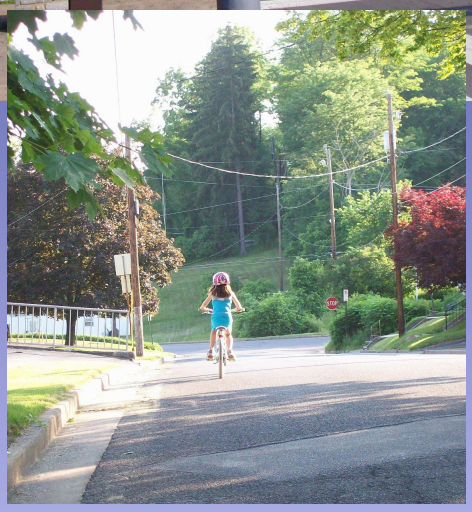

Comprehensive Pedestrian and Bicycle Program for the Borough of State College, Centre County

Part II – Policies, Toolbox, and Priorities—Final Report

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EXECUTIVE SUMMARY

The State College Borough Comprehensive Pedestrian and Bicycle Safety Program is intended to promote pedestrian and bicycle activity and safety by identifying policies, programs, and infrastructure improvements in the Borough. This program has been developed to complement the Pennsylvania Statewide Bicycle and Pedestrian Master Plan and other nationally recognized efforts to promote pedestrian and bicycle safety. The program is divided into the following sections:

- Detailed Crash Analysis & Prioritization of Areas of Concern (Part I);
- Definition of Policies to Promote Pedestrian and Bicycle Activity and Safety;
- Toolbox of Engineering, Educational, Enforcement Approaches for Pedestrian and Bicycle Safety;
- Prioritization of Projects to Promote Pedestrian and Bicycle Safety;

Part I (Detailed Crash Analysis & Prioritization of Areas of Concern) is provided as a stand-alone report. Part I provides a detailed review of pedestrian – vehicle crashes in the Borough of State College from 1989 through 2007. The identification of the top areas (locations) of concern for pedestrian safety are given in the Part I report. Finally, countermeasures were developed for implementation to improve safety at the top five areas of concern.

Part II begins with a description of key policies and programs to promote pedestrian and bicycle activity and safety. The goal of the policy section is to develop a framework to develop future improvements to the pedestrian and bicycle system in the Borough. The policy section describes planning, engineering, maintenance, enforcement, and educational concepts for pedestrian and bicycle safety. Also, as requested by the Borough, included are selected "toolbox" improvements for pedestrian and bicycle safety which are most applicable to the issues present in the Borough. The toolbox improvements focus on engineering, educational, and enforcement ideas which can be implemented for future projects on the pedestrian and bicycle system. Finally, a pedestrian and bicycle improvement projects priority list has been developed for short and long term projects in the Borough.

The comprehensive program report is a living document which needs to be continually updated to meet current needs for pedestrian and bicycle safety. The final version of this report will reflect the community input gathered during the public hearing process of the Borough of State College Transportation Commission. We recommend that this document serve as the framework for developing future pedestrian and bicycle safety projects in the Borough of State College and that the projects priority list be updated annually to reflect past improvements and future goals of the residents of the Borough.

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POLICIES TO PROMOTE PEDESTRIAN AND BICYCLE ACTIVITY AND SAFETY

GENERAL PLANNING POLICIES

- *Promote non-motorized transportation.*
  - ☐ Promote and facilitate the effective use of non-motorized transportation.
- *Identify recreational needs.*
  - ☐ Recognize the importance of walking, jogging, and bicycling activities as recreational pursuits and provide adequate opportunities for such activities.
- *Coordinate with community organizations.*
  - ☐ Confirm project process prior to implementation by coordinating the planning, development, and funding of non-motorized systems with affected citizens, neighborhood associations, and business groups. Consider pedestrians and bicyclists as users in the planning, design, construction, and maintenance of all roadway projects.
- *Give attention to pedestrians and bicyclists during the planning process.*
  - ☐ Consider pedestrians and bicyclists along with other travel modes in all aspects of developing the transportation system.
- *Implement a non-motorized transportation system.*
  - ☐ Implement the Comprehensive Pedestrian and Bicycle Program by designing and constructing a safety-oriented and connective non-motorized transportation system.
- *Prioritize pedestrian and bicycle projects.*
  - ☐ Assign high priority to pedestrian and bicycle projects that serve the following objectives:
    - ▪ Improve safety issues;
    - ▪ Provide access to activity centers;
    - ▪ Provide linkages to the transit and school bus systems;
    - ▪ Complete planned pedestrian or bicycle facilities or trails, and
    - ▪ Provide complete system connectivity or provide connections to the existing portions of the system to develop primary north-south or east-west routes.
    - ▪ Minimal energy paths - the route between two given points requiring the least amount of energy for a bicyclist or pedestrian to traverse, should be recognized and developed.
- *Coordinate with neighboring jurisdictions.*
  - ☐ Coordinate the design and construction of pedestrian and bicycle facilities with other agencies where Borough of State College corridors continue to other jurisdictions.
  - ☐ Pursue inter-local agreements as necessary to facilitate the design and construction of facilities.
- *Develop and Maintain Pedestrian and Bicycle System and Project Maps.*
  - ☐ Pedestrian and bicycle system maps, project maps, and project lists shall be used as the basis for all planning, design, construction, and maintenance of all roadway projects.

- ☐ Actively involve the community in implementing this program. Utilize Borough of State College citizens, the Transportation Commission, and the expertise of local biking and walking groups.
- ☐ Attempt to secure public non-motorized easements or land dedication via development, donation, tax deduction / exemption programs, or acquisition when the need is identified or supported in the Comprehensive Pedestrian and Bicycle Program.

- *Provide a Sound Funding Program.*
  - ☐ Provide adequate and predictable funding to construct and maintain pedestrian and bicycle capital projects as identified in the Comprehensive Pedestrian and Bicycle Program.
- *Five Year Plan Update.*
  - ☐ Update and review the Comprehensive Pedestrian and Bicycle Program every five years. The updates should consider the existing and future role of the single occupant vehicle in relation to non-motorized and public transportation modes, areas experiencing unforeseen development and/or redevelopment, and other emerging issues.
- *Coordinate Project Timing.*
  - ☐ Coordinate roadway and non-motorized projects to maximize construction efficiencies.
  - ☐ Evaluate projects during the CIP update process to look for opportunities to coordinate timing and to provide key system improvements.
- *Ensure there is no loss of existing facilities.*
  - ☐ When reconstructing or reconfiguring a roadway or right-of-way, strive to maintain or improve existing pedestrian and bicycle non-motorized facilities.
  - ☐ Maintain inventories of pedestrian and bicycle infrastructure.
  - ☐ As an evaluation criteria when selecting projects for the CIP, add criteria to consider whether a project results in a critical loss of non-motorized infrastructure.
- *Develop a Mobility Management Matrix.*
  - ☐ Review existing pedestrian and bicycle counting methods to develop a useable base of information to assist in prioritizing, programming and justifying the need and benefit of sidewalks, walking facilities, crossings, or bicycle facilities.
  - ☐ Better utilize pedestrian and bicycle counts that occur at intersections where vehicle traffic counts occur. Review the time of year when counts occur at key non-motorized locations to better reflect periods of pedestrian and bicycle usage. Data would be utilized to analyze use trends over time.
- *Address the special needs of all pedestrians and bicyclists.*
  - ☐ Address the special needs of citizens with various degrees of mobility in planning, designing, implementing, and maintaining transportation improvements and other transportation facilities and in delivering transportation services and programs.
  - ☐ Re-evaluate design standards for wheelchair ramps to address such factors as utility covers, catch basins, and obstructions.
  - ☐ Seek the input of the special needs population in the early stages of design for major CIP projects, and in prioritizing walkway, sidewalk and curb ramp projects. Continue to

utilize the Transportation Commission for their input on accessibility issues. Consider establishing a special needs advisory group.

- ☐ Consider the needs of the sight-impaired when planning, designing and maintaining sidewalk or walkway projects. Consider the users' impacts from obstacles that are above, below and adjacent to the user.
- ☐ Continue to fund the surveying, identification and installation of intersections in the Borough that need wheelchair ramps. Priorities for implementation shall include walkways or sidewalks that serve government offices of facilities, transportation, and places of public accommodation and employment.
- ☐ Continue funding requests for installing audible signal mechanisms to address the needs of the sight-impaired where warranted.

ENGINEERING POLICIES

- *Provide Way-Finding for Pedestrian and Bicycle Systems.*
  - ☐ Strategically place signs and provide maps to guide users through the pedestrian and bicycle systems.
  - ☐ Continue to implement pedestrian and bicycle system sign improvements along sidewalks, paths, trails and bicycle routes that direct pedestrians and bicyclists to key locations, destinations and routes. Use signage as one method of integrating pedestrian and bicycle facilities within the right-of-way.
  - ☐ Recognize the safety benefits of appropriate sign placement along sidewalks, paths, trails and bicycle routes by implementing non-motorized signing improvements.
  - ☐ Explore the need for route signing more thoroughly. Coordinate these routes and signing programs with abutting jurisdictions and regional facilities.
  - ☐ Review the routes indicated for bicycle route signing and install signs when it is determined that bicycle facilities along the route are complete enough. Include informational signs for key bicycle destinations at major decision points.
  - ☐ Continue to develop and integrate signage standards for the Borough-wide pedestrian and bicycle system. Develop a signage policy for off-street facilities. Review the most recent state and nationally recognized sign guidelines.
  - ☐ Identify key locations and gateways for installing spot signage and signage kiosks throughout the pedestrian and bicycle system.
  - ☐ Identify and evaluate the potential for using new approaches to guiding users through the non-motorized system, such as posting guide maps on the Internet.
  - ☐ Regularly update and print a Bicycling in the Borough of State College Map with new improvements to the bicycle system. Continue to seek financial assistance for the next bike map update from bike stores, bicycle organizations.
  - ☐ Develop a pedestrian walking guide map. The map may include routes to provide access to various parts of the borough. The guide should identify transit corridors as well as identify general circulation routes and points of interest in the Borough of State College. In addition, themed walking routes may be developed to highlight the borough's parks, history, architecture, art, among other topics. Consider selling

advertising space, or seeking financial assistance from local businesses or organizations, historical societies, arts groups, and CATA.

