design for Great Neighborhoods, Frederick D. Jarvis

Time-Saver Standards for Landscape Architecture, Design and Construction Data, Charles W. Harris, Nicholas T. Dines

Urban Spaces, David Kenneth Specter

DESERT VEGETATION 10

This Section Addresses:

- *Selecting Appropriate Plants*
- *Other Transportation Planting Factors*
- *Other Sources of Information*

This section provides a brief overview of the importance of selecting the correct plants for planting areas adjacent to transportation corridors. The desert environment is especially harsh in the roadway setting of reflected concrete and asphalt. This section recommends plant species for the streets and roadways in the Tempe area.

Selecting Appropriate Plants

Tempe is located in the Upland of the Sonoran Desert. This desert is about 120,000 square miles and expands into southwestern Arizona, southeastern California, and northwestern Mexico. For the most part, the Sonoran Desert is an arid terrain that receives between 4.72 to 11.81 inches of rain per year and can reach 110 degrees F or higher during the summer months. Arizona's portion of the Sonoran desert is characterized by a balance between winter and summer rainfall where frost is likely to occur but is not very severe.

The 1980 Groundwater Management Act (GMA) governs water use in the Metropolitan Phoenix Area water use, which includes the Tempe area. The Phoenix Active Management Area (AMA) is administered by the Arizona Department of Water Resources (ADWR), an agency of the State of Arizona, under the Municipal and Industrial Conservation Management Programs. The Phoenix AMA has a goal of achieving "safe yield" by 2025. "Safe yield" means that groundwater pumped from AMA aquifers must not exceed water naturally or artificially recharged. This goal is reached in part through restricting the amount of water that can be utilized in public rights of way, such as streets. The goal of safe yield, to balance total recharge with total withdrawals, has been approached predominately by conservation measures. The conservation of water in the public landscape has become a demonstration of responsible water use and the proliferation of desert-adapted and native plant material availability.

The ADWR Low Water Using Plant List governs plant selection within public rights-of-way. A list of plant species has been

Newly planted trees on 5th Street

generated that have acceptable levels of water uptake to be considered “low water-using.” The Low Water-Using Plant List is a regulatory document, periodically updated, which is compiled by the ADWR in cooperation with the Arizona Municipal Water Users Association, Landscape Technical Committee (AMWUA LTC) and others. The plant material listed includes native plants and plants from other desert regions of the world, including Australia, the Middle East and the Mediterranean. A bibliography that accompanies the list provides educational information on plant characteristics.

The Low Water Plant List is a broad list of plants intended for use in all landscape situations. The List is, however, not entirely adapted to a street environment. In a street environment, the intensity of reflected heat from asphalt pavement in the summer can reach over 120 degrees F (“Climate, Comfort, and Health”, C*ooling Strategies for CP/EV Light Rail Project).* This environment is especially difficult for plants, unless they are desert natives or desert-adapted from other arid regions in the world. Although native Sonoran Desert plant species are well adapted to this environment, several species of plant material from the Mediterranean, Middle East, Australia, and China also will thrive.

For this and other reasons, the City of Tempe has developed a specific list taken from the Low Water Plant List for use along its transportation corridors. Trees have been selected to convey a landscape theme for each arterial street that will also mature well in the particular conditions of the street environment (Table 10.1). Table 10.2 lists plants and shrubs and their characteristics used in the right-of-way.

Other Transportation Planting Factors

In addition to selection of plant material, transportation corridors present certain given environmental conditions for the growing and maintenance of a transit and street landscape. The following is a list of conditions that may be encountered in planting along street rights-of-way.

Visibility Triangle

A visibility triangle for driver visibility of oncoming traffic will dictate what plant material can be located on corners.

