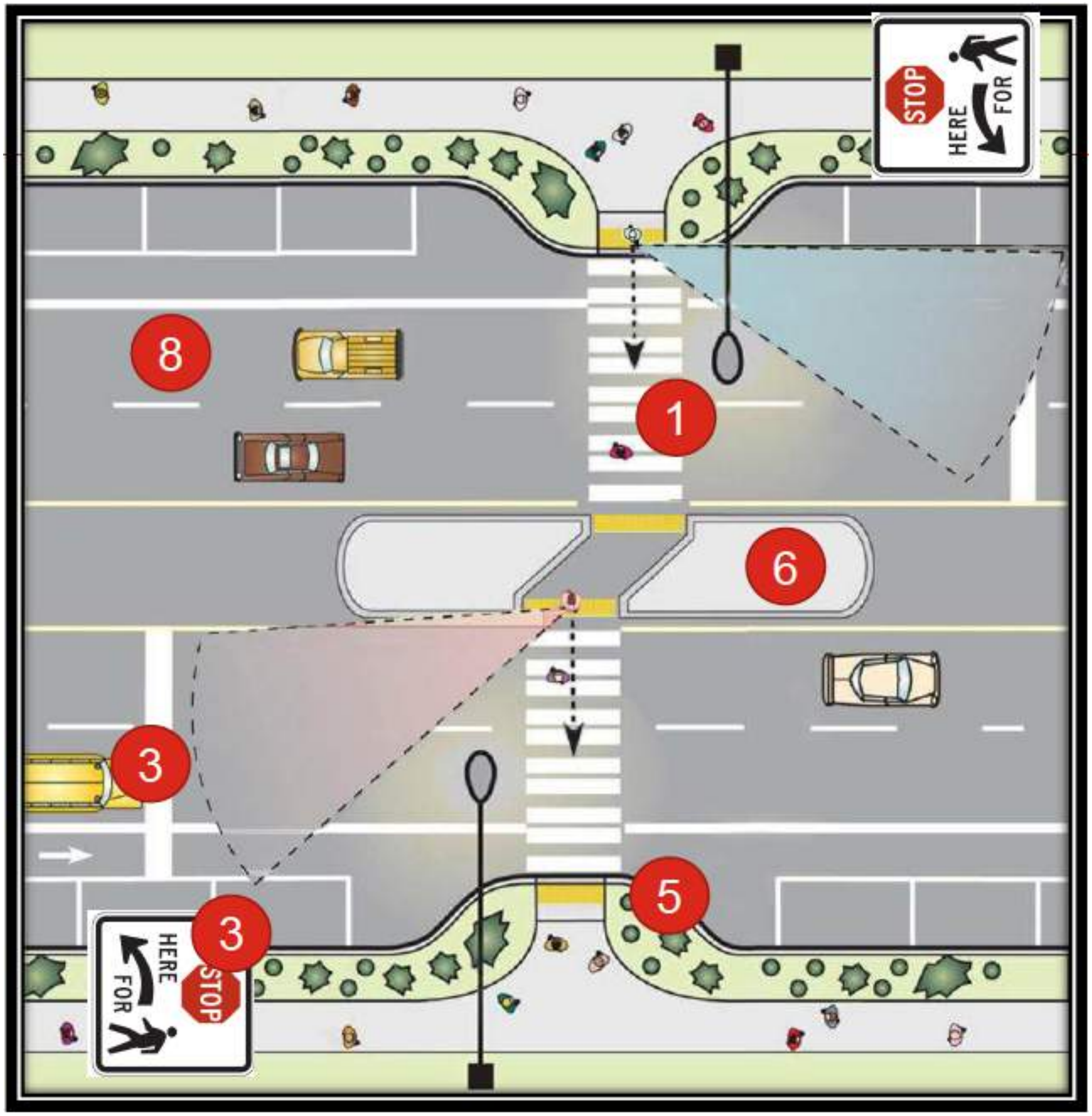
2022 Wyoming Crosswalks
Options and Costs Report



Prepared by Wyoming Pathways

Executive Summary

In response to the information provided at the May 24th, 2022 meeting of the Joint Judiciary committee of the Wyoming Legislature in Lander, Wyoming, Wyoming Pathways has put together a study of various options available to increase safety at school crosswalks.

Over the years, Wyoming Pathways has worked with consulting groups around the region to come up with best practices when it comes to safety for pedestrians and cyclists using our sidewalks, pathways, and roadways for human-powered transportation. We bring the following information to your attention, in an attempt to make safer crosswalks for all children across Wyoming as they head to their schools. The information shared was originally put together by Toole Design, an organization with offices across the country whose mission is to support innovative streets and dynamic communities where people of all ages and abilities can enjoy walking, biking, and access to transit.

The examples we've highlighted will create a safer experience for children when crossing the street and each have unique features to consider as they may benefit communities in different ways. As Senator French noted, elevating crosswalks through the use of additional asphalt or concrete would be very expensive and require significant work to ensure proper drainage and generally leads to significant maintenance costs as well. The remedies we've shared here not only avoid those concerns, but also add to an improved aesthetic in most cases, and in all cases are likely significantly less expensive over time.

While safety is our prime concern, we know from the research that features like those shown here, generally lead to higher quality of life, improved property values, and greater physical and mental well-being for folks who choose to commute by their own power.

We are grateful for your consideration of this important topic and are eager to remain partners in this effort with you.

Michael Kusiek,
Executive Director,
Wyoming Pathways

COST SUMMARY

Crosswalk Safety Improvement Options and Costs Summary

Source: http://www.pedbikesafe.org/PEDSAFE/countermeasures.cfm

			Per Crosswalk Cost Estimates					
#	**Option**	**Description**	**Median**	**Average**	**Minimum**	**Maximum**	**Cost Unit**	**Notes**
Countermeasures at Crossing Locations								
1	**Curbs Ramps**	Truncated Dome/ Detectable Warning	$ 37.00	$ 42.00	$ 6.18	$ 260.00	Square Foot	
		Wheelchair Ramp	$ 740.00	$ 810.00	$ 89.00	$ 3,600.00	Each	
		Wheelchair Ramp	$ 12.00	$ 12.00	$ 3.37	$ 76.00	Square Foot	
2	**Marked Crosswalks**	High Visibility Crosswalk	$ 3,070.00	$ 2,540.00	$ 600.00	$ 5,710.00	Each	
		Striped Crosswalk	$ 340.00	$ 770.00	$ 110.00	$ 2,090.00	Each	
		Striped Crosswalk	$ 5.87	$ 8.51	$ 1.03	$ 26.00	Linear Foot	
		Striped Crosswalk	$ 6.32	$ 7.38	$ 1.06	$ 31.00	Square Foot	
3	**Curb Extensions**	Depends on the design and site condition		$ 13,000.00	$ 2,000.00	$ 20,000.00	Each	
4	**Crossing Islands**	Depends on its size and construction materials			$ 2,140.00	$ 41,170.00	Each	Depends on its size and construction materials
		Depends on its size and construction materials		$ 10.00			Square Foot	Depends on its size and construction materials
5	**Raised Pedestrian Crossings**	Raised crosswalk			$ 7,110.00	$ 30,880.00	Each	Depends on drainage conditions and material used
6	**Lighting and Illumination**	In-pavement Lighting	$18,250	$17,620	$6,480	$40,000	Total	
		Streetlight	$3,602	$4,882	$310	$13,895	Each	
7	**Parking Restrictions (at Crossing Locations)**	Remove striping, add dilineators			$ 250.00	$ 300.00	Each	Varies based on the required signs and pavement markings
8	**Pedestrian Overpasses Underpasses**	Wooden Bridge	$122,610	$124,670	$91,010	$165,710	Lump Sum	
		Pre-Fab Steel Bridge	$191,400	$206,290	$41,850	$653,840	Each	
9	**Automated Pedestrian Detection**	Furnish and Install Pedestrian Detector	$180	$390	$68	$1,330	Each	The cost to install a pedestrian hybrid signal system is approximately $50,000 to $120,000, depending on site conditions and what equipment is already installed. Operation costs are approximately $4,000 per year. Adding automated detectors to an existing pedestrian signal can range from $10,000 to $70,000 per crosswalk.
10	**Leading Pedestrian Interval**	Alter the timing of a pedestrian signal			$ -	$ 3,500.00		
		Installing a new signal			$ 40,000.00	$ 100,000.00		
11	**Advance Yield/Stop Lines**	Advance stop/yield signs and lines			$ 300.00	$ 320.00		

PEDSAFE

Pedestrian Safety Guide and Countermeasure Selection System

Countermeasures

A total of 67 engineering, education, and enforcement countermeasures are discussed in this chapter. The treatments and programs selected for inclusion in this document are those that have been in place for an extended period of time and/or have proven effective when this document was written. New countermeasures continue to be developed, implemented, and evaluated. Thus, practitioners should not necessarily limit their choices to those included here; this material is a starting point.

The cost estimates provided for each countermeasure are only preliminary estimates. While the costs provided here include furnishing and installation, costs can vary widely based on numerous factors, including: road conditions, quantity, materials, size and location of state and/or municipality, time of year, design costs, and inflation. Costs were compiled by reviewing bid sheets from 40 states for the years 2010-2012, and from targeted searches for the price of specific countermeasures. A countermeasure cost database for pedestrian (and bicycle) treatments can be found at www.pedbikeinfo.org/costpaper.

The effectiveness of each of the following countermeasures on pedestrian crashes and safety has been documented in a separate report, entitled "Evaluation of Pedestrian-Related Roadway Measures: A Summary of Available Research."

Along the Roadway

Countermeasures include:

- Sidewalks, Walkways and Paved Shoulders
- Street Furniture/Walking Environment

At Crossing Locations

Countermeasures include:

- Curb Ramps
- Marked Crosswalks and Enhancements
- Curb Extensions
- Crossing Islands
- Raised Pedestrian Crossings
- Lighting and Illumination
- Parking Restrictions (at Crossing Locations)
- Pedestrian Overpasses/Underpasses
- Automated Pedestrian Detection
- Leading Pedestrian Interval
- Advance Yield/Stop Lines

Transit

Countermeasures include:

Curb Ramps

View Other At Crossing Locations Treatments

Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, or who have mobility restrictions that make it difficult to step up and down high curbs. Curb ramps must be installed at all intersections and midblock locations where there are pedestrian crossings, as mandated by federal legislation (1973 Rehabilitation Act and ADA 1990). Curb ramps must have a slope of no more than 1:12 (must not exceed 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 Proposed Guidelines for Accessible Public Rights of Way.[5]

Curb Ramps *pedbikeimages.org - Dan Burden (2006)*

Separate curb ramps for each crosswalk at an intersection should be provided rather than a single ramp at a corner for both crosswalks. The separate curb ramps improve orientation for visually impaired pedestrians by directing them toward the correct crosswalk. Similarly, tactile warnings alert pedestrians to the sidewalk and street edge. All newly constructed and altered roadway projects must include curb ramps. In addition, all agencies should upgrade existing facilities. One way to start this process is to conduct audits of the pedestrian facilities to make sure transit facilities, schools, public buildings, and parks are accessible to pedestrians who use wheelchairs.

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

Purpose

Pedestrians with mobility restrictions will often have trouble moving from the sidewalk to the level of the roadway when crossing a street. The height difference between the road and the sidewalk might prove to be an insurmountable barrier to pedestrians trying to use sidewalks. Curb ramps provide access to street crossings and improve sidewalk accessibility for people with mobility restrictions.

Considerations

• Follow Americans with Disabilities Act (ADA) design guidelines.
• Texture patterns must be detectable to visually impaired pedestrians.
• Curb ramps can be easily accommodated within curb extensions.

Estimated Cost

Infrastructure	Description	Median	Average	Min. Low	Max. High	Cost Unit	# of Sources (Observations)
Curb Ramp	Truncated Dome/ Detectable Warning	$37	$42	$6.18	$260	Square Foot	9 (15)
Curb Ramp	Wheelchair Ramp	$740	$810	$89	$3,600	Each	16 (31)
Curb Ramp	Wheelchair Ramp	$12	$12	$3.37	$76	Square Foot	10 (43)

As many cities include truncated domes/detectable warnings as part of their curb ramp installations, combining the cost per square foot for detectable warnings and the wheelchair ramps in accordance with local design standards and multiplying by eight will provide a per intersection cost for providing ADA-compliant curb ramps.