- *Identify and construct missing pedestrian links.*
  - ☐ Identify and complete key missing pedestrian and bicycle links.
  - ☐ Use the sidewalk inventory to determine the location and extent of missing sections of sidewalk in the Borough. Develop criteria to identify and prioritize missing links. Prioritize these projects by proximity to activity centers and transit.
- *Coordinate access around schools.*
  - ☐ Enhance the coordination and working relationship with the public and private schools in the Borough of State College to continue developing and implementing recommended walking and bicycle routes, access to school bus stops, and pedestrian and bicycle connections to and through school properties.
  - ☐ Continue coordination with the School District to identify, improve, and publish recommended walking routes. Update route maps, as needed, and develop a distribution system to youth.
  - ☐ Work with the public and private schools on school bus route access needs and give high priority to implementing these improvements.
  - ☐ Develop joint access and management agreements with the schools on connections to and through schools.
  - ☐ Regularly seek the input of students to identify and prioritize non-motorized improvements.
  - ☐ Develop guidelines for passenger waiting areas, bus pullouts and amenities at bus stops serving schools. Consider the large quantity of students loading and unloading at stops near schools and community centers. Coordinate with school district and CATA.
- *Incorporate pedestrian and bicycle accommodation in project design.*
  - ☐ Project design decisions should reflect the following factors:
    - Relationship to or role in overall system mobility
    - Intent of project
    - Type of bicycle facility, if applicable
    - Travel speed
    - Topography
    - Environmental factors
    - Cost
    - Neighborhood character
  - ☐ Address safety issues first, while also considering the Borough's long range facility needs and neighborhood concerns when planning, designing and maintaining non-motorized facilities.
- *Provide separation between sidewalks and roadways.*
  - ☐ Consider meandering sidewalks and paths only when necessary to preserve or avoid topographical features, existing trees, utility boxes and to minimize property disruption. Meandering sidewalks and paths may also be appropriate to retain the neighborhood character or natural vegetation along a street.
  - ☐ Establish standards that provide for bus stops that are accessible from sidewalks, across

swales and landscaping strips, at reasonable intervals.

- *Enhance pedestrian street crossings.*
  - ☐ Enhance the ability of pedestrians to safely cross or avoid barriers by constructing pedestrian crossing improvements at intersections and midblock crossings where justified by a traffic engineering study.
  - ☐ Utilize traffic engineering guidelines for pedestrian crossings to determine if a crosswalk is warranted. Analyze other locations as they are identified. Continue funding to implement the crossing recommendations in these locations.
  - ☐ Examine pedestrian access at locations where special needs for crossing have been identified by pedestrian accident records or by concentrations of elderly housing, employment centers for the disabled population, schools, or residential areas with high concentrations of people with language barriers.
  - ☐ Examine pedestrian access between the neighborhoods and major activity centers at peak locations and times of day to facilitate access and improve safety.
  - ☐ Continue to identify, evaluate and utilize, as appropriate, new approaches and technologies for enhancing pedestrian street crossings.
- *Utilize bicycle design standards.*
  - ☐ Adopt design standards to ensure that bicycle projects are coordinated and consistent in design.
  - ☐ Review material on bicycle facilities in state and federal guidelines and use them for guidance. Look for opportunities to provide flexibility in design of a facility without reducing the intent of a facility.
  - ☐ Provide for the ability of bicycles to trigger signals on bicycle system streets. Continue marking the “hot spots” on streets for triggering signals.
  - ☐ Develop a program and guidelines to enhance safety around sewer and utility covers along bicycle facilities. The guidelines should consider settling problems. Ensure new roadway projects and new construction use bicycle-friendly sewer and utility covers.
  - ☐ Develop design guidelines, whereby arterial streets that are identified as shared roadway. Provide a minimum of 14 foot outside lanes and 15 foot outside lanes on the uphill sections of streets (bike lane streets would be exempt from this standard).
  - ☐ Develop design guidelines for off-street bicycle paths that minimizes conflicts between various users. Design features could include extra width, separation of user types, stenciling, striping, signing or enforcement.
  - ☐ When implementing projects consider factors such as presence of mature landscaping, terrain, utilities, mailbox location/access, neighborhood character, and community wishes.
  - ☐ Continue to dedicate funding to channelize and mark bicycle lanes, wide shoulders and routes.
  - ☐ The Police Department should enforce parking violations in bike lanes and where parking is prohibited on multi-use shoulders. Parking on sidewalks should also be discouraged through enforcement.
- *Implement traffic calming to promote pedestrian and bicycle safety.*
  - ☐ Consider and mitigate, where possible, the impacts of neighborhood traffic calming

devices on existing and proposed pedestrian and bicycle facilities.

- *Provide safe linkages to the transit system.*
  - ☐ Encourage transit use by improving pedestrian and bicycle linkages to the existing and future transit and school bus systems, and by improving the security and utility of bus stops.
- *Provide safe pedestrian transit access.*
  - ☐ Increase the accessibility to transit by pedestrians.
  - ☐ Work with CATA to identify transit facilities, routes or side streets feeding the route, that lack sidewalks or warranted crossing facilities. Prioritize needed sidewalks or warranted crossing facilities and develop a strategy to construct them.
  - ☐ Coordinate roadway and intersection project designs with CATA and address transit needs when possible.
  - ☐ Support the provision of covered transit shelters at key locations along all transit routes.
  - ☐ Identify and inventory needed pedestrian facilities around CATA routes and work with CATA to construct these facilities in conjunction with developing their service.
- *Provide safe bicyclist transit access.*
  - ☐ Facilitate the use of transit by bicyclists.
  - ☐ Work with CATA to identify and fund a list of specific bicycle parking improvements at major transfer stations.
  - ☐ Work with CATA to provide a variety of bicycle parking types (lockers, covered racks, attendant) and facilities (support stations with phones, drinking fountains information kiosks, restrooms, showers, rental and repair service) at major transfer stations in conjunction with developing their service.
- *Promote pedestrians and bicycles through development review.*
  - ☐ Secure sidewalk easements consistent with the Comprehensive Pedestrian and Bicycle Program through the development review process.
- *Consider circulation between and within developments.*
  - ☐ Internal pedestrian circulation systems should be provided within and between existing, new or redeveloping commercial, multi-family or single family developments, and other appropriate activity centers, and should conveniently connect to frontage pedestrian systems and transit facilities.
  - ☐ Work with the School District to secure connections to the schools.
  - ☐ Work with commercial interests through the development review process to create pedestrian connections from the front door to the sidewalk and/or transit stop.
- *Consider non-motorized access during construction.*
  - ☐ Address issues of non-motorized access and safety, through or around a site during construction or maintenance work within the right-of-way.
  - ☐ Highlight to contractors and inspectors the importance construction impacts have on safety, comfort and usability for the disabled, pedestrians and bicyclists. This may involve developing special training or other educational materials.
  - ☐ Review policies that address non-motorized access during construction and implement

any policy changes through revisions to the Borough of State College's standards, codes and specifications.

- ☐ Require work performed in the right-of-way to designate a convenient detour route for non-motorized use, when necessary.
- ☐ Encourage the use, where feasible, of appropriate methods of non-permanent markings on sidewalks when identifying the location of underground utilities.

- *Develop Bicycle Parking Requirements.*
  - ☐ Require new or redeveloping properties to provide bicycle parking and other facilities to encourage the use of bicycles.
  - ☐ Consider model ordinances for bicycle parking that have been developed in other municipalities. This effort should include requirements for bus stations. The bicycle parking requirements should consider the size of the development and/or the nature of the re-development.
  - ☐ Encourage managers of large employment centers to provide secure parking, changing facilities and showers for bicyclists.
  - ☐ Seek funding whereby the Borough would install bike racks for businesses that request them.
  - ☐ The Borough should investigate and develop basic design guidelines for bicycle racks.

MAINTENANCE POLICIES

- *Maintain the pedestrian and bicycle system.*
  - ☐ Minimize hazards and obstructions on the pedestrian and bicycle system by ensuring that the system is properly maintained. Allow different levels of maintenance for certain key linkages based on amount and type of use or exposure to risk.
  - ☐ Require property owners to maintain clearance for pedestrians and bicyclists on walkways and bikeways by pruning low hanging and/or encroaching vegetation.
  - ☐ Coordinate maintenance responsibilities between Borough Departments to provide an integrated maintenance program for the entire pedestrian and bicycle system. Such a program would need to address staffing resources as well as liability issues.
- *Continue sidewalk construction, maintenance & repair programs*
  - ☐ Continue programs to construct, maintain, and repair sidewalks. Periodically review standards for maintenance and repair and revise as appropriate.
- *Provide proactive bicycle system maintenance.*
  - ☐ Place a high priority on the maintenance of the pedestrian and bicycle system.
  - ☐ Bicycle lanes, shoulders (and joint use shoulders), and separated bicycle paths should all be regularly swept and maintained on a regular schedule.
  - ☐ Establish and fund the regular maintenance of on-street bicycle facilities such as routine re-striping of bicycle lanes, and shoulders, re-stenciling of bicycle emblems, re-surfacing of lanes, and shoulders, hazard elimination and vegetation encroachment.
  - ☐ Develop a program for cyclists to easily contact appropriate Borough Departments for

problems. Consider designation of one Borough phone number as a contact to be posted at Park and Ride lockers, off-street trails, bike shop, etc.

- ☐ Develop and fund a program to replace all wide slotted drain grates on Bicycle System Routes.