Table 10.1

Recommended Trees for Rights-of Way

- *Acacia salicina*
- *Acacia saligna*
- *Acacia stenophyllus*
- *Elm*
- *Evergreen Elm*
- *Ficus nitida*
- *Heritage Oak*
- *Honey Locust*
- *Hybrid Olive*
- *Ornamental Citrus*
- *Phoenix Date Palms*
- *Phoenix Mesquite*
- *Robusta Palms*
- *Sissoo*
- *Sonoran Palo Verde*
- *Sophora*
- *Swan Hill*
- *Thevetia*
- *Wilson Olive*

Table 10.2 Recommended Shrubs for Transportation Rights-of Way

Shrubs:	Characteristics:
Acacia farnesiana	To be used in areas away from traffic due to thorns
Acacia willardiana	Lacy willow type tree as an accent
Agave family	To be used in non traffic areas due to thorns and theft
Ageratum corymbosum	Groundcover to be spaced a minimum of five ft. O.C.
Albizia julibrissan	Showy short lived tree for accent
Albizia lebbeck	Seed drop can create problems with litter and sprouts
Aloe family	Groundcover accent- difficult to remove litter around plants
Ambrosia dumas	Good shrub that will need to be replanted about every five years
Asclepias subulata	Accent plant to be kept away from sight triangles
Artiplex family	Plant only in authorized areas
Baccharis family	Plant only in authorized areas and NO Desert Broom
Baileya mulitradiata	Good color that reseeds readily
Bougainvillea family	Accent plant that needs surroundings to be considered
Buddleia murrubifolia	Keep away from sight triangle situations
Caesalpinia cacalaco	Accent tree that needs to be kept out of pedestrian way
Caesalpinia family	Needs to be kept from sight triangle
Calliandra family	Needs to be kept from sight triangle
Carissa Family	To be used away from traffic
Carnegiea gigantea	To be used away from traffic
Carpobrotus family	Struggling ground cover to be used sparingly
Cassia (Senna) family	Plant only in authorized areas
Centaurea cineraria	Showy plant that needs trimming every year
Cercidium family including Parkinsonia	Plant in only authorized areas
Cercis family	Plant away from traffic
Chilopsis linearis	Plant in authorized areas
Chitalpa tashkinensis	Plant in authorized areas
Chrysactinia mexicana	Slow growing groundcover
Convolvulus cneorum	Showy plant that needs good drainage
Cordia family	Plant away from traffic
Cortaderia selloana	Plant out of sight triangles
Dalea family	Groundcover that will spread to over 10 feet
Daesylirion family	Plant away from pedestrian traffic
Dodonea family	Plant away from sight triangles
Encelia farinosa	Showy plant that needs trimming after blooming
Eracameria laricifolia	Slow growing showy plant with annual trimming
Eucalyptus family	Plant in authorized areas
Ficus microcarpa nitida	Mill Ave tree can be used with care
Fouquieria family	Plant in authorized areas
Fraxinus family	Plant in authorized areas
Gazania family	Groundcover

Tempe regulates this as generally 33 feet from face of curb. Planting in sight triangles is typically limited to shrubs and groundcover less than 2 feet in height. Trees may not be allowed in the triangle. A surveillance window should be maintained between 2 feet and 7 feet for pedestrians and drivers, whether at intersections or elsewhere in the landscape.

Soil Compaction and Caliche

Soil compaction has been shown to be one of the leading causes of shortening urban tree life. Due to the nature of construction, which places heavy equipment for long periods of time on what often becomes the planting area, soil must be tilled and broken up to a maximum Proctor Density of 85 percent in order to establish root systems. The use of a structural soil additive is encouraged, to promote both moisture retention and aeration of the soil. Recommended application rate is 600 cubic feet per tree, or as recommended by the manufacturer. Use of aeration techniques such PVC tubing or gravel sumps should also be considered when trees are located in tree grates surrounded by pavement.

Landscaping should provide shade while maintaining a surveillance window.

Encountering caliche is also a potential plant health factor, inhibiting plant growth and establishment. Creation of caissons and plant pit drainage is recommended to promote adequate drainage. Compaction can be tested by choosing a sample plant pit in which to conduct a 24-hour filtration test to determine whether caissons are required.