For more information about curb ramp design, see 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.[5]

Case Studies

Berkeley, CA
Clemson, SC
Fort Plain, NY
Phoenix, Arizona
Ithaca, New York
Arlington County, VA
Montgomery County, Maryland
San Francisco, California

Marked Crosswalks

View Other At Crossing Locations Treatments

Marked crosswalks indicate optimal or preferred locations for pedestrians to cross and help designate right-of-way for motorists to yield to pedestrians. Pedestrians are sensitive to out-of-the-way travel, and reasonable accommodation should be made to make crossings both convenient and safe at locations with adequate visibility. Various crosswalk marking patterns are given in the Manual on Uniform Traffic Control Devices (MUTCD),[8] including transverse lines, ladder, and continental markings. However, high-visibility crosswalks are preferred over parallel line crosswalks.

Marked crosswalks are desirable at some high pedestrian volume locations to guide pedestrians along a preferred walking path. Crosswalks are often installed at signalized intersections and other selected locations with appropriate levels of pedestrian and vehicle traffic. Crosswalks should be installed in conjunction with other enhancements that physically reinforce crosswalks and reduce vehicle speeds. Recommended guidelines and priorities for crosswalk installation at uncontrolled locations are given in in the Resources section. These guidelines are based on a major study of 1,000 marked crosswalks and 1,000 unmarked crossings in 30 U.S. cities.[9]

A marked crosswalk alone is typically not enough for multilane roadway crossings where annual average daily traffic is in excess of 10,000 vehicles. More substantial crossing improvements are also needed to prevent an increase in pedestrian crash potential. More substantial treatments include the refuge island, PHB, and RRFB.

Purpose

Any location that is an intersection of two roadways has a natural crossing location. Marked crosswalks warn motorists to expect pedestrian crossings and indicate preferred crossing locations for pedestrians. However, motorists may fail to yield to pedestrians if the crossing is unmarked. All crossings should be accompanied with visibility enhancements to improve safety and reduce crashes.

Considerations

• Crosswalk locations should be convenient for pedestrian access.
• 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.
• One option for enhancing a marked crossing is to install a raised crosswalk.

Estimated Cost

Infrastructure	Description	Median	Average	Min. Low	Max. High	Cost Unit	# of Sources (Observations)
Crosswalk	High Visibility Crosswalk	$3,070	$2,540	$600	$5,710	Each	4(4)
Crosswalk	Striped Crosswalk	$340	$770	$110	$2,090	Each	8(8)
Crosswalk	Striped Crosswalk	$5.87	$8.51	$1.03	$26	Linear Foot	12(48)
Crosswalk	Striped Crosswalk	$6.32	$7.38	$1.06	$31	Square Foot	5(15)

The cost of high visibility crosswalk marking can range from $600-$5700 each with an average of $2540. Information about different types of marking patters can be found in the IT TENC Technical Committee 109-01 publication Pavement Marking Patterns Used at Uncontrolled Pedestrian Crossings.[10]

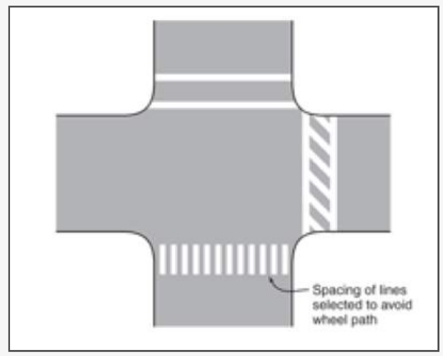
Safety Effects

A summary of studies that have looked at the safety effects of marked crosswalks and crosswalk enhancements can be found here.

Case Studies

Shoreline, Washington
Eureka, CA
Washington, District of Columbia
Las Vegas, Nevada
Ithaca, New York
Fort Pierce, FL
Cambridge, MA
Seattle, Washington
Portland, OR
Tucson, AZ
Arlington County, VA
Salt Lake City, UT
Tucson, AZ
Queens, New York
Brooklyn, New York
Eureka, California
Cambridge, MA
Tampa, Florida
Washington, District of Columbia
Albemarle, Virginia
Detroit, Michigan
St. Petersburg, Florida
San Francisco, California
Phoenix, Arizona

A marked crosswalk with a warning sign and pedestrian refuge island.
pedbikeimages.org - Carl Sundstrom



Examples of crosswalk markings.
2009 Manual on Uniform Traffic Control Devices.

The enhancements shown in this rendering of a midblock crosswalk include high-visibility markings, curb extensions, in-street pedestrian crossing signs, lighting, and warning signs.
Federal Highway Administration.

Curb Extensions

View Other At Crossing Locations Treatments

Curb extensions—also known as bulb-outs or neckdowns—extend the sidewalk or curb line out into the parking lane and reduce the effective street width. Curb extensions must not extend into travel lanes and should not extend across bicycle lanes. This countermeasure improves pedestrian crossings by reducing the pedestrian crossing distance, reducing the time that pedestrians are in the street, visually and physically narrowing the roadway, and improving the ability of pedestrians and motorists to see each other. Curb extensions also create space for the addition of a curb ramp.

Motorists are encouraged to travel more slowly at intersections or midblock locations with curb extensions, as the reduced 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). Additionally, curb extensions placed at an intersection essentially prevent motorists from parking in or too close to a crosswalk and 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.

This curb extension at an intersection shortens the crossing distance for pedestrians and creates space for landscaping. *pedbikeimages.org - Carl Sundstrom*

Curb extensions improving the ability of pedestrians and motorists to see each other.
Living Streets Page 7-13

A combination of curb extensions and a median refuge narrow the roadway, reduce the pedestrian crossing distance, and reduce the time that pedestrians are in the street.
Living Streets Page 5-7

Purpose

Wide roadways can create difficult crossing situations for pedestrians. Not only do pedestrians need more time to cross the roadway, but the roadway width encourages motorists to speed or take turns quickly. Curb extensions improve safety because they increase visibility, reduce speed of turning vehicles, encourage pedestrians to cross at designated locations, shorten the crossing distance, and prevent vehicles from parking at corners.

Considerations

• Curb extensions are only appropriate where there is an on-street parking lane and where transit and bicyclists would be traveling outside the curb edge for the length of the street. They should not extend more than 6 feet from the curb.
• The turning needs of larger vehicles, such as school buses and emergency vehicles, need to be considered in curb extension design, especially at intersections with significant truck of bus traffic. However, speeds should be relatively slow in a pedestrian environment so all vehicles should be traveling at speeds conducive to tight turns.
• Emergency access is often improved using 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

Crossing Islands

View Other At Crossing Locations Treatments

A crossing island is a median with a refuge area that is intended to help protect pedestrians crossing a multilane road. This countermeasure is sometimes referred to as a pedestrian refuge island. Crossing islands should be considered as a supplement to the crosswalk. They are appropriate at both uncontrolled locations (i.e., where no traffic signals or stop signs exist) and signalized crossings. When installed at a midblock crossing, the island should be supplemented with a marked, high-visibility crosswalk.

The presence of a pedestrian refuge island at a midblock location or intersection allows pedestrians to focus on one direction of traffic at a time as they cross and provides space to wait for an adequate gap in oncoming traffic before finishing the second phase of a crossing. Crossing islands are highly desirable for midblock pedestrian crossings on roads with four or more travel lanes, especially where speed limits are 35 mph or greater and/or where annual average daily traffic (AADT) is 9,000 or higher. They are also a candidate treatment option for uncontrolled pedestrian crossings on 3-lane or 2-lane roads that have high vehicle speeds or volumes.[9]

The factors contributing to pedestrian safety include reduced conflicts, reduced vehicle speeds approaching the island (when the approach is designed to influence driver behavior), greater attention called to the pedestrian crossing, opportunities for additional signs in the middle of the road, and reduced exposure time for pedestrians.

Purpose

Crossing islands enhance the safety of pedestrian crossings and reduce vehicle speeds approaching pedestrian crossings. It can be difficult for pedestrians to cross high-volume roadways if the crossing is uncontrolled, if the existing pedestrian signal is short, and/or there is not a safe stopping place in the middle of the roadway. Pedestrians might get caught in the middle of the roadway if the traffic signal changes before they have finished crossing the roadway or motorists do not abide to the crossing.

Considerations

• The design must accommodate pedestrians with disabilities. Islands should be a minimum of 4 feet wide (preferably 8 feet) and of adequate length to allow the anticipated number of pedestrians to stand and wait for gaps in traffic before crossing.
• The cut-through must include detectable warnings if the island width is at least 6 feet.
• Crossing islands at intersections or near driveways may affect left-turn access.
• Crossing islands at intersections or near driveways may affect left-turn access.
• If applicable, evaluate the impact of the island on bicycle facility design.
• Illuminate or highlight islands with street lights, signs, or reflectors to enhance visibility for motorists.
• Curb extensions may be built in conjunction with crossing islands where there is on-street parking.

Estimated Cost

The cost of a median island depends on its size and construction materials. The costs range from $2,140 to $41,170 per island depending on the design, site conditions, and whether the median can be added as part of a utility improvement or other street construction project. The average cost per square foot is approximately $10. The cost for an asphalt island or one without landscaping is less than the cost of installing a raised concrete pedestrian island with landscaping. Costs may be reduced if the island is incorporated into planned roadway improvements or utility work.[11]

Center crossing islands allow pedestrians to deal with only one direction of traffic at a time, and can be constructed so that crossing pedestrians are forced to the right to view oncoming traffic as they are halfway through the crossing. *Source: pedbikeimages.org - Lyubov Zuyeva (2011)*

Crossing islands can be located at intersections or midblock crossings to help protect crossing pedestrians from motor vehicles. hy and allows pedestrians to avoid conflicts with traffic at street level.
Source: Designing for Pedestrian Safety

Safety Effects

The installation of pedestrian refuge island can reduce pedestrian crashes by 32%, see NCHRP Research Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments.

Case Studies

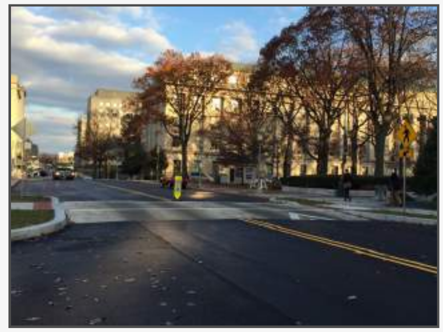
Eureka, CA
Las Vegas, Nevada
Fort Pierce, FL
Phoenix, Arizona
Seattle, Washington
Tucson, AZ
Portland, OR
Portland, OR
Naples, FL
Queens, New York
Brooklyn, New York
Eureka, California
Montgomery County, Maryland
Shoreline, Washington
Washington, District of Columbia
Village of Great Neck Plaza, New York
San Francisco, California
Norfolk, Virginia
Phoenix, Arizona

Raised Pedestrian Crossings

View Other At Crossing Locations Treatments

Raised crosswalks or raised intersections are ramped speed tables spanning the entire width of the roadway or intersection. Raised crosswalks are often placed at midblock crossing locations and only the width of a crosswalk. The crosswalk is demarcated with paint and/or special paving materials, and curb ramps are eliminated because the pedestrians cross the road the same level as the sidewalk. Raised crossings make the pedestrian more prominent in the driver's field of vision. Additionally, approach ramps may reduce vehicle speeds and improve motorist yielding. This countermeasure can reduce pedestrian crashes by 45%.

The crosswalk table is typically at least 10 feet wide and designed to allow the front and rear wheels of a passenger vehicle to be on top of the table at the same time. Detectable warnings (truncated domes) and curb ramps are installed at the street edge for pedestrians with impaired vision. In addition to their use on local and collector streets, raised crosswalks can be installed in campus settings, shopping centers, and pick-up/drop-off zones (e.g., airports, schools, transit centers). On one street in Cambridge, MA, motorists yielding to pedestrians crossing at the raised devices increased from approximately 10 percent before installation of the project to 55 percent after installation.[12]



This midblock raised pedestrian crossing features curb extensions and an in-street pedestrian crossing sign.
Pennsylvania Department of Transportation.