ENFORCEMENT POLICIES

- *Provide for security and safety of the pedestrian and bicycle system.*
  - ☐ The on-street and off-street transportation system should be designed and monitored to improve security and safety. Lighting, vegetation placement/removal, and police patrols are suggested methods to accomplish this.
  - ☐ Require, where feasible, street lighting along new construction of the non-motorized system that runs adjacent to the roadway.
  - ☐ As warranted, provide lighting at mid-block crossings and at intersections with roadways to improve visibility of pedestrians and bicycles.
  - ☐ Work with Police Department to identify locations with security concerns. Periodically review Police Department crime statistics along paths and trails.
  - ☐ Review maintained trails to identify vegetation to remove or trim to improve sight distance or blocks existing lighting.
  - ☐ Work with citizens to get input on issues of security and safety.
  - ☐ Work with franchise utilities to consider safety and security issues when locating vaults, transformers, risers, poles and appurtenances in new facilities.
- *Require property owner responsibility.*
  - ☐ Notify abutting property owners of their responsibility to maintain sidewalks including pruning overhead and encroaching vegetation, sweeping debris, removing snow and eliminating temporary barriers such as parked vehicles, trash containers and recycling bins. Notify property owners that the Borough is responsible for repairs in the public right-of-way.
  - ☐ Establish a spot improvement/maintenance request program whereby citizens can request minor spot improvements for pedestrians and bicycles. The form should be user-friendly for residents to use.
  - ☐ Identify additional opportunities for communicating property owner responsibility such as using Borough-wide mailings, or neighborhood association newsletters.
- *Enforce pedestrian safety laws.*
  - ☐ Increase the level of enforcement of vehicular laws that protect pedestrians and bicyclists.
  - ☐ The Police Department should step up enforcement of traffic laws that protect pedestrians at signalized and non-signalized intersections. Key infractions include vehicles creeping across stop bars and blocking crosswalks, vehicles turning right without looking to the right, vehicles not coming to a complete stop at intersections and parking on sidewalks.

- ☐ Work with the Police Department to emphasize accident prevention law enforcement at intersections and crosswalks.
- ☐ Consider the feasibility of using volunteer patrols to enforce pedestrian laws such as parking on sidewalks.
- ☐ Work with neighborhood associations to educate residents and their guests about safety and maintenance issues related to parking on sidewalks. Work may include drafting newsletter articles, targeting neighborhoods with informational fliers, and drafting notices for guests of residents.
- ☐ Work with local utilities and mail and package delivery services to educate their drivers as to the importance of not parking on sidewalks.
- ☐ Identify for Police Department enforcement, locations where parking on sidewalks or in multi-use shoulders and bike lanes is problematic.
- ☐ Publish the Police Department's traffic enforcement phone number in information distributed to pedestrians and at locations frequented by pedestrians.

EDUCATION POLICIES

- *Develop and promote share-the-road education programs.*
  - ☐ Develop an effective "share the road" concept for pedestrian and bicycle education programs for the motorized and non-motorized public.
  - ☐ Produce and distribute educational materials aimed at pedestrians and drivers that addresses share the road issues for all modes of travel. Coordinate the development of this material with the Police Department.
  - ☐ Incorporate the "Share the road" concept in future updates of the State College Bike Map.
  - ☐ Incorporate the "share the road" concept into a pedestrian guide map.
- *Provide staff training and education programs.*
  - ☐ Establish a training and education program to increase the awareness of Borough staff about pedestrian and bicycle needs including construction signing, maintenance needs, and increased technical expertise.
  - ☐ Continue to seek out training opportunities for staff, particularly advance classes and issues of concern for the disabled community.
  - ☐ Develop educational material for staff and others who perform work within the right-of-way.
  - ☐ Encourage staff to bring policies, plans and projects that include a non-motorized component to the Transportation Commission.
  - ☐ Utilize brown bag lectures as a method for bringing in speakers on non-motorized topics.
- *Develop a bicyclists information program.*
  - ☐ Develop and implement an information program for bicyclists in the Borough of State College.

- ☐ Post signs on off-street paths that encourages bicyclists to use audible signals when passing other bicycles or pedestrians. Also post signs that identify rules of courtesy on the off-street trails.
- ☐ Produce and distribute informational material suitable for bicyclists and drivers that explains the share the road concept. The material should relay to the public the rules and courtesies of sharing roadways, trails and sidewalks with all modes.
- ☐ Use kiosks to display information about bicycling to the public.
- ☐ The Police should encourage (through public outreach) bicyclists, especially young riders, to report accidents to the Police Department (when the accident meets Police Department reporting criteria) so accident location and frequency can be tracked.
- ☐ Publish the Police Department's traffic enforcement number in information distributed to bicyclists and at locations frequented by bicyclists.
- ☐ Publish the phone number to report traffic signals that bicyclists have problems triggering. This number should be included in information distributed to bicyclists, such as the bike map, or provided at locations frequented by bicyclists, such as bike shops or sign kiosks.

- *Cooperate with organizations to provide education programs.*
  - ☐ Cooperate with the public and private schools, bicycle clubs an other interest groups to provide education programs and strategies to promote safe riding skills and the transportation and recreation opportunities of bicycling.
  - ☐ Solicit feedback and input from students to identify improvements to the bicycle system.
  - ☐ Work with local bicycle clubs to develop educational programs and materials targeted to adults.
- *Develop and promote a motorists education program.*
  - ☐ Develop pedestrian and bicycle education programs for motorists.

ENGINEERING TOOLBOX

SIDEWALKS AND WALKWAYS

Description:

Sidewalks and walkways are "pedestrian lanes" that provide people with space to travel within the public right-of-way that is separated from roadway vehicles. They also provide places for children to walk, run, skate, ride bikes, and play. Sidewalks are associated with significant reductions in pedestrian collisions with motor vehicles. Such facilities also improve mobility for pedestrians and provide access for all types of pedestrian travel: to and from home, work, parks, schools, shopping areas, transit stops, etc. Walkways should be part of every new and renovated facility and every effort should be made to retrofit streets that currently do not have sidewalks.

While sidewalks are typically made of concrete, less expensive walkways may be constructed of asphalt, crushed stone, or other materials if they are properly maintained and accessible (firm, stable, and slip-resistant). Both FHWA and the Institute of Transportation Engineers (ITE) recommend a minimum width of 5 ft for a sidewalk or walkway, which allows two people to pass comfortably or to walk side-by-side. Wider sidewalks should be installed near schools, at transit stops, in downtown areas, or anywhere high concentrations of pedestrians exist. Sidewalks should be continuous along both sides of a street and sidewalks should be fully accessible to all pedestrians, including those in wheelchairs.

A buffer zone of 4 to 6 ft is desirable and should be provided to separate pedestrians from the street. The buffer zone will vary according to the street type. In downtown or commercial districts, a street furniture zone is usually appropriate. Parked cars and/or bicycle lanes can provide an acceptable buffer zone.

Appropriate Locations:

- While continuous walkways are the goal, retrofitting areas without them will usually occur in phases.
- In retrofitting streets that do not have a continuous or accessible system, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.
- Street furniture placement should not restrict pedestrian flow.

Typical Uses:

- Create the appropriate facility for the walking area of the public right-of-way
- Improve pedestrian safety dramatically.

Approximate Cost:

The cost is approximately $5 to $8 per square foot for concrete sidewalk.

CURB RAMPS

Description:

Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, and also for pedestrians with mobility impairments who have trouble stepping up and down high curbs. Curb ramps must be installed at all intersections and midblock locations where pedestrian crossings exist, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). Curb ramps must have a slope of no more than 1:12 (1 in/ft) or a maximum grade of 8.33 percent), and a maximum slope on any side flares of 1:10. More information on the specifications for curb ramps can be found in the *Revised Draft Guidelines for Accessible Public Rights of Ways*.

Where feasible, separate curb ramps for each crosswalk at an intersection should be provided rather than having a single ramp at a corner for both crosswalks. This provides improved orientation for visually impaired pedestrians. Similarly, tactile warnings will alert pedestrians to the sidewalk/street edge. All newly constructed and altered roadway projects must include curb ramps. In addition, existing facilities should be upgraded. Audits should be conducted for all pedestrian facilities to ensure transit stops, schools, public buildings, and parks, etc. are accessible to pedestrians who use wheelchairs.

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

For more information about curb ramp design, refer to *Designing Sidewalks and Trails for Access, Parts I and II*, by the Federal Highway Administration, and *Accessible Rights-of-Way: A Design Guide*, by the U.S. Access Board and the Federal Highway Administration. The Access Board's right-of-way report can be found at www.access-board.gov.

Appropriate Locations:

- Follow Americans with Disabilities Act (ADA) design guidelines.
- Texture patterns must be detectable to blind pedestrians.

Typical Uses:

- Provide access to street crossings.

Approximate Cost:

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

MARKED CROSSWALKS AND ENHANCEMENTS

Description:

Marked crosswalks indicate optimal or preferred locations for pedestrians to cross and help designate right-of-way for motorists to yield to pedestrians. Crosswalks are often installed at signalized intersections and other selected locations. Various crosswalk marking patterns are given in the MUTCD. Marked crosswalks are desirable at some high pedestrian volume locations (often in conjunction with other measures) to guide pedestrians along a preferred walking path. In some cases, they can be raised and should often be installed in conjunction with other enhancements that physically reinforce crosswalks and reduce vehicle speeds. It is also sometimes useful to supplement crosswalk markings with warning signs for motorist. At some locations, signs can get "lost" in visual clutter, so care must be taken in placement.

Pedestrians are sensitive to out-of-the-way travel, and reasonable accommodations should be made to make crossings both convenient and safe at locations with adequate visibility.