Effect of Reflected Heat

Street environments expose plants to reflected heat conditions from asphalt and concrete pavement. Some plant material, generally native upland species, can generally exist, even thrive in this condition. Care should be taken to take advantage of any adjacent shading incidentally available from adjacent tall buildings or structures that may shade the plants as well as people.

Soil Nutrients/High Salts

Phoenix metropolitan area soils are generally high in pH, may be high in salt, and devoid of essential nutrients. Desert-adapted plant materials can usually handle these soil conditions. Where pH is higher than 8.0, use of soil sulfur that is hand spread and watered into the soil can help reduce high pH.

A soil nutrient analysis should be performed to determine the level of soil amendments that may be required. Generally, native plant material does not require mulch or soil amendment per the University of Arizona Cooperative Extension Service.

Herbicides and Soil Sterilants

Use of soil sterilants under pavement was common in highway construction through the 1970s. These chemicals remain detrimental to plant growth for many years after their initial application. All soils should be tested for sterilants, if the site is adjacent to or planting will occur where there once was pavement. This Bioassay can be obtained locally, requiring approximately three weeks lead-time for testing.

Plant Material Sizes Appropriate for Pedestrian Environments

While highly dependent on the individual species, 36 inch box size is the minimum recommended for walkways adjacent to roadways to ensure some measure of clearance when trees are initially planted. Fifteen-gallon trees may be used in open landscape areas, such as retention areas, which are away from pedestrian traffic.

Plant Material with Thorns

Typically, desert-adapted plant material arm themselves with barbs or thorns. This characteristic can be dealt with within a streetscape environment by trimming thorns from all branches and the trunk of the tree adjacent to walkways up to 7 feet. Branches that overhang the walkway must also be removed, except if the basic form of the tree will be permanently affected. In this case, construction cones or other temporary barricades may be required until the tree grows above the desired clearance height. In bus stop locations or station platform areas, plant material with thorns are discouraged. This is due to the unique crowding of people typical of the platform environment. Children may also be at a higher risk of touching branches or trunks within this crowded environment. In certain adjacent pedestrian areas and other areas with high traffic and confined spaces, thorns or spiky plant material may also be an inappropriate choice.

Other Sources of Information

The following sources of information discuss and recommend many species of desert vegetation.

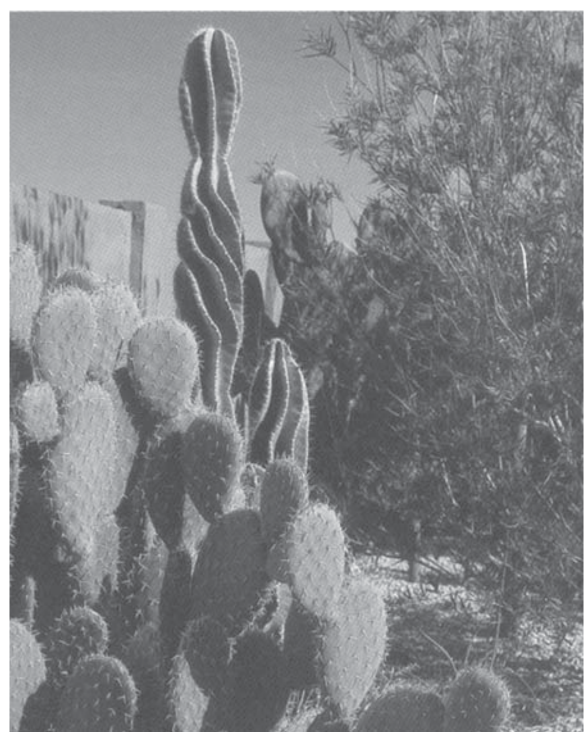
Desert Landscaping, University of Arizona Department, Water Resources Research Center