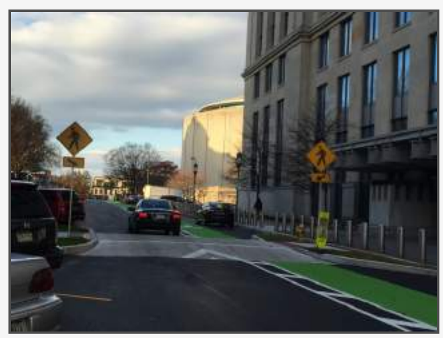
Purpose

Local and collector roads with high speeds pose a significant challenge for pedestrians crossing the roadway. Motorist reaction time is reduced at higher speeds, and additional measures may be needed to improve motorist speed and yielding compliance. Raised pedestrian crossings and intersections reduce vehicle speeds, reduce the need for curb ramps (though truncated domes should still be included), and enhance the pedestrian crossing environment.

Raised pedestrian crossing in Alexandria, Virginia.
Federal Highway Administration.

Considerations

• Typically installed on 2-lane or 3-lane roads with speed limits of 30 mph or less and annual average daily traffic (AADT) below about 9,000.
• May not be appropriate bus transit routes or primary emergency vehicle routes. These vehicles may experience issues with vertical deflection associated with raised crossings.
• Particular attention should be paid to impacts on drainage.
• May be inappropriate for crossings on curves or steep roadway grades.
• Snowplowing can be a concern for States with regular snowfall.
• Detectable warning strips at edges enable pedestrians with vision restrictions to detect the crossing.



Raised pedestrian crossing with curb extensions at a midblock location on a one-way street with a bike lane.
Pennsylvania Department of Transportation.

Estimated Cost

The intersections and crossings can be built with a variety of materials, including asphalt, concrete, stamped concrete, or pavers. Raised crosswalks are approximately $7,110 to $30,880 each depending on drainage conditions and material used. The cost of a raised intersection is highly dependent on the size of the roads can range from $25,000 to $100,000.

Safety Effects

A summary of studies that have looked at the safety effects of raised pedestrian crossings can be found here.

Case Studies

Cambridge, MA
Grand Junction, CO
West Palm Beach, FL
Cambridge, MA
Bellevue, WA
Tucson, AZ

Lighting and Illumination

View Other At Crossing Locations Treatments

Appropriate quality and placement of lighting can enhance an environment and increase comfort and safety. Pedestrians may assume that their ability to see oncoming headlights means motorists can see them at night; however, without sufficient lighting, motorists may not be able to see pedestrians in time to stop.

A single luminaire placed directly over the crosswalk does not adequately illuminate the pedestrian for the approaching motorist. It is best to place streetlights along both sides of arterial streets and provide a consistent level of lighting along a roadway. This includes lighting pedestrian crosswalks and approaches to the crosswalks. A study conducted by the Virginia Tech Transportation Institute found that 20 lx (a unit of illuminance) was necessary for motorists to detect a pedestrian in the crosswalk. To achieve 20 lx, the luminaire should be placed 10 feet from the crosswalk, in between the approaching vehicles and the crosswalk. At intersections, the luminaires should also be placed before the crosswalk on the approach into the intersection. This differs from traditional placement of luminaires over the actual intersection.[13]

In commercial areas or in downtown areas, specialty pedestrian-level lighting may be placed over the sidewalks to improve pedestrian comfort, security, and safety. Well-lit pedestrian areas make people walking through the area feel safer. Streetlights and building lights can enhance the ambiance of the area and the visibility of pedestrians in commercial areas with nighttime pedestrian activity. Nighttime pedestrian crossing areas may be supplemented with brighter or additional lighting.


Roadway lighting. *Source: pedbikeimages.org - Annie Lux*

Purpose

Roadway lighting has often focused on the needs of the motorist and not necessarily the safety of the pedestrian. However, it is important to consider lighting that illuminates pedestrian crosswalks and reduces glare to motorists. Pedestrian fatalities occur disproportionately during dark conditions. Adequate roadway lighting enhances the safety of all roadway users, while pedestrian-scale lighting improves nighttime security and enhances commercial districts.


Appropriate quality and placement of lighting can enhance an environment as well as increase comfort and safety.
Source: Living Streets Page 7-18

Considerations

- Install lighting on both sides of wide streets and streets in commercial districts.
- Use uniform lighting levels.
- Place lights in advance of midblock and intersection crosswalks on both approaches to illuminate the front of the pedestrian and avoid creating a silhouette.

Estimated Cost

Infrastructure	Description	Median	Average	Min. Low	Max. High	Cost Unit	# of Sources (Observations)
Lighting	In-pavement Lighting	$18,250	$17,620	$6,480	$40,000	Total	4(4)
Lighting	Streetlight	$3,602	$4,882	$310	$13,895	Each	12(17)

Lighting varies based on the fixture type, manufacturer differences, roadway widths, project-specific factors, and utility service agreement. Usually, in-pavement lights are installed as a system, which is the reason the total cost is included here, as opposed to an individual light cost. Also, though not included above, average approximate underpass lighting costs can range from $350 to $3,400 each, and crosswalk lighting can range from approximately $10,750 to $42,000 per crosswalk.


Pedestrian-scale lighting in Marion, Iowa.
pedbikeimages.org - Brandon Whyte

Safety Effects

A summary of studies that have looked at the safety effects of lighting and illumination can be found here.

Case Studies

Clemson, SC
Grand Junction, CO
Eureka, CA
Ithaca, New York
Fort Plain, NY
Tempe, AZ
University Place, WA
Phoenix, Arizona
Shoreline, Washington
Bellevue, WA
Montgomery County, Maryland
Santa Monica, CA
Asheville, NC
Eureka, California
Englewood, Ohio
San Francisco, California
Cambridge, Massachusetts

Parking Restrictions (at Crossing Locations)

View Other At Crossing Locations Treatments

Parking restrictions help improve pedestrian and motorist sightlines through an intersection and can include the removal of parking space markings and/or installation of new "parking prohibition" pavement markings, curb paint, or signage. Removing a parking space on the approach into an intersection may help pedestrians to safely cross the street by providing them with a clearer view of oncoming vehicles. Removing a parking space also frees up roadway space for other uses.

Generally, vehicles should not be parked within at least 20 feet of an intersection and parking restrictions should consider adequate sightlines for motorists and pedestrians to be able to see and react to each other. The minimum setback is 20 feet in advance of the crosswalk where speeds are 25 mph or less, and 30 feet where speeds are between 26 and 35 mph.

However, it may also be important to provide physical roadway measures to prevent motorists from parking on the sidewalk or in areas intended for pedestrians to walk. Curb extensions improve sightlines and shorten the distance pedestrians need to cross a roadway.

Parking restrictions at intersections may provide help pedestrians to safely cross the street by providing them with a clearer view of oncoming vehicles. *Source: Peter Lagerwey.*

This rendering shows how the design of on-street parking can improve visibility at a midblock crosswalk.
Federal Highway Administration.

Purpose

Sightlines of pedestrians and motorists are limited when vehicles are parked too close to pedestrian crossings, which increases risk for pedestrians who intend to cross the road.

Considerations

• Communicate with community stakeholders about parking space removal.
• Consistently enforce parking restrictions with signage, paint, and pavement markings.
• If curb extensions are out of the budget, vertical delineators can work to prevent motorists from parking vehicles too close to a crosswalk.

Estimated Cost

The cost of this countermeasure varies based on the required signs and pavement markings. Removing the striping of a parking space and/or adding paint is relatively inexpensive. However, the cost can increase substantially ($2,000 to $20,000) if curb extensions are added. Additionally, delineators cost approximately $50 to $100, and parking restriction signs cost approximately $200.

Case Studies

Hoboken, New Jersey
New York City, New York

Pedestrian Overpasses/Underpasses

View Other At Crossing Locations Treatments

Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from 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 because overpasses and underpasses are costly, visually intrusive, and poorly utilized when a more direct at-grade crossing is possible.

Overpasses and underpasses must accommodate all persons, as required by the ADA. More information on the specifications for accessing overpasses and underpasses can be found in the Proposed Guidelines for Accessible Public Rights of Way.[5] These measures include ramps or elevators. Extensive ramping accommodates 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.[17] Overpasses work best when the topography allows for a structure without ramps, such as an overpass over a sunken highway. Underpasses work best when designed to feel open and accessible. Underpasses are significantly less expensive when built as part of a construction or reconstruction project and generally offer gentler grade changes than overpasses. Grade separation is most feasible and appropriate in extreme cases where pedestrians must cross roadways such as freeways and high-speed, high-volume arterials.

Entrances and exits to overpasses and underpasses should be clearly visible to encourage pedestrian use. The AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities recommends that pedestrian overpasses be at least 8 feet wide. The width should be increased if the sidewalk leading up to the overpass is wider. If the overpass also accommodates bicyclists, the width should be at least 14 ft. Depending on the length of the overpass, it might be necessary to increase its width in order to counteract any visual perceptions of narrowness.[2] Similar guidelines apply to underpasses. Minimal widths should be between 14 and 16 ft, but underpass width should be increased if the underpass is longer than 60 ft.

Pedestrian overpasses and underpasses allow for the uninterrupted flow of pedestrian movement separate from vehicle traffic. *Source: pedbikeimages.org - Julia Diana (2009)*

Lighting, drainage, graffiti removal, and security are major concerns with underpasses.
Source: pedbikeimages.org - Dan Burden (2006)

Purpose

Sometimes it is necessary to completely separate pedestrians from vehicular traffic. Freeways, railways, and natural barriers can hinder the creation of traditional pedestrian facilities such as sidewalks and on-street crossings and often have a negative effect on pedestrian facility connectivity. Pedestrian overpasses and underpasses provide complete separation of pedestrians from motor vehicle traffic, provide crossings where no other pedestrian facility is available, and connect off-road trails and paths across major barriers.

Considerations

- Use sparingly and as a measure of last resort. Most appropriate over high-volume, 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.

Estimated Cost

Infrastructure	Description	Median	Average	Min. Low	Max. High	Cost Unit	# of Sources (Observations)
Overpass/Underpass	Wooden Bridge	$122,610	$124,670	$91,010	$165,710	Lump Sum	1(8)
Overpass/Underpass	Pre-Fab Steel Bridge	$191,400	$206,290	$41,850	$653,840	Each	5(5)

The cost for specific types of bridges can vary substantially, based on the specific situation, materials, and other factors and, as demonstrated in the table above for wooden and pre-fab steel bridges. Underpasses (not included in the table above) range from slightly less than $1,609,000 to $10,733,000 in total or around $120 per square foot. Overpasses (also not included below) have a range from $150 to $250 per square foot or $1,073,000 to $5,366,000 per complete installation, depending on site conditions.

Safety Effects

A summary of studies that have looked at the safety effects of pedestrian overpasses and underpasses can be found here.

Case Studies

West Long Branch, New Jersey
Las Vegas, NV
Prescott, AZ
Phoenix, Arizona
Shoreline, Washington
San Diego, CA
Phoenix, AZ
Austin, TX
Huntington, WV
Clark County, Washington

PEDSAFE

Pedestrian Safety Guide and Countermeasure Selection System

Automated Pedestrian Detection

View Other Signals and Signs Treatments

Automated pedestrian detection devices are able to sense when a pedestrian is waiting at a crosswalk and automatically send a signal to switch to a pedestrian WALK phase. Some automated pedestrian detection devices are also able to determine whether a pedestrian needs more time to cross the roadway and will lengthen the crossing interval to accommodate the slower pedestrian. Automated pedestrian detection devices reduce the percentage of pedestrians who cross roadways at inappropriate times, such as when the DON'T WALK signal is visible.

There are generally two types of pedestrian detection technology: microwave and infrared. A delay can be built into either of the devices so that the Walk signal is called only if the pedestrian stays within the detection zone for a certain amount of time. The delay helps to prevent pedestrians who walk by the detection zone from accidentally activating the WALK signal.