Appropriate Locations:

- Crosswalk locations should be convenient for pedestrian access.
- Crosswalk markings alone are unlikely to benefit pedestrian safety. Ideally, crosswalks should be used in conjunction with other measures, such as curb extensions, to improve the safety of a pedestrian crossing, particularly on multi-lane roads with average daily traffic (ADT) above about 10,000.
- Marked crosswalks are important for pedestrians with vision loss.
- Crosswalk markings must be placed to include the ramp so that a wheelchair does not have to leave the crosswalk to access the ramp.

Typical Uses:

- Warn motorists to expect pedestrian crossings.
- Indicate preferred crossing locations.

Approximate Cost:

Approximate installation costs are $100 for a regular striped crosswalk, $300 for a ladder crosswalk, and $8,000 for a patterned concrete crosswalk. Maintenance of the markings must also be considered.

STREET FURNITURE/WALKING ENVIRONMENT

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

Sidewalks and walkways should be kept clear of poles, signposts, newspaper racks, and other obstacles that could block the path, obscure a driver's view or pedestrian visibility, or become a tripping hazard. Benches, water fountains, bicycle parking racks, and other street furniture should be carefully placed to create an unobstructed path for pedestrians. More information on the requirements for street furniture can be found in the *Revised Draft Guidelines for Accessible Public Rights of Way*. Such areas must also be properly maintained and kept clear of debris, overgrown landscaping, tripping hazards, or areas where water accumulates. Snow removal is also important for maintaining pedestrian safety and mobility.

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

Appropriate Locations:
- Good-quality street furniture will show that the community values its public spaces and is more cost-effective in the long run.
- Include plans for landscape irrigation and maintenance at the outset.
- Ensure proper placement of furniture; do not block pedestrian walkway or curb ramps or create sightline problems.
- Ensure adequacy of overhead clearances and detect ability of protruding objects for pedestrians who are blind or visually impaired.

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

Approximate Cost:
Varies depending on the type of furniture, the material out of which it is constructed, and the amount of planting material used.

PEDESTRIAN STREETS / MALLS

Description:

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

Appropriate Locations:

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

Typical Uses:

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

Approximate Cost:

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

PEDESTRIAN OVERPASSES / UNDERPASSES

Description:

Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from the vehicle traffic. However, they should be a measure of last resort, and it is usually more appropriate to use traffic-calming measures or install a pedestrian-activated signal that is accessible to all pedestrians. This is also an extremely high-cost and visually intrusive measure.

Such a facility must accommodate all persons, as required by the ADA. More information on the specifications for accessing overpasses and underpasses can be found in the *Revised Draft Guidelines for Accessible Public Rights of Way*. These measures include ramps or elevators. Extensive ramping will accommodate wheelchairs and bicyclists, but results in long crossing distances and steep slopes that discourage use.

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

Appropriate Locations:

- Use sparingly and as a measure of last resort. Most appropriate over busy, high-speed highways, railroad tracks, or natural barriers.
- Pedestrians will not use if a more direct route is available.
- Lighting, drainage, graffiti removal, and security are also major concerns with underpasses.
- Must be wheelchair accessible, which generally results in long ramps on either end of the overpass.

Typical Uses:

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

Approximate Cost:

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

CURB RADIUS REDUCTION

Description:

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

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

Where there is a parking and/or bicycle lane, curb radii can be even tighter, because the vehicles will have more room to negotiate the turn. Curb radii can, in fact, be tighter than any modern guide would allow: older cities in the Northeast and in Europe frequently have radii of (2 to 5 ft) without suffering any detrimental effects.

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

Appropriate Locations:

- Consider effective radii by taking into account parking and bicycle lanes.
- Make sure that public maintenance vehicles, school buses, and emergency vehicles are accommodated.
- Large trucks and buses may ride over the curb at intersections with tight radii, creating a danger for pedestrians who are waiting to cross.

Typical Uses:

- Safer intersection design.
- Slow right-turning vehicles.
- Reduce crossing distances, improve visibility between drivers and pedestrians, and provide space for accessible curb ramps.
- Shorter crossing distances can lead to improved signal timing.

Approximate Cost:

Construction costs for reconstructing a tighter turning radii are approximately $2,000 to $20,000 per corner, depending on site conditions (e.g., drainage and utilities may need to be relocated).

IMPROVED RIGHT-TURN SLIP-LANE DESIGN

Description:

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

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

Channelized right turn-lanes remain a challenge for visually-impaired pedestrians. First, there are difficulties associated with knowing where the crosswalk is located or knowing where to cross. Second, it is difficult for a pedestrian who is visually-impaired to know when a vehicle has yielded right-of-way. While accessible pedestrian signals can help with these issues, more research is currently underway through the National Cooperative Highway Research Program (NCHRP) to further explore the problem and develop potential solutions. Refer to NCHRP Project 3-78, *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities* for the latest status report.

Appropriate Locations:

- Evaluate first whether a slip lane is really necessary.

Typical Uses:

- Separate right-turning traffic.
- Slow turning-vehicle speeds and improve safety.
- Allow drivers to see approaching cross-street traffic more clearly.
- Reduce the crossing distance for pedestrians.

Approximate Cost:

Approximately $50,000 to $200,000 to reconfigure roadway, add striping and construct an island, assuming additional right-of-way is not required.

RAISED PEDESTRIAN CROSSINGS

Description:

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

Appropriate Locations:

- Do not use on a sharp curve or if the street is a bus route or emergency route. One device may be necessary and serve the primary needs. Several raised devices may be disruptive, so other measures should be considered.
- Speed tables and raised crosswalks and intersections can be an urban design element through the use of special paving materials.
- Detectable warning strips at edges enable pedestrians with vision impairments to detect the crossing.
- Care must be taken to manage drainage.

Typical Uses:

- Reduce vehicle speeds.
- Enhance the pedestrian environment at the crossings.

Approximate Cost:

Raised crosswalks are approximately $2,000 to $15,000, depending on drainage conditions and material used. The cost of a raised intersection is highly dependent on the size of the roads. They can cost from $25,000 to $75,000.

PEDESTRIAN SIGNALS

Description:

Pedestrian signal indications should be used at traffic signals wherever warranted, according to the MUTCD. The use of WALK/DON'T WALK pedestrian signal indications at signal locations are important in many cases, including when vehicle signals are not visible to pedestrians, when signal timing is complex (e.g., there is a dedicated left-turn signal for motorists), at established school zone crossings, when an exclusive pedestrian interval is provided, and for wide streets where pedestrian clearance information is considered helpful.

The international pedestrian symbol signal is preferable and is recommended in the MUTCD. Existing WALK and DON'T WALK messages may remain for the rest of their usual life but should not be used for new installations. Pedestrian signals should be clearly visible to the pedestrian at all times when in the crosswalk or waiting on the far side of the street. Larger pedestrian signals can be beneficial in some circumstances (e.g., where the streets are wide). Signals may be supplemented with audible or other messages to make crossing information accessible for all pedestrians, including those with vision impairments. The decision to install audible pedestrian signals should consider the noise impact on the surrounding area. Much more extensive information on the use of accessible pedestrian signs (APS) and the types of APS technologies now available is provided online at www.walkinginfo.org/aps.

Appropriate Locations:

- Ensure that signals are visible to pedestrians.
- When possible, provide a walk interval for every cycle.
- Pedestrian push buttons must be well positioned and within easy reach for all approaching pedestrians. Section 4E.09 within the MUTCD provides detailed guidance for the placement of push buttons to ensure accessibility.

Typical Uses:

- Indicate appropriate time for pedestrians to cross.
- Provide pedestrian clearance interval.
- Provide countdown information to pedestrians.

Approximate Cost:

$10,000 to $40,000 for new installations.

PEDESTRIAN SIGNAL TIMING

Description:

There are several types of signal timing for pedestrian signals, including concurrent, exclusive, "Leading pedestrian interval" (LPI), and all-red interval. In general, shorter cycle lengths and longer walk intervals provide better service to pedestrians and encourage better signal compliance. For optimal pedestrian service, fixed-time signal operation usually works best. Pedestrian pushbuttons may be installed at locations where pedestrians are expected intermittently. Quick response to the pushbutton or feedback to the pedestrian should be programmed into the system. When used, pushbuttons should be well signed and within reach and operable from a flat surface for pedestrians in wheelchairs and with visual disabilities. They should be conveniently placed in the area where pedestrians wait to cross. Section 4E.09 within the MUTCD provides detailed guidance for the placement of push buttons to ensure accessibility.

In addition to concurrent pedestrian signal timing (where motorists may turn left or right across pedestrians' paths after yielding to pedestrians), exclusive pedestrian intervals stop traffic in all directions. Exclusive pedestrian timing has been shown to reduce pedestrian crashes by 50 percent in some downtown locations with heavy pedestrian volumes and low vehicle speeds and volumes. With concurrent signals, pedestrians usually have more crossing opportunities and have to wait less. Unless a system is willing to take more time from vehicular phases, pedestrians will often have to wait a long time for an exclusive signal. This is not very pedestrian-friendly, and many pedestrians will simply choose to ignore the signal and cross if and when there is a gap in traffic, negating the potential safety benefits of the exclusive signal. Exclusive pedestrian phases do introduce a problem for pedestrians with visual impairments, as the audible cues associated with surging parallel traffic streams are no longer present, which makes it difficult to know when to begin crossing.

A simple, useful change is the LPI, An LPI gives pedestrians an advance walk signal before the motorists get a green light, giving the pedestrian several seconds to start in the crosswalk where there is a concurrent signal. This makes pedestrians more visible to motorists and motorists more likely to yield to them. The advance pedestrian phase is particularly effective where there is a two-lane turning movement. To be useful to pedestrians with vision impairments, an LPI needs to be accompanied by an audible signal to indicate the WALK interval.

There are some situations where an exclusive pedestrian phase may be preferable to an LPI. Exclusive phases are desirable where there are high-volume turning movements that conflict with the pedestrians crossing.