Landscaping for Desert Wildlife, Arizona Game and Fish, Heritage Fund

Trees and Shrubs of the Southwestern Deserts, Benson, L. and R. Darrow

The Low-Water Flower Garden, Johnson, E.A. and S. Millard

Xeriscape Gardens, Arizona Municipal Water Users Association



Thorny plant material adapted for the desert

Native Plant Society

Southwestern Landscaping that Saves Energy and Water, McPherson, GE and C. Sacamano

Plants for Dry Climates, How to Select, Grow, and Enjoy, Duffield, M. and W. Jones

SAFETY IN WORK ZONES  11

This Section Addresses:

- *Protective Barriers*
- *Covered Walkways*
- *Sidewalk Closure During Construction*
- *Intersections and Crossings Near Work Zones*
- *Maintenance*
- *Other Sources of Information*

Safety is an important issue in and around work zones for pedestrians, bicyclists, and drivers. Since pedestrians travel at slower speeds than other modes of transportation, they are more susceptible to the impacts of access, dirt, noise, and fumes from construction areas. Work zones should be monitored at all times for pedestrian safety needs. Temporary access and detours should be provided to ensure safe, unimpeded pedestrian travel in and around work zones. Access to pedestrian facilities, such as bus stops, crosswalks, and links between origins and destinations should be provided.

Traffic control by police or construction workers through flagging and signs may be needed in certain areas when work vehicles and equipment are traveling across pedestrian paths or when pedestrian traffic is heavy. At a minimum, the pedestrian travel way should be clearly marked and signed through the construction zone. Construction sites should keep all objects out of the pedestrian path including equipment, vehicles, construction signs, and cones. Pedestrians should feel safe and secure when traveling near work zones.

Safe and convenient passage through or around a work zone should be provided. Pedestrians may ignore a detour that is out of the direction of their travel.

The City of Tempe should train construction inspection staff to recognize improper and unsafe pedestrian facilities during construction.

Protective Barriers

Near work zones where higher volumes of pedestrians or school children exist, pedestrian fences or other protective barriers may be needed to prevent pedestrian access into a construction area. Barriers should be made of sturdy, non-bendable material such as wood or metal. Pedestrian fences should be at least eight feet high to discourage pedestrians from climbing over the fence. Table 11.1 lists other considerations for encouraging safety in work zones.

Fencing used to secure a work area supported by blocks needs to be positioned to avoid creating obstacles or tripping hazards for pedestrians.

Table 11.1

Consideration for Pedestrian Safety in Work Zones

- *Separate pedestrians from conflicts with construction vehicles, equipment, and operations.*
- *Separate pedestrians from conflicts with traffic traveling around or through the construction area.*
- *Provide a safe, convenient, and accessible route that maintains the direction and character of the original route.*
- *In urban areas, avoid work vehicle traffic during high pedestrian travel times which include mornings between 8:00 am-9:00 am, lunch times between 11:30 am-1:30 pm, and in the evenings between 4:30 pm-5:30 pm.*
- *Provide police patrol or guards for pedestrian safety when needed, especially during times of high construction and/or high pedestrian traffic.*
- *Communicate construction activity and pedestrian impacts through local media and pedestrian interest groups. Contact community and school officials in the area.*
- *Avoid using delineating materials that are difficult to recognize by people with impaired sight.*
- *Walkways through construction zones should be a minimum width of five feet.*

Source: Based on ITE' Design and Safety of Pedestrian Facilities; adapted and expanded for this Guidebook

Covered Walkways

For construction of structures adjacent to sidewalks, a covered walkway may be required to protect pedestrians from falling debris. Covered walkways should be designed to provide:

- sturdiness,
- adequate light and visibility for nighttime use and safety,
- proper sight distance at intersections and crosswalks, and
- adequate and impact-resistant longitudinal separation from vehicles on higher speed streets. For work zones adjacent to high speed traffic, wooden railings, chain link fencing, and other similar systems are not acceptable.