Automated pedestrian detection devices called PUFFIN (Pedestrian User-Friendly Intelligent) crossings have been in use in the United Kingdom for several years. They use an infrared detector or pressure-sensitive mat to sense pedestrians waiting for a crosswalk signal. These devices also notice if a pedestrian leaves the area and can cancel the pedestrian walk signal, if necessary. If a pedestrian takes longer than the allotted amount of time to cross the crosswalk, the PUFFIN signal is able to lengthen the WALK signal. PUFFIN crossings reduce the waiting times for pedestrians and motorists by ensuring that no signal is unnecessarily short or long.[19]

A signalized intersection with a push button pedestrian activated signal. *Source: Designing for Pedestrian Safety*

Purpose

At certain pedestrian crossings, it is necessary for a pedestrian to push a button to receive a pedestrian WALK signal. However, studies have shown that many pedestrians ignore the button or believe that the button is malfunctioning if there is a significant delay in receiving a signal.[18] Visually impaired pedestrians also might not know that it is necessary to push a button to cross the roadway. Automated pedestrian detection provides more timely pedestrian indications and ensures that pedestrians have enough time to safely cross the roadway.

Considerations

• These types of crossings have been successfully used in Europe for many years. It is important to carefully consider where pedestrian signals for automated pedestrian detection devices are placed.

Estimated Cost

Infrastructure	Description	Median	Average	Min. Low	Max. High	Cost Unit	# of Sources (Observations)
Pedestrian Detection	Furnish and Install Pedestrian Detector	$180	$390	$68	$1,330	Each	7(14)

The cost to install a pedestrian hybrid signal system is approximately $50,000 to $120,000, depending on site conditions and what equipment is already installed. Operation costs are approximately $4,000 per year. Adding automated detectors to an existing pedestrian signal can range from $10,000 to $70,000 per crosswalk.

Safety Effects

A summary of studies that have looked at the safety effects of devices using automated pedestrian detection can be found here.

Case Studies

Las Vegas, Nevada
Village of Great Neck Plaza, New York
San Francisco, California
Tucson, Arizona
Miami-Dade County, Florida

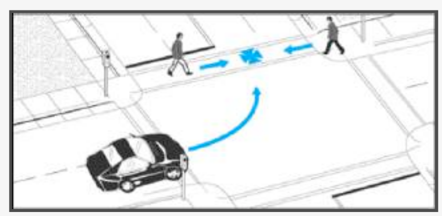
Leading Pedestrian Interval

View Other Signals and Signs Treatments

LPIs can be programmed into traffic signals to minimize conflicts between pedestrians crossing a roadway and left or right turning vehicles. LPIs give the pedestrian the WALK signal 3-7 seconds before the motorists are allowed to proceed through the intersection.[20]

By giving pedestrians a head start, it is less likely that there will be conflict between pedestrians and turning vehicles. LPIs increase the percentage of motorists who yield the right of way to pedestrians because pedestrians are in the crosswalk by the time the traffic signal turns green for parallel vehicle movements.

Vehicle-pedestrian incidents often occur at intersections where a pedestrian is crossing the street during a WALK interval. *Source: Gina Coffman (2012)*



A LPI allows pedestrians to be fully in the crosswalk before motorists attempt to turn.

Purpose

Vehicle-pedestrian incidents often occur at intersections where a pedestrian is crossing the street during a WALK interval. Pedestrians are especially vulnerable to left turning vehicles. Leading pedestrian intervals (LPIs) give pedestrians time to establish their presence in the crosswalk before motorists can start turning.

Considerations

- If an intersection has particularly high pedestrian traffic, you might consider adding an exclusive pedestrian phase instead of a leading pedestrian interval.
- Make sure that the LPI is accompanied by an audible noise that lets visually impaired pedestrians know that it's safe to cross.
- Keep in mind that right turn on red rules might limit the effectiveness of LPIs. Consider restricting right turn on red use at intersections.

Estimated Cost

The cost to alter the timing of a pedestrian signal can be relatively inexpensive (from $0 to $3,500), depending on the site specifications and the size of the city. Installing a new signal can range from $40,000-$100,000.

Safety Effects

A summary of studies that have looked at the safety effects of devices using a leading pedestrian interval can be found here.

Case Studies

St. Petersburg, FL
San Francisco, California
Miami-Dade County, Florida
Reston, Virginia

Advance Yield/Stop Lines

Advance yield/stop line include the stop bar or “sharks teeth” yield markings placed 20 to 50 feet in advance of a marked crosswalk to indicate where vehicles are required to stop or yield in compliance with the accompanying “STOP Here for Pedestrians” or “YIELD Here to Pedestrians” (signs R1-6, R1-6a, R1-9, and R1-9a). This countermeasure can greatly reduce the likelihood of a multiple-threat crash at unsignalized midblock crossings. The multiple threat crash occurs at crosswalks on multilane roadways, and this occurs when a driver stops too close to the crosswalk and lets a pedestrian cross, masking visibility of the adjacent travel lane. This situation can result in a high-speed crash, which usually leads to fatalities or very severe injuries[8] to allow for better visibility.

This countermeasure discourages drivers from stopping too close to crosswalks and blocking other drivers’ views of pedestrians and pedestrians’ views of vehicles. Pedestrians can see if a vehicle is stopping or not stopping and can take evasive action. Studies have found that advance yield markings at midblock crossings can be particularly useful when combined with signs and beacons, such as the Pedestrian Hybrid Beacon or Rectangular Rapid-Flashing Beacon (RRFB). One study found that use of a "sign alone reduced conflicts between drivers and pedestrians by 67 percent, and with the addition of an advanced stop or yield line, this type of conflict was reduced by 90 percent compared to baseline levels.”[2]

Purpose

Advance stop lines and yield markings improve the visibility of pedestrians to motorists and prevent multiple-threat crashes.[9]

Considerations

• The decision to use an advance stop or yield line depends on state law. Most states require drivers to yield to pedestrians in a crosswalk; about a dozen states require drivers to stop for pedestrians in a crosswalk.
• Effectiveness depends on motorist compliance with the marked stop/yield line. Motorists might ignore markings/signage if placed too far in advance of the crosswalk.
• Parking should be restricted between the stop or yield line and the crosswalk to allow for better visibility.[10]

Estimated Cost

The cost of each advance stop/yield signs and lines are approximately $300 and $320 respectively.

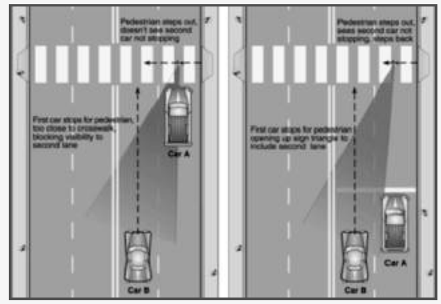
Safety Effects

The installation of advance yield or stop markings and signs can reduce pedestrian crashes by 25%. For more information, see NCHRP Research Report 841: Development of Crash Modification Factors for uncontrolled Pedestrian Crossing Treatments.

Case Studies

Las Vegas, Nevada
Halifax, Nova Scotia
Tampa, Florida
San Francisco, California

View Other At Crossing Locations Treatments



Advance stop lines and yield markings improve the visibility of pedestrians to motorists and prevent multiple-threat crashes.

The advance stop bar is supplemented with the "Stop Here For Pedestrians" signs.
Source: Toole Design Group.

Advance yield markings at a midblock crosswalk with a refuge island.
pedbikeimages.org - Toole Design Group.

Costs for Pedestrian and Bicyclist Infrastructure Improvements

A Resource for Researchers, Engineers, Planners, and the General Public

Authors: Max A. Bushell, Bryan W. Poole, Charles V. Zegeer, Daniel A. Rodriguez

UNC Highway Safety Research Center

Prepared for the Federal Highway Administration and supported by the Robert Wood Johnson Foundation through its Active Living Research program

October, 2013

Contents

Acknowledgements

This project was made possible through funding from the Federal Highway Administration (FHWA), the Robert Wood Johnson Foundation, through its Active Living Research program and the University of North Carolina Highway Safety Research Center (UNC HSRC). The authors would like to particularly acknowledge the support of Gabe Rousseau and Tamara Redmon of FHWA and James Sallis, the Program Director of Active Living Research at UCSD, as well as David Harkey of UNC HSRC. Ann McGrane, a graduate student in the Department of City and Regional Planning at The University of North Carolina at Chapel Hill, and Dan Gelinne, a Program Associate with the Pedestrian and Bicycle Information Center (PBIC), also contributed to this project.

Authors

Max A. Bushell was a Research Assistant and Junior Pedestrian and Bicycle Professional for the FHWA-sponsored Pedestrian and Bicycle Information Center (PBIC) at the time that this paper was originally written. He is now Transportation Planner at Stantec Consulting Services, Ltd. He holds a Bachelor's Degree from Cornell University and a Master's Degree in City and Regional Planning from the University of North Carolina at Chapel Hill. At the PBIC, Mr. Bushell has provided project support to the development of the Pedestrian Safety Strategic Plan and Strategic Plan Background Report, updated the Highway Safety Manual to include Pedestrian and Bicycle research, performed ArcGIS analysis work, been involved in data collection work, drafted sections to update the PEDSAFE Countermeasure Selection System tool, served as a Walk Friendly Communities Reviewer, and worked as a Project Manager for the development of a Bike to Work Event Website.

Bryan W. Poole is a current graduate student at the Department of City and Regional Planning at the University of North Carolina at Chapel Hill and is also a Graduate Research Assistant with the PBIC and HSRC. He holds a Bachelor's Degree from Point Loma Nazarene University and a graduate degree from Duke Divinity School. Mr. Poole has previously drafted description and cost information updates to PEDSAFE, assisted with the Watch For Me NC Campaign, and recently completed a paper on the implications of automated enforcement systems for pedestrian and bicycle safety.

Charlie V. Zegeer is the Associate Director of Engineering and Planning for HSRC, where he has worked from 1986 to present. He is also currently the Director of the Pedestrian and Bicycle Information Center (PBIC), the existing FHWA-sponsored National Bicycle and Pedestrian Clearinghouse. In all, he has authored more than 150 reports and publications, mostly dealing with pedestrian and bicyclist safety. He has also received several international awards, including those from Transportation Research Board (TRB) and Institute of Transportation Engineers (ITE). Mr. Zegeer is a registered Professional Engineer and an Emeritus Member of the TRB Pedestrian Committee. He received his Bachelor's Degree in Civil Engineering (Virginia Tech) in 1972 and a Master's Degree in Civil Engineering (Transportation) from the University of Kentucky in 1974.

Daniel A. Rodríguez is Director of the Carolina Transportation Program (ctp.unc.edu), Associate Professor in City and Regional Planning and Adjunct Associate Professor of Epidemiology at University of North Carolina, Chapel Hill. Dr. Rodríguez received a Master's Degree in Transportation from MIT and a Ph.D. in Urban, Technological, and Environmental Planning from The University of Michigan in 2000. Dr. Rodriguez's research focuses on the reciprocal relationship between the built environment, including bus rapid transit, and the behavior of travelers. He is the author of more than 60-peer reviewed publications and a co-author of the book *Urban Land Use Planning* (University of Illinois Press). Dr.

Rodríguez's research has been funded by the National Institutes of Health, the Environmental Protection Agency, and the Robert Wood Johnson Foundation, among others.

The Highway Safety Research Center

The University of North Carolina at Chapel Hill's Highway Safety Research Center has been a leading research institute that has helped shape the field of transportation safety. The Center's mission is to improve the safety, security, access, and efficiency of all surface transportation modes through a balanced, interdisciplinary program of research, evaluation and information dissemination.

Today, HSRC research stretches across multiple disciplines, from social and behavioral sciences to engineering and planning, and addresses many of the new challenging concerns of the North Carolina and American public. Among other things, HSRC researchers are exploring ways of making roads safer for pedestrians and bicyclists, researching the effects of aging on driver performance, studying how driver distractions such as cell phone use affect transportation safety, researching how fatigue and sleep-deprivation affect driver performance, and examining how changes in roadway design and traffic operations can make travel safer for all road users.