Appropriate Locations:

- A "Pedestrian Scramble" usually creates a longer cycle length and a longer wait between crossings.
- Scramble timing is most applicable to downtown areas with high pedestrian volumes (e.g., more than 1,200 pedestrian crossings per day).
- Scramble timing eliminates conflicts with turning vehicles if pedestrians and motorists obey their signals.
- The benefits of this treatment may not extend to vision-impaired pedestrians.
- Wider intersections require longer cycle lengths.
- Longer walk or pedestrian clearance intervals may also lead to longer cycle lengths.
- Use fixed-time operation unless pedestrian arrivals are intermittent.

Typical Uses:

- A "Pedestrian Scramble" provides an exclusive pedestrian crossing phase with no conflicting traffic.

Approximate Cost:

Adjusting signal timing is very low cost and requires a few hours of staff time to accomplish. New signal equipment ranges from $20,000 to $140,000.

SIGNING

Description:

Signs can provide important information that can improve road safety. By letting people know what to expect, there is a greater chance that they will react and behave appropriately. For example, giving motorists advance warning of an upcoming pedestrian crossing or that they are entering a traffic-calmed area will alert them to modify their speed. Sign use should be done judiciously, as overuse breeds noncompliance and disrespect. Too many signs may also create visual clutter and signs can get lost.

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

Advance pedestrian warning signs should be used where pedestrian crossings may not be expected by motorists, especially if there are many motorists who are unfamiliar with the area. A fluorescent yellow/green color is approved for pedestrians, bicycle, and school warning signs (Section 2A.11 of the MUTCD). This bright color attracts the attention of drivers because it is unique.

All signs should be periodically checked to make sure that they are in good condition, free from graffiti, reflective at night, and continue to serve a purpose. In unusual cases, signs may be used to prohibit pedestrian crossings at an undesirable location and re-route them to a safer crossing location, or warn pedestrians of unexpected driver maneuvers. It is preferable to create safe crossings where there are clear pedestrian destinations. If unexpected driving maneuvers occur at what is an otherwise legal pedestrian crossing, an evaluation should be done to find ways to remedy or prevent the unsafe motorist maneuvers.

Appropriate Locations:

- Overuse of signs breeds noncompliance and disrespect. Too many signs can lead to visual clutter with the result that a driver is not likely to read or pay attention to any of the signs.
- Traffic signs used on public property must comply with the Manual on Uniform Traffic Control Devices (MUTCD).
- Signs should be checked to assure adequate nighttime reflectivity.

Typical Uses:

- Provide regulation, warning, or information to road users as to what to expect and how to behave.

Approximate Cost:

$50 to $150 per sign plus installation costs.

ADVANCED STOP LINES

Description:
At signalized intersections and midblock crossings, the vehicle stop line can be moved father back from the pedestrian crosswalk for an improved factor of safety and for improved visibility of pedestrians. In some places, the stop line has been moved back by 15 to 30 ft relative to the marked crosswalk with considerable safety benefits for pedestrians. One study found that use of a "Stop Here For Pedestrians" sign alone reduced conflicts between drivers and pedestrians by 67 percent. With the addition of an advanced stop line, this type of conflict was reduced by 90 percent compared to baseline levels.

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

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

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

Typical Uses:
- Improve visibility of pedestrians to motorists.
- Allow pedestrians to advance in a crosswalk before motor vehicle turn.

Approximate Cost:
There is no extra cost when the recessed stop line is installed on new paving or as part of repaving projects. A STOP HERE ON RED (R10-6) sign can be used to supplement the recessed stop line.

RIGHT-TURN-ON-RED RESTRICTIONS

Description:

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

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

Prohibiting RTOR should be considered where and/or when there are high pedestrian volumes. This can be done with a simple sign posting, although there are some options that are more effective than a standard sign. For example, one option is a larger 30-in by 36-in NO TURN ON RED sign, which is more conspicuous. For areas where a right-turn-on-red restriction is needed during certain times, time-of-day restrictions may be appropriate. A variable-message NO TURN ON RED sign is also an option.

Appropriate Locations:

- Prohibiting RTOR is a simple, low-cost measure. Together with a leading pedestrian interval, the signal changes can benefit pedestrians with minimal impact on traffic.
- Part-time RTOR prohibitions during the busiest times of the day may be sufficient to address the problem.
- Signs should be clearly visible to right-turning motorists stopped in the curb lane at the crosswalk.

Typical Uses:

- Increase pedestrian safety and decrease crashes with right-turning vehicles

Approximate Cost:

$30 to $150 per NO TURN ON RED sign plus installation at $200 per sign. Electronic signs have higher costs.

Crash Reduction Factor:

$CRF = (0.984)^n$

Where n= number of approaches where RTOR is prohibited.

INTERSECTION MEDIAN BARRIERS

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

This treatment can benefit pedestrians who need to cross any leg of the intersection, but restricts vehicle entry into and out of neighborhoods and can therefore greatly reduce cut-through traffic. However, since this treatment can dramatically influence traffic patterns and have potentially negative consequences caused by shifting traffic, it should be used cautiously.

Cut-throughs must be incorporated into the design for pedestrian and bicyclist use.

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

Typical Uses:
- Reduce cut-through traffic on a neighborhood street.
- Provide refuge for pedestrian crossing wide streets.

Approximate Cost:
$10,000 to $20,000.

Crash Reduction Factor:

0.54 at locations with marked crosswalks

0.61 at locations with unmarked crosswalks.

BICYCLE LANES

Description:
Bike lanes indicate a preferential or exclusive space for bicycle travel along a street. Bike lanes have been found to provide more consistent separation between bicyclists and passing motorists. Marking bicycle lanes can also benefit pedestrians – as turning motorists slow and yield more to bicyclists, they will also be doing so for pedestrians.

Bike lanes are typically designated by striping and/or signing. If the addition of bike lanes results in fewer motor vehicle lanes, safety may be enhanced for pedestrians crossing the street. Bicycle lanes also provide a buffer between motor vehicle traffic and pedestrians when sidewalks are immediately adjacent to the curb. On high-speed, high-volume roads, it may be more appropriate to provide a multi-use path to physically separate both bicyclists and pedestrians from motor vehicle traffic. However, the application of this treatment requires that care be taken to minimize the conflicts between bicyclists and pedestrians.

Appropriate Locations:
- All roads should be evaluated for on-street bicycle facilities.
- Provide adequate space between the bike lane and parked cars so that open doors do not create a hazard for bicyclists.

Typical Uses:
- Create on-street travel facilities for bicyclists.
- Narrow the roadway to encourage lower motor vehicle speeds.
- Provide additional separation between pedestrians and motor vehicles.
- Adding on-street bike lanes reduces the distance pedestrians must travel to cross automobile lanes.

Approximate Cost:
The cost of installing a bike lane is approximately $5,000 to $50,000 per mile, depending on the condition of the pavement, the need to remove and repaint the lane lines, the need to adjust signalization, and other factors. It is most cost efficient to create bicycle lanes during street reconstruction, street resurfacing, or at the time of original construction.

ROADWAY NARROWING

Description:
Roadway narrowing can be achieved in several different ways:

a. Lane widths can be reduced to 10 or 11 ft and excess asphalt striped with a bicycle lane or shoulder.
b. On-street parking lanes can be added.
c. Curbs can be moved to narrow the cross section and extend the width of sidewalks and landscape areas.

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

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

Typical Uses:
♦Multiple benefits of lower vehicle speeds, increased safety, and redistributing space to other users.

Approximate Cost:
Adding striped shoulders or on-street bike lanes can cost as little as $1,000 per mile if the old paint does not need to be changed. The cost for restriping a street to bike lanes or reducing the number of lanes to add on-street parking is $5,000 to $10,000 per mile), depending on the number of old lane lines to be removed. Constructing a raised median or widening a sidewalk can cost $100,000 or more per mile.

LANE REDUCTION

Description:

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

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

A typical three-lane configuration consisting of two travel lanes and a two-way left-turn lane (TWLTL) also has advantages for motorists. Through traffic can maintain a fairly constant speed, while left-turning drivers can exit the traffic stream and wait in the TWLTL. However, TWLTLs can also create problems for opposing left-turn vehicles and may be used as acceleration lanes by some motorists. Designs that incorporate raised medians and left-turn bays may offer a better solution.

Appropriate Locations:

- Roadway capacity operation and overall road safety need to be considered before reducing the number of lanes.
- Ensure street connections so major arterials can be crossed at controlled intersections.

Typical Uses:

- Remedy a situation where there is excess capacity.
- Provide space for pedestrians, bicyclists, and parked cars.
- Reduce crossing time, which can help optimize signal timing.
- Improve social interaction and neighborhood feel along the street.

Approximate Cost:

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

If a reconfiguration is done after repaving or with an overlay, and curbs do not need to be changed, there is little or no cost for the change.

DRIVEWAY IMPROVEMENTS

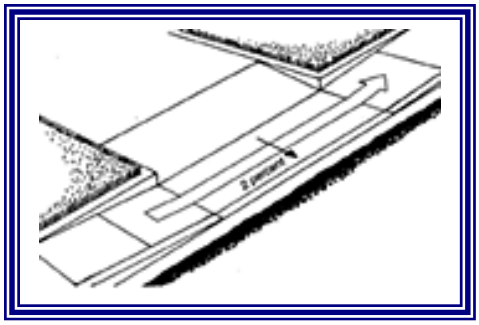
Description:
Several driveway designs may cause safety and access problems for pedestrians, including excessively wide and/or sloped driveways, driveways with large turning radii, multiple adjacent driveways, driveways that are not well defined, and driveways where motorist attention is focused on finding a gap in congested traffic. In addition, driveways without a level sidewalk landing may not comply with ADA standards. Refer to Chapter 5 in *Designing Sidewalks and Trails for Access, Park II of II: Best Practices Design Guide* for further guidance.

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

When driveways cross sidewalks, it is necessary to maintain a sidewalk level across the driveway of no more than 2 percent side slope. This is more usable for all pedestrians, especially those in wheelchairs, and makes it clear to motorists that they must watch for pedestrians. It is important to minimize large signs and bushes at driveways to improve the visibility between motorists and pedestrians. The sidewalk material (usually concrete) should be maintained across the driveway as well.