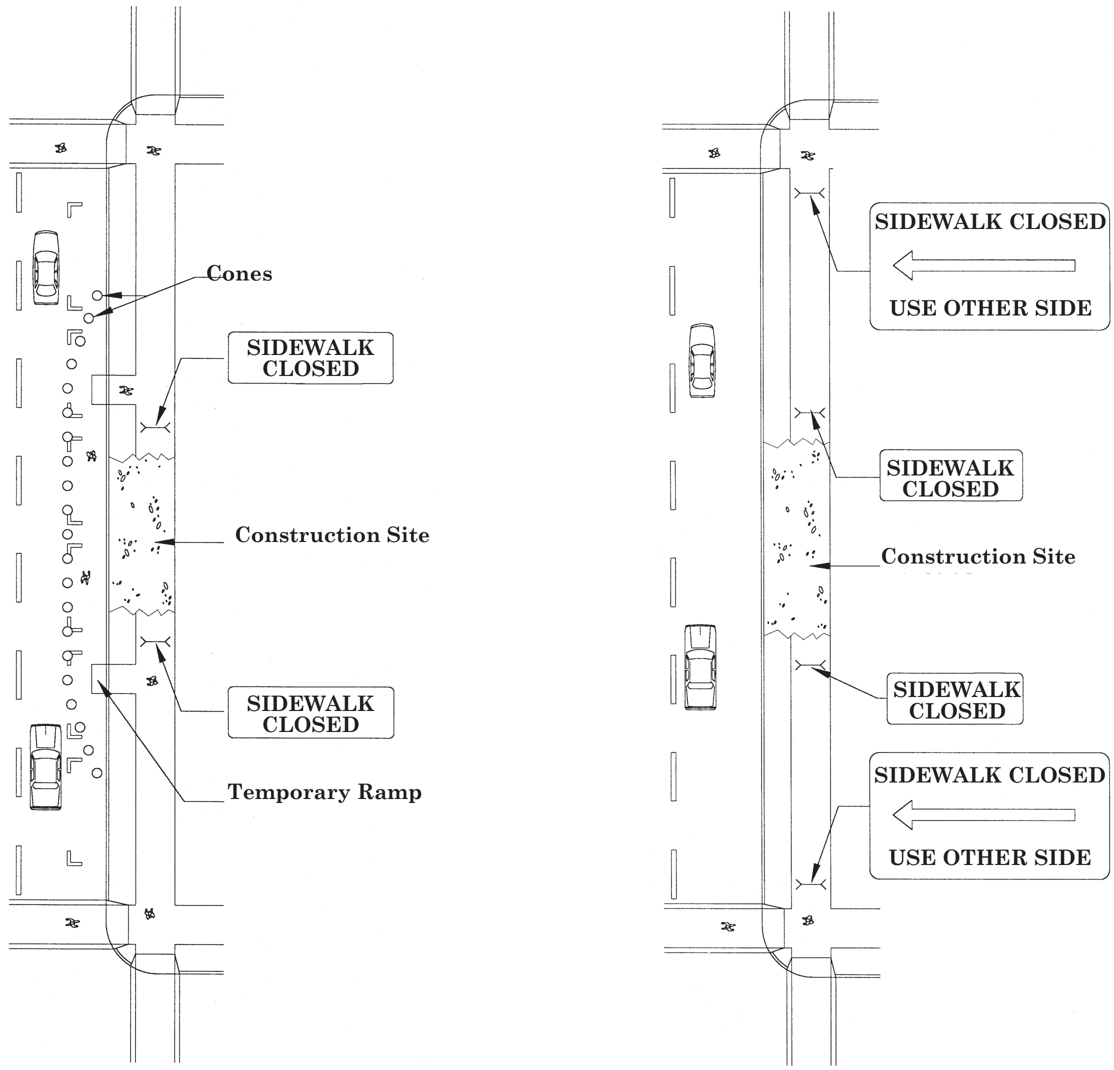
Sidewalk Closure During Construction

It is undesirable to close sidewalks or pathways during construction. This should be the last option. If sidewalks have to be closed, construction sites should provide alternative pedestrian routes on the same side of the street. If no other alternative is available, safe crossings to the other side of the street and easy-to-read and distinguishable signs and placement markings should be located at the construction site. Temporary walkways must also be safe and clear of obstructions such as debris, potholes, grade changes, and mud.