Cover Page Photo Credits

- www.pedbikeimages.org / Dan Burden

Executive Summary

Costs for pedestrian and bicycle safety infrastructure often vary greatly from city to city and state to state. This document (and associated database) is intended to provide meaningful estimates of infrastructure costs by collecting up-to-date cost information for pedestrian and bicycle treatments from states and cities across the country. Using this information, researchers, engineers, planners, and the general public can better understand the cost of pedestrian and bicycle treatments in their communities and make informed decisions about which infrastructure enhancements are best suited for implementation. By collecting countrywide cost information, this database should contain useful information for any state or city, even if costs from that particular state or city are not included for a given treatment.

A better understanding of pedestrian and bicycle infrastructure costs will hopefully ensure that funding is allocated to pedestrian and bicycle improvements more efficiently. The goal is to encourage more communities to enhance facilities for non-motorized users and increase the safety of those choosing to walk and bike. Building a new roadway for automobiles can cost tens of millions of dollars to construct, and many of the pedestrian and bicycle infrastructure projects and facilities are extremely low-cost in comparison. This infrastructure can also serve to improve safety for all road users, while also promoting healthier lifestyles through more bicycling and walking. The tables provided in this document provide general estimates and cost ranges for 77 pedestrian and bicycle facilities using more than 1,700 cost observations, and are presented with a median and average price, the minimum and maximum cost, and the number of sources. By making more informed decisions about the costs of pedestrian and bicycle infrastructure treatments, decision-makers will be able to dedicate funds to those treatments secure in the knowledge that these investments are often affordable as well as determine which treatment is the most cost-effective.

It must be noted that costs can vary widely from state to state and also from site to site. Therefore, the cost information contained in this report should be used only for estimating purposes and not necessarily for determining actual bid prices for a specific infrastructure project.

Making the Case for Pedestrian and Bicycle Infrastructure

Walking and bicycling have both been frequently overlooked as city, state, and federal governments focus their effort and funds on building sophisticated transportation systems. Yet there are a growing percentage of people that want to change the common notion of transportation and mobility. They want livable communities where they can commute to work, socialize and recreate by foot and bicycle.

Recent socio-economic and cultural trends highlight the desire for walkable and bikeable communities. The 15-Year Report on Walking and Biking determined that 12 percent of all trips are now made by bicycle or foot in 2009, a 25 percent increase from 2001, even though there are often not adequate facilities for safe walking or bicycling. Bicyclists and pedestrians make up 14 percent of traffic fatalities, although federal funding for biking and walking projects is approximately 2 percent of the federal transportation budget.[1]

While new national initiatives, such as Complete Streets and Safe Routes to School, are examples of programs that support pedestrian facility development, problems persist. In 2010, 4,280 pedestrians and 618 bicyclists were killed and roughly 59,000 pedestrians and 52,000 bicyclists were injured.[2,3] Though these totals have decreased somewhat in recent years, pedestrian and bicyclist safety is an ongoing problem that should continue to be comprehensively addressed at all levels of government.

Creating a walkable and bikeable community starts with the built environment: having destinations close to each other; siting schools, parks, and public spaces appropriately; allowing mixed-use developments; having sufficient densities to support transit; creating commercial districts that people can access by bicycle, foot and wheelchair; etc. Most walking trips are less than .5 mi (0.8 km), so having a compact environment is essential. Similarly, while half of all household trips are three miles or less, fewer than 2 percent of those trips are made by bicycle.[4] Finally, a recent study found bicyclists will go out of their way to use bicycle infrastructure, highlighting the importance of having sufficient facilities.[5] The connection between land-use planning and transportation planning is critical to safely and effectively accommodate trips by foot and bicycle.

Developing pedestrian and bicycle infrastructure has economic benefits also. Studies have found that bicycle infrastructure improvements can have a positive overall impact on business, and that people who walk or bike to a commercial area spend more money per month than those who accessed the area by automobile.[6] The removal of on-street parking is often thought to negatively impact business, but reports show adding facilities such as bicycle racks and bicycle lanes can actually increase economic activity, and also help create a buffer from moving traffic that aides both pedestrian and bicyclist activity.[7] Finally, improving bicycle and pedestrian infrastructure can lead to positively impacting real estate values. Homes near bicycle paths have been found to support higher sales prices, and areas that facilitate walkability and attract pedestrians sustain higher rents, revenues and resale values.[8]

Pedestrian and bicycle- specific infrastructure improvements can also improve conditions for all road users. The 2011 Sustainable Streets Index, published by New York City's Department of Transportation, found that improvements such as pedestrian islands and bicycle paths led to an overall reduction in motorist crashes as well as injury crashes, a decrease in speeding, and an increase in pedestrian and bicycle activities.[9]

Finally, new roadway projects can cost tens of millions of dollars to construct, depending on location and type of road. Many of the pedestrian and bicycle infrastructure projects and facilities highlighted in this paper are extremely low-cost in comparison.

Walking/Bicycling and Public Health

The health benefits of walking and bicycling have been well-documented by public health and medical professionals. Current CDC recommendations suggest that adults ages 18 and up should get 150 minutes of moderate-intensity exercise throughout the week to experience the health benefits of physical activity. Brisk 10 minute walks or short trips by bicycle to work can both help contribute to this overall goal. Health benefits of undertaking these activities include weight management, increased bone and muscle strength, improved mental health and mood, and increased coordination. As the focus of healthcare transitions from focusing on the treatment to the prevention of disease, walking and biking are being promoted as an accessible and easy way to improve both our current and future well-being.

As a result, urban planners, engineers, and public health professionals are increasingly working together to create pedestrian- and bicycle-friendly environments that promote these activities for both leisure and transportation purposes. Researchers who study the effect of the built environment on walking and biking have discovered that numerous variables affect such decisions. The proximity of destinations, the presence and quality of sidewalks or bicycle lanes, perceptions of safety and security, the steepness of grades, the presence of other people, separation from traffic, and aesthetics are all factors that can encourage or discourage people from walking or biking. Policies and roadway features can also help promote active transportation, such as the use of wayfinding signage and pedestrian and bicyclist-oriented crossing signals. Studies have shown that facilities such as separated paths, bike boxes, sidewalks and benches are associated with enhanced safety and/or activity.[10] Through the design or redesign of environments to make walking and biking safer or more pleasant, planners and engineers can help people of all ages get the exercise they need to live longer, healthier lives. The infrastructure costs summarized in this document are intended to aide and encourage improvements to these environments.

Methodology

Highway Safety Research Center (HSRC) staff began work on a database of general engineering in late 2011. Using this as a basis and with additional support from the Federal Highway Administration and Active Living Research, HSRC researchers developed a pedestrian and bicycle infrastructure cost database for use by planners, engineers, and others. A summary of costs from that database is provided herein with a direct link to the full infrastructure cost database.

Beginning with bid-letting summaries or price indices from states across the country, infrastructure costs were identified and entered into a database. Bid-letting sheets were usually available from State Departments of Transportation web sites, which contain a range of costs based on local contractor bids. In some cases, however, only one bid – or an average of all bids – is listed. In this situation, either the range of bids or the single bid is included in the database. While staff attempted to use the most up-to-date bid-letting and pricing sheets available, the availability of bid-letting summaries varies from state to state. As such, some information in the database dates from 2009 or earlier. Most of the costs, however, are from 2010, 2011, or 2012. All costs have been updated to 2012 US Dollar equivalents using the United States Consumer Price Index published by the Bureau of Labor Statistics.[11]

HSRC researchers also subscribed to the Bid Express service, an online resource that facilitates secure online project bidding for city and state agencies and contractors. Using Bid Tabulation sheets downloaded from the website with the permission of the service and relevant agencies, Bid Express cost data were added into the database. Data from the Bid Express service is mostly from 2011, but may also include 2010 information.[12] Special approval was obtained from Bid Express for inclusion of cost information from selected states to be used in the database and this report.

For some treatments, particularly newer innovative treatments, cost information was not included in bid-letting sheets. To ensure that costs were included for as many treatments as possible, HSRC researchers also conducted targeted searches of selected infrastructure measures, using conventional search engines as well as searching state and city websites. The source of data as well as a hyperlink is included in each of the more than 1,700 cost entries in the database. Drawing from city plans, manufacturer pricing information, and other sources, these targeted searches provided information that was otherwise unavailable from other sources. By using search terms such as “pedestrian”, “bicycle”, “sidewalk”, “bike lane”, and many others and by conducting a general scan of each document, costs pertaining specifically to pedestrian and bicyclist-related infrastructure improvements were identified, entered into the database, and included in the following cost summaries.

After costs were compiled, interviews were conducted with Department of Transportation employees in various states to validate the cost averages. HSRC researchers contacted the safety, engineering, or construction divisions of State Departments of Transportation (DOT) in North Carolina, Tennessee, Florida, Nebraska, Wyoming, Ohio, and California to determine what information is included in the costs. According to these State DOTs, the costs found in Bid Letting or Bid Tabulation Sheets include labor, materials, mobilization costs (though mobilization costs were often bid separately as well), and contractor profits, effectively making the treatment cost a complete “in the ground” cost.

The database includes the following categories of information for each cost item:

- Infrastructure Name – the title of the treatment (e.g. Sidewalk)
- Infrastructure Description – the details of the treatment (e.g. Portland Cement)
    - Specifics/Classes – specific identifying details (e.g. 4 inch patterned)
- Initial (Total) Cost – if a total cost is provided, it is included here
- Revised Cost – the costs modified to the standard unit
- Revised Unit – the unit of infrastructure treatment, if it was modified
- Information Source Year – the year of the cost information
- Inflation Year – the year used to calculate the inflation factor
- Cost with Inflation – the cost indexed to 2012 dollars
- Annual (Maintenance) Cost – if provided, how much the treatment costs to maintain, usually per year
- Low Cost– if a range of costs is provided, the lowest cost
- Revised Low – the unit of infrastructure treatment, if it was modified
- Low with Inflation – the low cost indexed to 2012 dollars
- High Cost Estimate – if a range of costs is provided, the highest cost
- Revised High – the unit of infrastructure treatment, if it was modified
- High with Inflation – the high cost indexed to 2012 dollars
- Cost Unit – the unit to which the cost is linked (e.g. lump sum, each, per mile, per linear foot, per square yard, etc.)
- State Name – the state name in postal code format
- Information Source Citation – the title of the information source, usually a bid-letting sheet or specific research paper

- Page Number within Document – the page within the information source that contains this cost
- Sample Size – the number of bids and/or instances of treatment implementation
- Link to Source – the reference URL for the source of the treatment cost
- Notes – Any other relevant information or caveats that are important to consider in relation to the specific cost

Only infrastructure costs that are specifically pedestrian or bicycle related are entered into the database. Other documents containing infrastructure cost information such as spot safety evaluations, city plans, government agency reports, guidebooks, and cost reports among others are also included in this database. In order to present a useable database, costs were eliminated if they were extreme outliers, that is, generally greater or less than two standard deviations away from the mean cost.[i] Costs were also removed if they did not appear to include complete cost information (i.e. only the cost of the unit without the cost to install).

Database users should understand that these costs were taken from various sources across the country and that costs may vary between states and also by the quantity purchased. Generally, costs per unit (square yard, linear foot, each, etc.) may vary widely depending on the size of the order, with larger quantities usually leading to lower per unit costs.

Also, there are non-geographic factors that influence variability of costs, and which could not be adequately addressed in this database due to the lack of information in the source data. One of these is the issue of economies of scale and resulting non-linearity of costs. A small project may require a fixed cost such as access to a cement truck or engineering services. The costs of these services unsurprisingly would decline with increasing project scale. Another limitation is related to economies of scope, as it would be more cost effective to add a bicycle lane along with a sidewalk rather than doing both projects separately. There can also be price differences if the project is for a new development versus a retrofit project, with retrofit projects often having higher costs. Finally, differences in contracts and negotiations over the length of time a project will take can also influence cost information. Faster completion times can lower the inconvenience to non-active commuters, but can also raise the price of installation. All of these issues inevitably influence the costs captured in this database. The assumption, however, is that the range of costs will help mitigate these factors and allows for a useful database. In order to obtain a more detailed estimate, however, both geographic and non-geographic factors must be considered.