Appropriate Locations:
- It is best to properly design and consolidate driveways at the outset.

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



Approximate Cost:
No additional cost if part of original construction.

ONE-WAY/TWO-WAY STREET CONVERSIONS

Description:

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

As a system, one-way streets can increase travel distances of motorists and bicyclists and can create confusion, especially for non-local residents. One-way streets operate best in pairs, separated by no more than 0.25 mi. Conversion costs can be quite high to build crossovers where the one-way streets convert back to two-way streets, and to rebuild traffic signals and revise striping, signing, and parking meters.

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

Conversions can go the other way as well: some places are returning one-way streets back to two-way to allow better local access to businesses and homes and to slow traffic. Two-way streets tend to be slower due to "friction," especially on residential streets without a marked center line, and they may also eliminate the potential for multiple-threat crashes that exists on multi-lane, one-way streets.

Appropriate Locations:

- Consider impacts on other streets.
- Be aware that one-way streets may decrease automobile accessibility to businesses.
- Be careful not to create speeding problems where a two-way street is changed to a one-way street. Redesign or traffic-calming measures may be required to address this.
- Will improve signal synchronization on the one-way streets, but will hinder synchronization on cross-streets.
- Generally requires a one-way pair, with two nearby streets being converted to one-way.

Typical Uses:

- Manage traffic patterns.
- Reduce conflicts.
- A one-way to two-way conversion will generally reduce speeds.

Approximate Cost:

$20,000 to $200,000 per mile, depending on length of treatment and whether the conversion requires modification to signals. If crossovers are needed at the end points of the one-way streets, they may cost millions of dollars.

TRANSIT STOP TREATMENTS

Description:
Well-designed transit routes and accessible stops are essential to a usable system.

The stops should be designed to provide safe and convenient access and should be comfortable places for people to wait. Adequate bus stop signing, lighting, a bus shelter with seating, trash receptacles, and bicycle parking are also desirable features. Bus stops should be highly visible locations that pedestrians can reach easily by means of accessible travel routes. Therefore, a complete sidewalk system is essential to support a public transportation system. Convenient crossings are also important.

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

Far-side bus stops generally encourage pedestrians to cross behind the bus. Relocating the bus stop to the far side of the intersection can improve pedestrian safety since it eliminates the sight-distance restriction caused by the bus. Placing bus stops at the far side of intersections can also improve motor vehicle operation.

The bus stop location should be fully accessible to pedestrians in wheelchairs, should have paved connections to sidewalks where landscape buffers exist, and should not block pedestrian travel on the sidewalk. Adequate room should exist to operate wheelchair lifts. Yet, it is also useful to install curb ramps at bus stops to that a passenger can board from the street if bus-lift deployment is blocked. Additional information on making bus stops accessible can be found in Chapter 3 of *Accessible Rights-of-Way: A Design Guide.*

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

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

Approximate Cost:
$1,000 to $10,000. Cost varies widely depending on type of improvements.

ROADWAY LIGHTING IMPROVEMENTS

Description:

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

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

In commercial areas or in downtown areas, specialty pedestrian-level lighting may be placed over the sidewalks to improve pedestrian comfort, security, and safety.

Appropriate Locations:

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

Typical Uses:

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

Approximate Cost:

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

Crash Reduction Factor:

CRF (All crashes) = 0.96

ROUNDABOUTS

Description:

A roundabout is a circular intersection that eliminates some of the conflict traffic, such as left turns, that causes crashes at traditional intersections. Traffic maneuvers around the circle in a counterclockwise direction, and then turns right onto the desired street. All traffic yields to motorists in the roundabout and left-turn movements are eliminated. Unlike a signalized intersection, vehicles generally flow and merge through the roundabout from each approaching street without having to stop.

Roundabouts need to accommodate pedestrians and bicyclists. It is important that automobile traffic yields to pedestrians crossing the roundabout. Splitter islands at the approaches slow vehicles and allow pedestrians to cross one direction of travel at a time. Single-lane approaches can be designed to keep speeds down to safer levels and allow pedestrians to cross. Multilane approaches can create multiple threats for pedestrians and are not recommended.

Wayfinding and gap selection cues need to be adequately addressed in the design of roundabouts so that roundabouts are not a barrier to pedestrians with vision impairments. One possible solution is the use of accessible pedestrian signals placed on sidewalks and splitter islands to indicate both where to cross and when to cross. More research is currently underway through the National Cooperative Highway Research Program (NCHRP) to further explore the problem and develop potential solutions.

Bicyclists also may be disadvantaged by roundabout design. Unless the road is narrow (one lane in each direction), speeds are slow, and traffic very light, bicyclists may not be able to share the road comfortably. Marking bicycle lanes through the roundabout has not been shown to be safer. In larger roundabouts, an off road bicycle path may be necessary to allow cyclists to use the pedestrian route. This is inconvenient and takes longer but it will improve safety. Refer to the FHWA report *Roundabouts, An Informational Guide* for more information related to the design of facilities for both pedestrians and bicyclists.

Appropriate Locations:

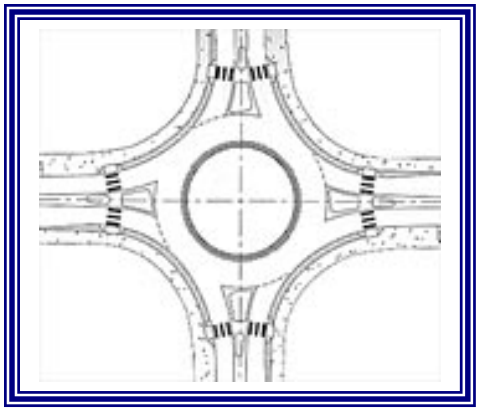
- Street widths and/or available right-of-way need to be sufficient to accommodate a properly designed roundabout.
- Roundabouts have a mixed record regarding pedestrian and bicyclists safety – a low design speed is required.
- Roundabouts are generally not appropriate for the intersection of two multilane roads.
- Roundabouts often work best where the traffic flows are balanced on all approaches.
- Deflection on each left of the intersection must be set to control speeds to (15-18 mi/h)

Typical Uses:

- Improve safety at intersections experiencing a large number of angle collisions.
- Convert signalized intersection to improve traffic flow efficiency.
- Reduce speeds at intersection.
- Create a gateway into an area.

Approximate Cost:

The cost for a landscaped roundabo varies widely and can range fro $45,000 to $150,000 for neighborho intersections and up to $250,000 f arterial street intersections, n including additional right-of-w acquisition. Yet, roundabouts ha lower ongoing maintenance costs th traffic signals.



Crash Reduction Factor:

Single lane urban (All crashes) = 0.44

TRAFFIC SIGNAL ENHANCEMENTS

Description:

A variety of traffic signal enhancements that can benefit pedestrians and bicyclists are available. These include automatic pedestrian detectors, providing larger traffic signals to ensure visibility, placing signals so that motorists waiting at a red light can't see the other signals and anticipate the green, and installing countdown signals to provide pedestrians with information about the amount of time remaining in a crossing interval.

Countdown signals may be designed to begin counting down at the beginning of the walk phase or at the beginning of the clearance (flashing DON'T WALK) interval.

Since pedestrian pushbutton devices are not activated by about one-half of pedestrians (even fewer activate them where there are sufficient motor vehicle gaps), new "intelligent" microwave or infrared pedestrian detectors are now being installed and tested in some U.S. cities. These automatically activate the red traffic and WALK signals when pedestrians are detected. Detectors can also be used to extend the crossing time for slower moving pedestrians in the crosswalk. Automatic pedestrian detectors have been found to improve pedestrian signal compliance and also reduce pedestrian conflicts with motor vehicles. However, they are still considered experimental and their reliability may vary under different environmental conditions.

More information on some of these technologies is available online at www.walkinginfo.org/pedsmart. This web site was developed in 1999 and includes information on several types of smart technologies, the problems they may address, and the vendors of the devices. Locations where many of the devices were installed at the time are also included as case studies.

Appropriate Locations:

- Pedestrian signals need to indicate the crossing interval by visual, audible, and/or tactile means if pedestrians with vision impairments are to take advantage of them.

Typical Uses:

- Improve pedestrian accommodation at signalized crossings.

Approximate Cost:

About $5,000 to $10,000 to add new pedestrian signals and mark crosswalks.

TRAFFIC SIGNALS

Description:

Traffic signals create gaps in the traffic flow, allowing pedestrians to cross the street. They should allow adequate crossing time for pedestrians and an adequate clearance interval based upon a maximum walking speed of 3.5 ft/s. Signals are particularly important at high-use, mid-block crossings on higher speed roads, multi-lane roads, or at highly congested intersections. National warrants from the Manual on Uniform Traffic Control Devices are based on the number of pedestrians and vehicles crossing the intersection, among other factors. However, judgment must also be used on a case-by-case basis. For example, a requirement for installing a traffic signal is that there are a certain number of pedestrians present. If a new facility is being built – a park or recreational path, for example – there will be a new demand, and the signal could be installed in conjunction with the new facility based on projected crossing demand. There may also be latent demand if a destination is no currently accessible, but could become so with new facilities or redesign.

In downtown areas, signals are often closely spaced, sometimes every block. Timed sequencing of signals may reduce the amount of time allotted per cycle for pedestrian crossing to unsafe lengths. Signals are usually spaced farther apart in suburban or outlying areas, but similar considerations for pedestrian phasing should be made. When high pedestrian traffic exists during a majority of the day, fixed-time signals should be used to consistently allow crossing opportunities. Pedestrian actuation should only be used when pedestrian crossings are intermittent and should be made accessible to all pedestrians, including those with disabilities.

Appropriate Locations:

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

Typical Uses:

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

Approximate Cost:

$30,000 to $140,000.