If a temporary route is created in the roadway adjacent to the closed sidewalk, the parking lane or one travel lane in a multi-lane street may be used for pedestrian travel, with appropriate barricades, cones, and signing, as illustrated in Figure 11.1. When using a barricade, it must be a continuous route, detectable by a cane. When a parking lane or travel lane is not available for closure, pedestrians must be detoured with advance signing in accordance with the *Manual on Uniform Traffic Control Devices* and *Phoenix Barricade Manual.* For midblock construction, signs should be placed at the nearest intersection to forewarn pedestrians of a sidewalk closure. Signs should also be placed to avoid blocking the paths of pedestrians.

Figure 11.1

Temporary Pedestrian Routes



Note: Parking lane used for pedestrian travel.
Source: Adapted from MUTCD and Phoenix Barricade Manual

Note: If travel or parking lane is not available/detour pedestrians with advanced signing.

Intersections and Crossings Near Work Zones

- At intersections, avoid closing crosswalks.
- At signalized intersections, mark temporary crosswalks if they are relocated from their previous location. Maintain access to pedestrian push buttons.
- Include pedestrian phases in temporary signals.
- Place advanced signing at intersections to alert pedestrians of mid-block work sites and direct them to alternate routes.

Accessibility in the Work Zone

The removal of a pedestrian travelway in the right-of-way may severely limit or preclude a person with a disability from navigating. The temporary travelway should be convenient and accessible for all users and should minimize or avoid extra travel distance. The temporary travelway should have no vertical protrusions up to 80 inches. The travelway should be well protected with a barricade. Barricades should be continuous, stable, and non-flexible. The barricade should be constructed with a toe rail no higher than 1-1/2 inches above the adjacent surface and a continuous railing mounted on top. The barricade height should not exceed 42 inches and the top rail shall be situated to allow pedestrians to use the rail as a guide for their hands. The top railing of the barricade should have diagonal stripes with at 70 percent contrast. This will assure the barricade is highly visible to pedestrians.

Warnings should be provided at both the near side and the far side of the intersection preceding the disrupted right-of-way. Warning signs should be accessible to pedestrians who are visually impaired. Broadcast signs and flashing beacons with audible tones are examples of signs and devices that could be used.

Maintenance

Pedestrian facilities in and adjacent to work zones should be maintained to provide safety and functionality. Proper maintenance will maximize the effectiveness and life of work zone pedestrian facilities. Poor maintenance can result in increased work zone accidents. Table 11.2 summarizes recommended maintenance activity for pedestrian facilities in and adjacent to work zones.

Table 11.2

Issue	Recommended Maintenance
Temporary pathways constructed of inexpensive, short-life materials	Pathway surfaces should be inspected regularly. Surface materials should be treated with nonslip materials. Surface materials with holes, cracks or vertical separation should be replaced.
Detour pedestrian paths increase volumes on detour roadway	Detour pathway should be inspected regularly for adequacy of signal timing, signing, and pedestrian traffic hazards.
Construction material debris on pathway	Require contractor to maintan clear pathways.
Changing pedestrian route during construction	Inspect pedestrian signing regularly to ensure a clearly understood pathway.
Damaged traffic barriers	Replace and reevaluate adequacy for pedestrian safety.

Other Sources of Information

- *Bicycle and Pedestrian Facilities Planning and Design Guidelines*, North Central Texas Council of Governments
- *Florida Pedestrian Planning and Design Guidelines*
- *Oregon Bicycle and Pedestrian Plan*
- ITE's *Design and Safety of Pedestrian Facilities*
- *Building a True Community,* PROWAAC
- *Manual on Uniform Traffic Control Devices*
- City of Phoenix: *Traffic Control and Barricade Manual*