Key Assumptions

In order to provide cost estimates for some treatments, HSRC researchers made certain assumptions, given in the bulleted list below.

- General assumptions:
  - If cost information included multiple years, i.e. 2002-2003, the earliest year was used for the purposes of determining the inflation factor.
  - All costs are updated to 2012 dollars.

[i] Due to large cost variances and insufficient data, judgment had to be made concerning certain treatments apart from the standard deviation criteria.

    - Costs are assumed to include engineering, design, mobilization, and furnish and installation costs.
- Specific assumptions for estimating purposes (where linear length of sidewalk, bikeway, bike lane, etc. are used):
    - All bike lanes are five feet in width.
    - Wide curb lanes are four feet in width.
    - Separated bikeways are eight feet in width.
    - Multi-use paths, whether paved or unpaved are eight feet in width.
    - All sidewalks are five feet in width and have a thickness of four inches.

Sources

This database is based mostly on bid letting sheets and costs summaries from State Departments of Transportation. As a result, the potential exists that the cost information is skewed toward state-funded transportation projects rather than local jurisdictions. In order to offset this factor, information was obtained through targeted searches, yielding data from research reports, pedestrian/bicycle guides, and city and county websites. While some states have available and easily obtainable information, others do not have any easily accessible information for specific treatments or do not provide this information publicly. As such, some state information sources supplied a large amount of information to this database, while for others, little or no data has been included. If no cost information was available for a certain state, however, efforts were made to include information from a nearby state or a city within that state. In total, 1,747 costs were obtained from 40 states to create this database. The states with the most cost information include Ohio (161), California (146), Minnesota (115), Massachusetts (104), and Wisconsin (101). The states for which no information was included in the database are Delaware, the District of Columbia, Hawaii, Mississippi, Nevada, Pennsylvania, South Dakota, Tennessee, Utah, and West Virginia. For a complete listing of cost frequency by state, see Appendix D.

It is useful to note that while these infrastructure costs constitute, in most cases, the most up-to-date information available, these are cost estimates. The capricious nature of estimating infrastructure costs means that these data only provide a general idea of what any treatment may cost for a specific location.

Infrastructure Cost Tables

The following tables summarize information from the larger database of infrastructure costs. The average cost, median cost, and the absolute low and high cost ranges are provided to create both a price estimate and price range for each infrastructure element. The median and average infrastructure treatment costs are both presented since the "average" cost value may be misleading (i.e. it may be influenced heavily by one or two outliers). The tables only include cost information with a minimum of four sources.

The paragraphs under each subheading provide information regarding what is included in the table and any caveats associated with using this cost information, while the tables provide the finalized cost estimates and ranges. For some treatments, there was not enough information to create a table. In these cases, cost information is provided in the paragraphs. In terms of units, some treatments were presented in different units, such as "each" and "per square feet". If there were four or more treatment costs per unit, the treatment is presented in the following table by both units to provide more detail. Additionally, a column indicating the number of sources, defined as the number of agencies/organizations, and observations, which represent the actual number of costs included from all sources, is included in the tables. In some cases, the authors have provided examples, usually as a "per intersection" or "per unit" basis, of how this cost information can be used by practitioners to create a complete cost estimate for a treatment in the paragraphs as well.

Generally, infrastructure cost information in this document will include engineering, design, mobilization, and furnish and installation costs. However, these costs are likely to vary based on site conditions, choice of contractor, and other factors. In some cases, such as for bikeways, site preparation costs have been presented in this document in a separate section in order for database users to get a better sense of what types of actions are necessary to prepare a site and what actions may be necessary to retrofit a site.

A brief description of each treatment and external issues that can dramatically alter facility costs is given before each listed cost. For more specific information about each of the following treatments, please consult the Pedestrian Safety Guide and Countermeasure Selection System Guide (PEDSAFE) (2004) or the Bicycle Safety Guide and Countermeasure Selection System (BIKESAFE) (2006), which were developed for FHWA by HSRC. Most of the definitions provided below for pedestrian and bicycle infrastructure improvements were based on information from PEDSAFE and/or BIKESAFE.

Bicycle Facilities

From various types of bicycle parking to bicycle lanes and separated paths, this category encompasses most bicycle infrastructure costs identified in this project.

Figure 1: Bike Parking

Bicycle Parking

Bicycle Parking includes bicycle racks (see Figure 1), bicycle lockers (see Figure 2), and bicycle stations. Bicycle racks are fixed objects, usually constructed out of metal, to which bicycles can be securely locked, while bicycle lockers are used to securely store a single bicycle. Depending on bike parking design and materials, cost may vary widely. For example, a bicycle rack may be as simple as an inverted U rack designed for two bikes, but may also include more elaborate designs, such as wave design or ornamental bike racks that hold multiple bikes. Bike Stations are buildings or structures designed to provide secure bicycle parking and often incorporate other amenities such as showers or bike maintenance services. Due to insufficient data, cost ranges were obtained for the following bicycle parking facilities: bicycle stations (approximately $250,000) and bus racks (approximately $730). Removing a bicycle rack costs approximately $1,000. The costs below are presented in terms of the cost per unit.

Figure 2: Bicycle Locker

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Bicycle Parking	Bicycle Locker	$2,140	$2,090	$1,280	$2,680	Each	4 (5)
Bicycle Parking	Bicycle Rack	$540	$660	$64	$3,610	Each	19 (21)

Table 1: Costs for Bicycle Parking

Bikeway

The Bikeway category contains bicycle lanes, bicycle paths, and signed bicycle routes. The cost of separated multi-use paths designed for bicyclists and pedestrians can be found in the "Path" section below on page 25. For the purposes of standardizing the units, bicycle lanes are assumed to be five feet in width and bicycle paths 8 feet, with costs given in miles. Additionally bicycle boulevards, streets designed to give priority to bicyclists as through-going traffic, typically range from approximately $200,000 to $650,000 each. Bikeways, or bike paths, are separated facilities designed specifically for bicycles (see Figure 3), while bicycle lanes are designated travel lanes for bicyclists. Separated bikeway projects typically cost between $536,664 and $4,293,320 per mile, depending on site conditions, path width, and materials used. Indicated by bike route signs, signed bike routes are used to direct bicyclists to safer facilities and/or are located on lightly

Figure 3: Bikeway (Concrete Bicycle Path)

trafficked roads. These types of large-scale bicycle treatments will vary greatly due to differences in project specifications and the scale and length of the treatment.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Bikeway	Bicycle Lane	$89,470	$133,170	$5,360	$536,680	Mile	6 (6)
Bikeway	Signed Bicycle Route	$27,240	$25,070	$5,360	$64,330	Mile	3 (6)
Bikeway	Signed Bicycle Route with Improvements	$241,230	$239,440	$42,890	$536,070	Mile	1 (6)

Table 2: Costs for Bikeway

Bikeway Preparation

The costs for bikeways shown above are assumed to include all costs including bikeway preparation, if applicable. However, costs were also identified for specific actions related to preparing a site for a separated bikeway, including excavation, grading, curb/gutter removal, and clearing and grubbing (removing vegetation and roots). Though cost information was limited, the following individual costs were obtained (all costs are approximate): excavation ($55 per foot); grading ($2,000 per acre); curb/gutter removal ($5 per linear foot); and clearing and grubbing ($2,000 to $15,500 per acre, depending on the width of the road and whether it is done on one or both sides of the road).

Traffic Calming Measures

Traffic calming measures are engineering tools used with the goal of reducing vehicle speed and improving the safety of motorists, pedestrians, and bicyclists. Common traffic calming measures include chicanes, chokers, curb extensions (neckdowns/bulb-outs), median islands, and raised crossings among others. In this section, cost information will be provided per unit, though certain traffic calming measures may also be given in linear or square feet. Any users of the database will, in cases when a treatment is provided in linear of square feet, need to calculate a cost based on the project specifications.

Chicanes

Chicanes are concrete islands that offset traffic, and create a horizontal diversion of traffic used to reduce the speed of vehicular traffic on local streets. Landscaped chicanes have the added benefit of adding more green landscaping to a street. Figure 3 illustrates how chicanes can be combined with a median island to ensure motorists do not disregard roadway markings.

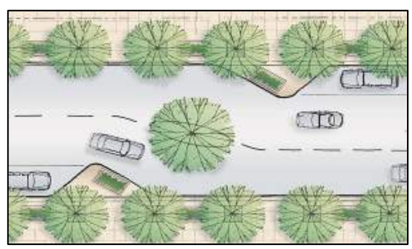


Figure 4 - Chicane

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Chicanes	Chicane	$8,050	$9,960	$2,140	$25,730	Each	8 (9)

Table 3: Cost for Chicanes

Curb Extensions

Curb extensions (see Figure 5), alternatively called chokers or bulb-outs, extend the sidewalk or curb line out into the parking lane, which reduces the effective street width and creates a pinch point along the street. They can be created by bringing both curbs in, or by more dramatically widening one side at a midblock location. They can also be used at intersections, creating a gateway effect. Costs can vary depending on drainage, the addition of street furnishings/landscaping/special paving, and whether utilities must be relocated.

Figure 4: Curb Extension

The cost to retrofit a four-leg intersection with curb extensions would be approximately $100,000 (8 X $12,620), though costs will likely vary based on site conditions, drainage, and curb extension design.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Curb Extension	Curb Extension/ Choker/ Bulb-Out	$10,150	$13,000	$1,070	$41,170	Each	19 (28)

Table 4: Cost of Curb Extension

Diverters

A diverter is an island built at a residential street intersection that prevents certain through and/or turning movements. They can be placed across both lanes of traffic as a full diverter or across one lane of traffic as a semi-diverter. There are four primary types of diverters: diagonal, star, forced turn, and truncated diverters (see Figure 6). A diagonal diverter breaks up cut-through movements and forces right or left turns in certain directions. A star diverter consists of a star-shaped island placed at the intersection, which forces right turns from each approach. A forced turn diverter is an island that forces drivers in one or more lanes of an intersection to turn in only direction. A truncated diagonal diverter, also known as a semi-diverter, has one end open to allow additional turning movements. The costs presented in the table below are limited to full diverters and truncated diagonal, or semi-, diverters. The cost of installations will vary based on the amount of material needed and the drainage needs at the site.

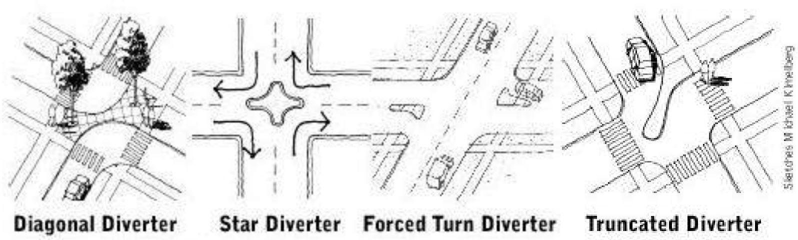


Figure 5: Diverters

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Diverter	Diverter	$22,790	$26,040	$10,000	$51,460	Each	5 (6)
Diverter	Partial/Semi Diverter	$15,000	$15,060	$5,000	$35,000	Each	3 (4)

Table 5: Diverter Cost

Island

Crossing islands — also known as center islands, refuge islands, pedestrian islands, or median slow points — are raised islands placed in the center of the street at intersections or midblock crossings to help protect crossing pedestrians from motor vehicles (see Figure 7). They allow pedestrians to deal with only one direction of traffic at a time, and enable pedestrians to stop partway across the street and wait for an adequate gap in traffic before crossing the second half of the street. Crossing islands can be constructed at an angle to the right so that crossing pedestrians are forced to the right to view oncoming traffic as they are halfway through the crossing.

Figure 6: Crossing Island

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Island	Median Island	$10,460	$13,520	$2,140	$41,170	Each	17 (19)
Island	Median Island	$9.80	$10	$2.28	$26	Square Foot	6 (15)

Table 6: Island Cost

Median

Medians are raised islands that separate opposing streams of traffic and limit turning movements (see Figure 8). They are typically narrower than islands, are placed in the center of a roadway, and are separated from the travel lanes by a curb. Medians facilitate pedestrian crossings, improve pedestrian visibility to motorists, slow motor vehicle speeds, and provide space for lighting and landscaping. The costs for installing a median can vary based on the type of median, the materials, and the scope of the project.