GATEWAYS

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

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

Typical Uses:
- Create an expectation for motorists to drive more slowly and watch for pedestrians when entering a commercial, business, or residential district from a higher speed roadway.
- Create a unique image for an area.

Approximate Cost:
Varies widely depending on the measures chosen.

LANDSCAPING

Description:

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

The most significant issue with any landscaping scheme is ongoing maintenance. Some communities have managed effectively by creating homeowners associations to pay for landscape maintenance or through the volunteer efforts of neighbors. Others have found them to be unreliable and budget for public maintenance instead. Consider adding irrigation systems in areas with extensive planting.

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

Appropriate Locations:

- Maintenance must be considered and agreed to up-front, whether it is the municipality or the neighborhood residents who will take responsibility for maintenance.
- Shrubs should be low-growing and trees should be trimmed up to at least 8 to 10 ft to ensure that sight distances and head room are maintained and personal security is not compromised.
- Plants and trees should be chosen with care to match the character of the area; be easily maintained; and not create other problems, such as buckling sidewalks.
- Minimum clear widths and heights, as specified in the *Revised Draft Guidelines for Accessible Public Rights-of-Way*, must be maintained.

Typical Uses:

- Enhance the street environment.
- Calm traffic by creating a visual narrowing of the roadway.

Approximate Cost:

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

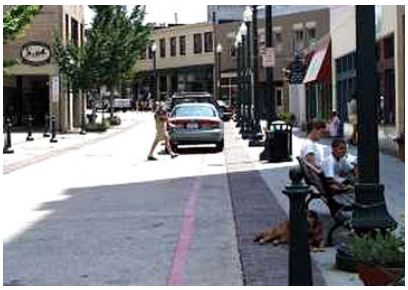
WOONERF

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

Consideration must be given to provide access by fire trucks, sanitation vehicles and other service vehicles (school buses and street sweepers), if needed.

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

Typical Uses:
- Create a very low automobile volume, primarily on local access streets.
- Create a public space for social and possibly commercial activities and play by area children.



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

CURB EXTENSIONS

Description:

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

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

Curb extensions are only appropriate where there is an on-street parking lane. Curb extensions must not extend into travel lanes, bicycle lanes, or shoulders (curb extensions should not extend more than 6 ft from the curb. The turning needs of larger vehicles, such as school buses, need to be considered in curb extension design.

Appropriate Locations:

- Curb extensions can provide adequate space on narrow sidewalks for curb ramps and landings.
- Curb extensions should only be used where there is a parking lane, and where transit and bicyclists would be traveling outside the curb edge for the length of the street.
- Midblock extensions provide an opportunity to enhance midblock crossings. Care should be taken to ensure that street furniture and landscaping do not block motorists' views of pedestrians.
- Where intersections are used by significant numbers of trucks or buses, the curb extensions need to be designed to accommodate them.
- It is not necessary for a roadway to be designed so that a vehicle can turn from a curb lane to a curb lane. Vehicles can often encroach into adjacent lanes safely where volumes are low and/or speeds are slow. Speeds should be slower in a pedestrian environment.
- Emergency access is often improved through the use of curb extensions if intersections are kept clear of parked cars. Fire engines and other emergency vehicles can climb a curb where they would not be able to move a parked are. At midblock locations, curb extensions can keep fire hydrants clear of parked cars and make them more accessible.
- Curb extensions can create additional space for curb ramps, landscaping, and street furniture that are sensitive to motorist and pedestrian sightlines; this is especially beneficial w here sidewalks are otherwise too narrow.
- Ensure that curb extension design facilitates adequate drainage.

Typical Uses:

- Improve safety for pedestrians and motorists at intersections.
- Increase visibility and reduce speed of turning vehicles.
- Shorten crossing distance and reduce pedestrian exposure.

Approximate Cost:

Curb extensions cost from $2,000 to $20,000 per corner, depending on design and site conditions. Drainage is usually the most significant determinant of cost.

SCHOOL ZONE IMPROVEMENTS

Description:

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

Other helpful measures include parking prohibitions near intersections and crosswalks near schools; increased child supervision at crossings; and the use of signs and markings, such as the school advance warning sign (which can be fluorescent yellow/green) and SPEED LIMIT 15 MPH WHEN FLASHING. Schools should develop "safe routes to school" plans and work with local agencies to identify and correct problem areas. Marked crosswalks can help guide children to the best routes to school. School administrators and parent-teacher organizations needs to educate students and parents about school safety and access to and from school. Education, enforcement, and well-designed roads must all be in place to encourage motorists to drive appropriately.

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

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

Appropriate Locations:

- Safety must be a combined effort between local traffic officials, police, school officials, parents, and students.

Typical Uses:

- Provide enhanced safety around schools.

Approximate Cost:

Costs would depend on the school zone treatment selected. For example, if signs were chosen, costs might include $50 to $150 per sign plus installation costs.

NEIGHBORHOOD IDENTITY

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

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

Appropriate Locations:
- Supports community efforts, but has no direct traffic benefits.

Typical Uses:
- Increase the visibility of a neighborhood or district and support community efforts to define their neighborhood.

Approximate Cost:
$50 to $150 per sign. Some signs may cost more because they are usually custom made.

ON-STREET PARKING ENHANCEMENTS

Description:

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

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

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

Appropriate Locations:

- Parking may take up space desired for other uses, such as wider sidewalks or bicycle lanes.
- Approaches to crosswalks and intersections should be cleared and curb extensions added at crossing locations for pedestrian safety.
- Parking meters should be used in downtown areas where there is a need for parking turnover. This can generate revenue for the community.

Typical Uses:

- Provide motorist access to destinations along a street.
- Aid in speed reduction by increasing friction along the street.
- Provide a buffer between sidewalk edge and moving traffic.

Approximate Cost:

$30 to $150 per sign. About $300 per parking meter and installation. Curb paint and stall marks or striping costs are additional.

EDUCATION TOOLBOX

PEDESTRIAN & BICYCLE / DRIVER EDUCATION

Description:

Providing education, outreach, and training is a key strategy in increasing pedestrian and motorist awareness and behavior. While efforts most certainly provide information, the primary goal of an educational strategy is to motivate people to alter their behavior and reduce reckless actions. To implement the strategy, an integrated, multidisciplinary approach that links hard policies (e.g., changes in infrastructure) and soft policies (e.g., public relations campaigns) and addresses both pedestrians and drivers has the greatest chance of success.

There are several broad approaches to education that can be conducted with moderate resources. They include 1) highlighting pedestrian features when introducing new infrastructure; 2) conduction internal campaigns within the organization to build staff support for pedestrian safety programs; 3) incorporating pedestrian safety messages into public relations efforts; 4) developing relationships with sister state agencies and statewide consumer groups; and 5) marketing alternative travel modes.

There are three specific types of educational campaigns – public awareness, targeted campaigns, and individual campaigns. Public awareness campaigns are a great example of a vehicle used to garner public support. An effective campaign can "lay the groundwork" for subsequent pedestrian safety initiatives and can increase the likelihood of their success. Campaigns to target groups are usually aimed at changing behavior patterns in specific groups of people (e.g., motorists, elderly, school children). Since changing behavior in these groups can be a long and arduous task, these campaigns tend to be ongoing efforts aimed at long-term results. Individual campaigns differ from campaigns at target groups because the audience is reached through an intermediary. Intervention occurs at an individual level through safety guards, doctors and other authority figures. Using these different approaches in concert reaches a broader audience and increases the likelihood of long-term success in changing attitudes and behaviors.

Appropriate Locations:

- Educational messages should encourage people to think about their own travel attitudes and behaviors and make more informed choices.
- Pedestrian educational campaigns must be a part of a long-term and ongoing traffic safety program.
- Educational programs and materials should be sensitive of different groups of people.
- Outreach material should be interesting and involve visual as well as written messages.
- Difficulty in gaining political support needed to ensure a comprehensive program.
- Difficulty in introducing safety education within established school system curriculums.

Typical Uses:

- Provide information to roadway users.
- To motivate a change in specific behaviors to reduce the risk of pedestrian injuries.

Approximate Cost:

Costs vary widely depending on type of educational programs used.

Resources:

Pedestrian safety Campaign:
http://safety.fhwa.dot.gov/local_program/pedcampaign/

ENFORCEMENT TOOLBOX

POLICE ENFORCEMENT

Description:

Police enforcement is a primary component in preserving pedestrian and bicycle right-of-way and maintaining a safe environment for all modes of travel. Well-publicized enforcement campaigns are often effective in deterring careless and reckless driving and encouraging drivers to share the roadway with pedestrians and bicyclists when combined with strategically installed traffic control devices and public education programs. Most importantly, by enforcing the traffic code, police forces implant a sense of right and wrong in the general public and lend credibility to traffic safety educational programs and traffic control devices.

Over the years, police departments around the country have consistently enforced traffic laws pertaining to driving under the influence, speeding, and running red lights. They have developed effective and socially accepted methods for measuring this behavior and apprehending offenders. However, enforcement of right of way laws has proven more difficult, as police forces have focused attention on more objective violations and/or not provided appropriate training to police officers. Good enforcement requires enforcing traditional traffic laws as well as ensuring equal protection for drivers as well as pedestrians and bicyclists.

There are a number of actions that municipalities can use to implement enforcement campaigns designed to protect pedestrians. These include increased police presence around school zones, residential neighborhoods, and other areas with high pedestrian activity; "pedestrian stings" involving police officers in civilian clothing; and high profile, hard hitting mass media campaigns to sign-post change and help set the public agenda. Some enforcement campaigns require special legislation to provide a legal basis for stricter crosswalk codes or right of way changes while other campaigns operate under existing ordinances.

Appropriate Locations:

- Campaigns must be sensitive to the needs of different neighborhoods, age/ethnic groups, etc.
- To avoid PR problems, police officers need to be trained properly beforehand.
- Enforcement should be conducted with the help of staff support and awareness of the courts.
- Enforcement operations should be focused on drivers rather than pedestrians.
- Enforcement operations should begin with warnings and flyers before moving on to issuing citations for violations.