Medians will often require grading, excavation, grubbing, and other site preparation activities. These costs are included in the cost information above, but may vary based on site conditions and the type of median.

Figure 8: Raised Median

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Median	Median	$6.00	$7.26	$1.86	$44	Square Foot	9 (30)

Table 7: Median Cost

Raised Crossing

A raised intersection is essentially a speed table for the entire intersection.[ii] Construction involves providing ramps on each vehicle approach, which elevates the entire intersection to the level of the sidewalk. A raised pedestrian crossing is similar to a raised intersection, but it is only the width of a crosswalk, usually 10 to 15 ft. (see Figure 9). Raised intersections and crosswalks encourage motorists to yield to pedestrians because the raised crosswalk increases pedestrian visibility and forces motorists to slow down before going over the speed table. Costs will vary based on the width of the road, as well as drainage conditions and the type of material used.

Figure 9: Raised Crossing

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Raised Crossing	Raised Crosswalk	$7,110	$8,170	$1,290	$30,880	Each	14 (14)
Raised Crossing	Raised Intersection	$59,160	$50,540	$12,500	$114,150	Each	5 (5)

Table 8: Raised Crossing Cost

Roundabout/Traffic Circle

Traffic circles can include anything from small mini-circles to large roundabouts (see Figures 10 and 11).

Figure 10: Mini-Circle

Figure 11: Roundabout

Costs for these items were not specified in enough detail to differentiate design details of each cost estimate. Roundabouts are circular intersections designed to eliminate left turns by requiring traffic to

[ii] For a description of speed tables, see Appendix B.

exit to the right of the circle. Roundabouts are installed to reduce vehicular speeds, improve safety at intersections through eliminating angle collisions, help traffic flow more efficiently, reduce operation costs when converting from signalized intersections, and help create gateway treatments to signify the entrance of a special district or area. Costs will vary widely, depending on the size, site conditions, and whether right-of-way acquisitions are needed. Roundabouts usually have lower ongoing maintenance costs than traffic signals, depending on whether the roundabout is landscaped.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Roundabout/ Traffic Circle	Roundabout/ Traffic Circle	$27,190	$85,370	$5,000	$523,080	Each	11 (14)

Table 9: Roundabout/ Traffic Circle Cost

Speed Treatments

Speed humps are vertical traffic control measures that tend to have the most predictable speed reduction impacts. Speed humps are paved (usually asphalt) and approximately 3 to 4 inches-high at their center, and extend the full width of the street with height tapering near the drain gutter to allow unimpeded bicycle travel (see Figure 12). Speed bumps are typically smaller with a more extreme grade, which forces automobiles to more significantly reduce speeds but can more significantly impede bicyclists.

Figure 12: Speed Hump

A speed table is a term used to describe a very long and broad speed hump, or a flat-topped speed hump, where sometimes a pedestrian crossing is provided in the flat portion of the speed table. The speed table can either be parabolic, making it more like a speed hump, or trapezoidal. Speed tables can be used in combination with curb extensions where parking exists. Costs can vary depending on the drainage needs of each site, the width of the road, and the specific design used.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Speed Bump/Hump /Cushion/Table	Speed Hump	$2,130	$2,640	$690	$6,860	Each	14 (14)
Speed Bump/Hump /Cushion/Table	Speed Bump	$1,670	$1,550	$540	$2,300	Each	4 (4)
Speed Bump/Hump /Cushion/Table	Speed Table	$2,090	$2,400	$2,000	$4,180	Each	5 (5)

Table 10: Speed Hump/ Cushion/ Table Cost

Speed treatments are usually installed as sets, typically in groups of three. For instance, assume that a two mile residential road has speeding issues and citizens petition to install speed humps. After examining the feasibility of the installation, the city decides to install three speed humps to ameliorate the issue, at a cost of $7,500 ($2,500 X 3).

Pedestrian Accommodations

Pedestrian accommodation treatment costs are presented in this section. In this case, pedestrian accommodation refers to infrastructure provided to enhance the pedestrian environment that may include improving pedestrian safety, mobility and/or access. In many cases, treatment costs in this section will be presented as lump sums, though in some instances, the cost information may be provided in linear feet or square feet.

Bollard

Traffic bollards are posts embedded in the ground, which are used to keep pedestrians safer, by slowing vehicle speeds and separating pedestrian from motor vehicle traffic, and/or limiting vehicle access either temporarily or permanently (see Figure 13). There are multiple types of bollards available for use (fixed, rising, security, removable, breakaway, decorative, flexible, etc.). The cost below combines these various types into one set of costs, and thus the costs will vary depending on the specific bollard type and material used.

Figure 13: Bollards

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources
Bollard	Bollard	$650	$730	$62	$4,130	Each	28 (42)

Table 11: Bollard Cost

Curb Ramp

Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, or who have mobility impairments that make it difficult to step up and down the curbs (see Figure 14). While curb ramps are needed for use on all types of streets, priority locations are streets in downtown areas and near transit stops, schools, parks, medical facilities, shopping areas, and residences with people who use wheelchairs. Truncated domes/ detectable warning surfaces provide a distinctive surface pattern that is detectable underfoot as a warning to those who are visually impaired of an approaching street and are required at all intersections with sidewalks in compliance with the Americans with Disabilities Act (ADA) of 1990.

Figure 14: Curb Ramp

As many cities include truncated domes/detectable warnings as part of their curb ramp installations, combining the cost per square foot for detectable warnings and the wheelchair ramps in accordance with local design standards and multiplying by eight will provide a per intersection cost for providing ADA-compliant curb ramps.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Curb Ramp	Truncated Dome/ Detectable Warning	$37	$42	$6.18	$260	Square Foot	9 (15)
Curb Ramp	Wheelchair Ramp	$740	$810	$89	$3,600	Each	16 (31)
Curb Ramp	Wheelchair Ramp	$12	$12	$3.37	$76	Square Foot	10 (43)

Table 12: Curb Ramp Cost

Fence/Gate

Fencing and gating can help separate pedestrians and cyclists from roadways and railroad tracks, and can also be used in the construction of pedestrian/bicyclist paths, bridges, and overpasses (see Figure 15). The cost of pedestrian fencing and gates will vary depending on the location, type, design, material, height, etc. used. For instance, fencing may include chain link, ornamental or other fence types. The median and average costs provided below provide a range of estimates of what fencing is likely to cost.

Figure 15: Fencing

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Fence/Gate	Fence	$120	$130	$17	$370	Linear Foot	7 (7)
Fence/Gate	Gate	$510	$910	$330	$1,710	Each	5 (5)

Table 13: Fence/ Gate Cost

Gateway

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, mixed-use, or commercial district (see Figure 16). They often place a higher emphasis on aesthetics and are frequently used to identify neighborhood and commercial areas within a larger urban setting. Sign costs below reflect a variety of materials, including plastic ($500), metal (approximately $200), and wood (approximately $530).

Figure 16: Gateway Treatment

The cost of gateway structures can range greatly depending on the specific type of items chosen. The costs below combine a variety of gateway structure treatments, such as: monument signs (approximately $19,000), street spanning arches supported by metal posts within bulb-outs (approximately $64,000), and gateway columns ($10,000).

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Gateway	Gateway Sign	$350	$340	$130	$520	Each	3 (4)
Gateway	Structure	$15,350	$22,750	$5,000	$64,330	Each	5 (6)

Table 14: Gateway Cost

Lighting

Adequate roadway lighting enhances the safety of all roadway users, while pedestrian-scale lighting improves nighttime security and enhances commercial districts (see Figure 17). These costs can vary depending on the fixture type and service agreement with local utility, as well as if other improvements are made to the streetscape at the same time. Also, though not included below, average approximate underpass lighting costs can range from $350 to $3,400 each, and crosswalk lighting can range from approximately $10,750 to $42,000 per crosswalk.

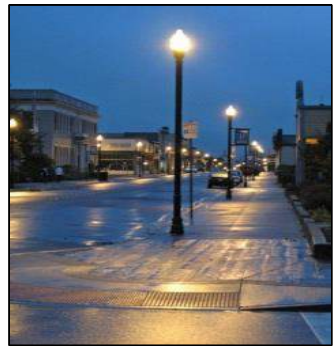


Figure 17: Lighting

The cost range for in-pavement lights is very broad, based on manufacturer differences, roadway widths, and project-specific factors. Usually, in-pavement lights are installed as a system, which is the reason the total cost of installing lights at a location is included here, as opposed to an individual light cost.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Lighting	In-pavement Lighting	$18,250	$17,620	$6,480	$40,000	Total	4 (4)
Lighting	Streetlight	$3,600	$4,880	$310	$13,900	Each	12 (17)

Table 15: Lighting Cost

Overpass/Underpass

Pedestrian Overpasses and Underpasses completely separate pedestrians from vehicular traffic and provide safe pedestrian accommodation over often impassable barriers, such as highways, railways, and natural barriers such as rivers (see Figures 18 and 19). Over- and Underpasses consist of different types of structures, including bridges, and are generally very expensive, though some cost savings can be realized depending on the materials used. Cost information is typically provided as a lump sum cost, but can also be presented as a cost per square foot.

Figure 18: Pedestrian Overpass

Underpasses (excluding bridges) range from slightly less than $1,609,000 to $10,733,000 in total or around $120 per square foot. Overpasses (excluding bridges) have a range from $150 to $250 per square foot or $1,073,000 to $5,366,000 per complete installation, depending on site conditions.

The cost for specific types of bridges can vary substantially, based on the specific situation, materials, and other factors, as demonstrated in the table below for wooden and pre-fab steel bridges.

Figure 19: Pedestrian Underpass

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Overpass/Underpass	Wooden Bridge	$122,610	$124,670	$91,010	$165,710	Each	1 (8)
Overpass/Underpass	Pre-Fab Steel Bridge	$191,400	$206,290	$41,850	$653,840	Each	5 (5)

Table 16: Overpass/ Underpass Cost

Railing

Pedestrian railings provide an important safety benefit on walkways, and are required for ADA compliance on ramps with steep inclines and along stairways.[iii] They also buffer the pedestrian path from vehicular traffic. Pedestrian railing materials range from aluminum and steel to wood and chain link fence. All of these costs are aggregated in the table below.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Railing	Pedestrian Rail	$95	$100	$7.20	$690	Linear Foot	29 (83)

Table 17: Railing Cost

Street Furniture

Street furniture often serves as a buffer between the sidewalk and the roadway, providing an important safety benefit to pedestrians. Including trees, benches, bus shelters, newspaper racks, kiosks, and other pedestrian amenities, street furniture also serves to create a more pleasant and attractive environment for pedestrians.
The cost of street furniture will vary depending on the design, style, and manufacturer for benches, bus shelters, and other street furniture, while trees will also vary in cost based on the type and size of tree

[iii] Handrails are required for ADA accessibility on both sides of paths with rise greater than 6 inches or a horizontal projection greater than 72 inches, as well as all stairways.

(see Figure 20). The costs that follow and provided in the table below assume to include installation, which can vary based on the number of items installed at one time.

More substantial structures tend to be more expensive, with gazebos averaging at nearly $53,000, with a range of $36,600 to $71,600; information kiosks averaging at slightly less than $16,000; and shade shelters averaging at $30,000, with a range of $29,290 to $41,850.

Historical markers average at $3,498 with a range of $1,230 to $4,700, while newspaper racks typically cost slightly less than $6,500. Picnic tables cost around $1,683 on average with a range of $530 to $4,180 based on materials and manufacturer. Lastly, tree grates cost an average of $1,340 or between $1,400 and $3,500 (not including the tree), while shrubs cost between $55 and $80. Street furniture removal costs are also available. Bench removal costs around $910 with a range of costs from $80 to $3,140, while bus shelter removal averages at $3,690 with a range of as low as $720 to $10,460. Costs for removing trash cans ($320 average, $130 to $520 range) and tree grates ($250 average, $52 to $890 range) are also available.