Typical Uses:

- Increase drive-awareness of the need to share the roadway.
- Reduce pedestrian-related traffic crashes.

Approximate Cost:

Cost varies depending on amount of training, number of officers involved, public relations work, duration of the program, and other factors.

SPEED-MONITORING TRAILER

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

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

Appropriate Locations:
- Occasional enforcement is needed to supplement the speed-monitoring trailers.
- Speed-monitoring trailers are not a substitute for engineering measures.
- Should not obstruct pedestrian travelway or sightlines.

Typical Uses:
- Enhance enforcement efforts through public education and awareness.

Approximate Cost:
$10,000 to $15,000 to purchases the speed-monitoring trailer, plus the cost to move the trailer to different locations and to monitor the trailer.

PEDESTRIAN AND BICYCLE IMPROVEMENT PROJECTS PRIORITY LIST

Short-Term Projects Improvement List – 2009 - 2010

☐ Implement the recommended improvements at the *top five areas of concern for pedestrian safety* (from Part I of the Pedestrian and Bicycle Safety Program).

- ***Beaver Avenue & Atherton Street***
  - Implement the LPI during the next system-wide signal retiming;
  - Install a barrier (i.e. decorative drop chain fence, etc.) along Atherton Street from Beaver Avenue to College Avenue.
  - Install a curb extension (pedestrian node) on the south-east corner of the intersection shadowing the parking lane on Beaver Avenue;

- ***College Avenue & Atherton Street***
  - Implement the LPI the next system-wide signal retiming;
  - Install a barrier (i.e. decorative drop chain fence, etc.) along Atherton Street from Beaver Avenue to College Avenue.

- ***College Avenue & Allen Street***
  - Install a curb extension or pedestrian node on the north side of the intersection for both College Avenue crosswalks.

- ***College Avenue & Burrowes Street***
  - Install a curb extension or pedestrian node on the west side of the intersection on the north and south sides of College Avenue.
  - Remove the protected northbound left turn signal phase and implement the LPI at for the west crosswalk.

- ***Beaver Avenue & Locust Lane***
  - Install a curb extension or pedestrian node on the south-east and south-west side of the intersection.

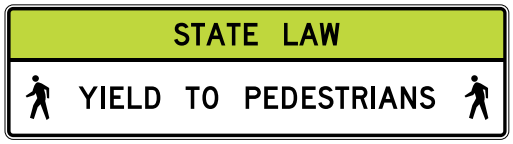
☐ Install advanced stop lines at all signalized intersections in the Borough of State College.

☐ Verify and / or implement "No Turn on Red" restrictions at all signalized intersections with significant pedestrian activity within the Borough of State College.

☐ Consider pre-timed traffic signal operation in the Downtown central business district (CBD) to provide more consistent pedestrian crossing time, especially during peak periods.

☐ Implement longer pedestrian crossing times at Downtown CBD traffic signals through the use of variable "Walk" intervals by time of day.

- ☐ Retime pedestrian phases at all Borough traffic signals for the proposed walking speed of 3.5 feet per second per the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD).
- ☐ Install gateway (overhead) signage to indicate "pedestrian activity" on major arterial streets leading to Downtown State College.
  - College Avenue
  - Beaver Avenue
  - Atherton Street



- ☐ Implement an online "spot improvement" request form for pedestrians and bicyclists. Suggestions for maintenance and safety improvements can be more easily communicated to staff.
- ☐ Install "share the road arrows" at all applicable locations along bicycle routes and upgrade route marking signage per guidelines in the 2009 MUTCD.

Long-Term Projects Improvement List – 2009-2014

- ☐ Evaluate the effectiveness of past pedestrian and bicycle improvement projects.
- ☐ Create a pedestrian and bicycle education and enforcement task force to review existing programs and materials and assign responsibility for implementing new efforts.
- ☐ Review and update the pedestrian and bicycle improvement projects priority list each year when developing the capital improvement plan (CIP).
- ☐ Identify candidate improvement projects by reviewing the program matrix and identify gaps in addressing pedestrian and bicycle policies.
- ☐ Update pedestrian and bicycle route maps and facility maps on a yearly basis. Publish the maps the on Borough website and provide maps at other key user locations.
- ☐ Monitor yearly pedestrian and bicycle crash statistics to uncover any trends in pedestrian and bicycle safety.
- ☐ Create a plan to reduce speeds along Atherton Street -- especially near the CBD. Consider changing the streetscape environment rather than trying to influence speed directly by speed limit signage.

Pedestrian and Bicycle Program Matrix
Comprehensive Pedestrian and Bicycle Program
Borough of State College, Centre County, PA

Policies / Recommendations	**Short Term Projects Improvement List 2009 - 2010**									**Long Term Projects Improvement List 2009 - 2014**						
	Implement recommendations from the top five areas of concern for pedestrian safety.	Install advanced stop lines at all signalized intersections	Implement NTOR restrictions at all signalized intersections with heavy ped. Activity.	Consider pre-timed traffic signal operation in CBD to provide more "WALK" interval time.	Implement longer "WALK" intervals at traffic signals by time of day.	Retime all traffic signals for new MUTCD pedestrian walking speed.	Install "gateway" signage for pedestrian activity along arterial roadways leading to the CBD.	Implement an online "spot improvement" form for community feedback.	Upgrade and install bicycle route pavement markings and signage.	Evaluate the effectiveness of past pedestrian and bicycle improvements.	Create a pedestrian and bicycle education and enforcement task force.	Review and update the pedestrian and bicycle improvements project list yearly.	4. Review the program matrix and identify gaps in planning for pedestrian and bicycle safety and mobility.	Update pedestrian and bicycle facility maps on a yearly basis. Publish for public use.	Monitor yearly crash statistics.	Create a plan to reduce speeds along Atherton Streetto improve ped./bike safety
Planning																
Promote non-motorized transportation.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Identify recreational needs.														■		
Coordinate with community organizations.								■			■					
Give attention to pedestrians and bicyclists during the planning process.	■							■			■		■	■		
Implement a non-motorized transportation system.														■		
Prioritize pedestrian and bicycle projects.																
Coordinate with neighboring jurisdictions.							■		■		■					
Develop and Maintain Pedestrian and Bicycle System and Project Maps.														■		
Provide a Sound Funding Program.												■				
Five Year Plan Update.												■				
Coordinate Project Timing.												■				
Ensure there is no loss of existing facilities.														■		
Develop a Mobility Management Matrix.										■		■				
Address the special needs of all pedestrians and bicyclists.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Engineering																
Provide Way-Finding for Pedestrian and Bicycle Systems.									■							
Identify and construct missing pedestrian links.														■		
Coordinate access around schools.																
Incorporate pedestrian and bicycle accommodation in project design.									■			■			■	
Provide separation between sidewalks and roadways.																
Enhance pedestrian street crossings.	■	■	■	■	■	■										■
Utilize bicycle design standards.									■							
Implement traffic calming to promote pedestrian and bicycle safety.																
Provide safe linkages to the transit system.																
Provide safe pedestrian transit access.	■															
Provide safe bicyclist transit access.									■							
Promote pedestrians and bicycles through development review.																
Consider circulation between and within developments.																
Consider non-motorized access during construction.																
Develop Bicycle Parking Requirements.																
Maintenance																
Maintain the pedestrian and bicycle system.		■	■	■	■	■	■		■							
Continue sidewalk construction, maintenance & repair programs							■									
Provide proactive bicycle system maintenance.							■		■						■	
Enforcement																
Provide for security and safety of the pedestrian and bicycle system.									■		■				■	
Require property owner responsibility.																
Enforce pedestrian safety laws.							■								■	
Education																
Develop and promote share-the-road education programs.								■	■		■					
Provide staff training and education programs.								■			■					
Develop a bicyclists information program.								■	■		■			■		
Cooperate with organizations to provide education programs.								■			■					
Develop and promote a motorists education program.								■			■					

APPENDIX

REFERENCES

Chapel Hill Planning Department. *Chapel Hill Bicycle & Pedestrian Action Plan.* Fourth Edition, September 2005.

City of Bellevue Transportation Department. *Pedestrian and Bicycle Transportation Plan Update.* October 1999.

City of Edina. *Comprehensive Bicycle Transportation Plan*. September 2007.

Federal Highway Administration. *How to Develop a Pedestrian Safety Action Plan*. Report FHWA-SA-05-12. February 1996

Federal Highway Administration. *Improving Conditions for Bicycling and Walking*. January 1998.

Federal Highway Administration. *Manual on Uniform Traffic Control Devices*. 2003 Edition with Revisions 1 and 2. December 2007.

Federal Highway Administration. *Model Pedestrian Safety Program User's Guide*. Report FHWA-RD-87-039. April 1987.

Federal Highway Administration. *PedSafe: Pedestrian Safety Guide and Countermeasure Selection System.* Report FHWA-SA-04-003. September 2004.

Harkey, DL., Srinivasan, R., Baek, J., Council, FM., Eccles, K., Lefler, N., Gross, F., Persaud, B., Lyon, C., Hauer, E., Bonneson, JA. *NCHRP Report 617: Accident Modification Factors for Traffic Engineering and ITS Improvements*. (2008) Transportation Research Board, Washington, D.C.

Pennsylvania Department of Transportation. *Statewide Bicycle and Pedestrian Master Plan.* May 1996.

Oregon Department of Transportation. *Oregon Bicycle and Pedestrian Plan.* 2nd Edition, 1995.

Zegeer, CV., Stutts, J., Huang, H., Cynecki, MJ., Van Houten, R., Alberson, B., Pfeffer, R., Neuman, TR., Slack, KL., Hardy, KK. *NCHRP Report 500 Volume 10: A Guide for Reducing Collisions Involving Pedestrians*. (2004) Transportation Research Board, Washington, D.C.