Figure 20: Bench

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Street Furniture	Street Trees	$460	$430	$54	$940	Each	7(7)
Street Furniture	Bench	$1,660	$1,550	$220	$5,750	Each	15 (17)
Street Furniture	Bus Shelter	$11,490	$11,560	$5,230	$41,850	Each	4 (4)
Street Furniture	Trash/ Recycling Receptacle	$1,330	$1,420	$310	$3,220	Each	12 (13)

Table 18: Street Furniture Cost

Street Closures

Full and partial (half) street closures are the ultimate way of discouraging automobile through traffic, while still allowing pedestrian and bicycle traffic. Typically, full street closures close the street entirely to vehicles, while partial street closures restrict turning movements onto streets, without having to create one-way streets. Depending on the street closure strategy, which could use bollards, islands, or other measures, the costs are likely to vary substantially. Full street closures can cost from less than $500 to $120,000, while partial street closures usually cost around $37,500, but can cost as low as $10,290 or as high as $41,170.

Figure 21: Full Street Closure

The wide ranges in price for full and partial street closures are related to the strategies used to complete the street closure. For instance, a full street closure (see Figure 21) can be accomplished by only adding a few bollards, but under a different strategy might involve altering roadway design by installing new concrete islands, restriping, and adding channelizer cones and signage. Depending on the site conditions, either strategy might be appropriate. More information about exact street closure costs can be found in the full database.

Pedestrian Crossings and Paths

This section provides information about the cost of facilities for pedestrians and includes information about sidewalks, crosswalks, and paths. Treatment information for sidewalks is presented in miles or square feet, while crosswalks are included as a cost per unit. Path costs are presented in either miles or linear feet. For some infrastructure treatments, such as paths, cost information was presented using a variety of different units. Assuming that a standard multi-use path is eight feet wide, the authors converted cost information for paths to linear feet and miles.

Figure 22: Crosswalk

Crosswalks

Striped crosswalks indicate a legal and preferred crossing for pedestrians, and may be installed at intersections or midblock locations. Motorists often fail to yield to pedestrians at these crossing points so marked crosswalks (see Figure 22) are often installed to warn motorists to expect pedestrians crossings ahead and also to indicate a preferred crossing location to pedestrians. A wide variety of crosswalk marking patterns exist, including parallel lines (standard crosswalk marking) and high visibility types, which include ladder, transverse lines, and zebra among others (see Figure 23).

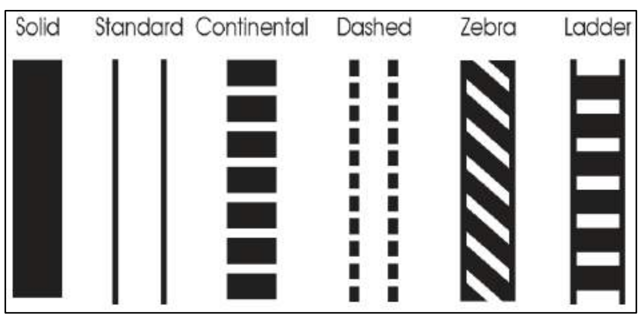


Figure 23: Optional Crosswalk Marking Patterns

Cost information for striped crosswalks of all varieties as well as for high visibility crosswalks is given in the table above. However, some of the bid prices for striped crosswalks may include some high visibility crosswalks, though it was not specified.

For other crosswalk types, costs tend to vary by a large amount. For instance, for crosswalks using other materials such as brick or pavement scoring, costs range from $7.25 to $15 per square foot, or approximately $2,500 to $5,000 each. Ladder crosswalks cost range from $350 to $1,000 each and patterned concrete crosswalks cost $3,470 each or $9.68 per square foot on average.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Crosswalk	High Visibility Crosswalk	$3,070	$2,540	$600	$5,710	Each	4(4)
Crosswalk	Striped Crosswalk	$340	$770	$110	$2,090	Each	8 (8)
Crosswalk	Striped Crosswalk	$5.87	$8.51	$1.03	$26	Linear Foot	12 (48)
Crosswalk	Striped Crosswalk	$6.32	$7.38	$1.06	$31	Square Foot	5 (15)

Table 19: Crosswalk Cost

Since street widths vary a large amount depending on the situation, it is difficult to estimate the cost to provide crosswalks at every intersection. However, if a high visibility crosswalk costs approximately $3,000 per crossing, the cost for the entire intersection would be $12,000 ($3,000 X 4).

Sidewalks

Sidewalks are the most basic pedestrian facility and provide an area within the public right-of-way for pedestrian travel (see Figure 24). Sidewalk materials can vary substantially, including concrete, asphalt, brick, or other materials. In some cases, sidewalk costs are presented as a combination of both sidewalks and curbs, though it is important to note that the costs presented in the table below represent the cost of the sidewalk "in the ground" and may or may not include curb and gutter. All sidewalk costs are presented either by linear foot or by square foot with all unit conversion assuming that sidewalks are five feet in width. Sidewalk costs without sufficient details to include in the table are included in the following paragraphs.

Figure 24: Sidewalk

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Sidewalk	Asphalt Paved Shoulder	$5.81	$5.56	$2.96	$7.65	Square Foot	1 (4)
Sidewalk	Asphalt Sidewalk	$16	$35	$6.02	$150	Linear Foot	7 (11)

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Sidewalk	Brick Sidewalk	$60	$60	$12	$160	Linear Foot	9 (9)
Sidewalk	Concrete Paved Shoulder	$6.10	$6.64	$2.79	$58	Square Foot	1 (11)
Sidewalk	Concrete Sidewalk	$27	$32	$2.09	$410	Linear Foot	46 (164)
Sidewalk	Concrete Sidewalk - Patterned	$38	$36	$11	$170	Linear Foot	4 (5)
Sidewalk	Concrete Sidewalk - Stamped	$45	$45	$4.66	$160	Linear Foot	12 (17)
Sidewalk	Concrete Sidewalk + Curb	$170	$150	$23	$230	Linear Foot	4 (7)
Sidewalk	Sidewalk Unspecified	$34	$45	$14	$150	Linear Foot	17 (24)
Sidewalk	Sidewalk Pavers	$70	$80	$54	$200	Linear Foot	3 (4)

Table 20: Sidewalk Cost

Paths

Multi-use paths are the safest facilities for pedestrians and bicyclists, providing mobility options away from the roadway. Often accommodating both pedestrians and bikes, multi-use paths are usually at least eight feet in width, can be both paved and unpaved, and are used for both recreation and transportation purposes. Costs will vary substantially for multi-use paths, based on the materials used, right-of-way costs, and other factors.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Path	Boardwalk	$1,957,040	$2,219,470	$789,390	$4,288,520	Mile	5 (5)
Path	Multi-Use Trail - Paved	$261,000	$481,140	$64,710	$4,288,520	Mile	11 (42)
Path	Multi-Use Trail - Unpaved	$83,870	$121,390	$29,520	$412,720	Mile	3 (7)

Table 21: Path Cost

Mid-Block Crossings

Mid-block crossings can be necessary on major roads with few intersections or in areas with documented pedestrian crash problems. Often installed in conjunction with other safety and traffic calming features, particularly advance yield lines, in-pavement yield/stop signs, raised pedestrian crossings, or Rectangular Rapid Flash Beacons or High Intensity Activated Crosswalk (HAWK) signals, mid-block crossings can make substantial improvements in pedestrian safety, while also having traffic calming effects. Mid-block crossings are striped crosswalks away from intersections and are very helpful in the vicinity of transit stops or in other areas where pedestrians are likely to cross the road often.

Mid-block crossings are typically much more expensive than standard crosswalk treatments, with costs ranging from approximately $2,700 to more than $71,000 if bulb-outs, trees, landscaping, crosswalks, etc. are included. It is a good idea to consider the context of the situation in order to apply a tailored solution, usually a combination of infrastructure treatments, to ensure that pedestrians are accommodated in the safest possible way.

Signals

Signals for both pedestrians and bicyclists are included in this section. Pedestrian and bicycle detectors and speed trailers are included in this section as well. New signal types have become more prevalent in the last ten years, including the Rectangular Rapid Flash Beacon and the Pedestrian Hybrid Beacon, formerly known as a High Intensity Activated Crosswalk (HAWK) signal. These are included here. Efforts will be made to include any new signals as they become more prevalent.

Flashing Beacon

Flashing beacons are typically used in conjunction with pedestrian crossings to provide an enhanced warning for vehicles to yield to pedestrians. Rectangular rapid flashing beacons (RRFBs) differ from regular flashing beacons in that RRFBs have a rapid strobe-like warning flash, are brighter, and can be specifically aimed (see Figure 25). As a relatively new treatment, RRFBs have not been implemented extensively throughout this country, but are now becoming more prevalent in certain states and cities. The cost to furnish and install a flashing beacon can vary widely, depending on site conditions and the type of device used. The costs shown in the table include the complete system installation with labor and materials.

Figure 25: Rapid Flash Beacon

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Flashing Beacon	Flashing Beacon	$5,170	$10,010	$360	$59,100	Each	16 (25)
Flashing Beacon	RRFB	$14,160	$22,250	$4,520	$52,310	Each	3 (4)

Table 22: Flashing Beacon Cost

Pedestrian Hybrid Beacon

The Pedestrian Hybrid Beacon, otherwise known as the High Intensity Activated Crosswalk (HAWK) signal, is a special type of beacon to warn and control vehicles to allow pedestrians to safely cross a road or highway at a marked midblock crossing location (see Figure 26). Developed by the City of Tucson, Arizona in the 1990s, the pedestrian hybrid beacon is comprised of three signal sections, overhead pedestrian crosswalk signs, pedestrian detectors, and countdown pedestrian signal heads. According to a FHWA study, pedestrian hybrid beacons have a large impact on vehicle yielding rates.[13] As with RRFBs, pedestrian hybrid beacons are typically more expensive to implement and maintain than some devices, but less expensive than full traffic signals.

Figure 26: Pedestrian Hybrid Beacon

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Pedestrian Hybrid Beacon	Pedestrian Hybrid Beacon	$51,460	$57,680	$21,440	$128,660	Each	9 (9)

Table 23: Pedestrian Hybrid Beacon Cost

Pedestrian and Bicycle Detection

Pedestrian and bicycle detection devices are used to determine if a pedestrian or bicyclist is waiting for the signal. There are many different ways that these devices detect pedestrians and bicyclists. For instance, bicycle detectors ($1,920 on average, $1,070 to $2,680 range) are usually loop detectors embedded in the pavement, while pedestrian detectors use video and other strategies to detect the presence of pedestrians waiting to cross.

Actuated pedestrian detectors provide dynamic recognition of pedestrians and signal to motorists to stop once a pedestrian approaches a crosswalk. The cost to retrofit a signal with a pushbutton at an existing pedestrian signal averages around $350. The cost to remove a pushbutton installation is slightly more than $45 on average, with a range of $21 to $92.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Pedestrian/Bike Detection	Furnish and Install Pedestrian Detector	$180	$390	$68	$1,330	Each	7 (14)
Pedestrian/Bike Detection	Push Button	$230	$350	$61	$2,510	Each	22 (34)

Table 24: Pedestrian/ Bike Detection Cost

Signals for Drivers and Pedestrians

Signals serve the important function of guiding and regulating traffic and help reduce conflicts between different road users. Many of the costs in the table below are representative of various components of a signal and are not representative of the complete cost of a signal. Some information about signals is not included in the table, namely bicycle signals, which have an average cost of $12,800. In the table, “Signal Face” refers to the cost of a signal’s front display visible to pedestrians, while “Signal Head” refers to the entire unit. The adjacent image displays a pedestrian countdown timer signal (see Figure 27).

Figure 277: Pedestrian Signal

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Signal	Audible Pedestrian Signal	$810	$800	$550	$990	Each	4 (4)
Signal	Countdown Timer Module	$600	$740	$190	$1,930	Each	14 (18)

Signal	Pedestrian Signal	$980	$1,480	$130	$10,000	Each	22 (33)
Signal	Signal Face	$490	$430	$130	$800	Each	3 (6)
Signal	Signal Head	$570	$550	$100	$1,450	Each	12 (26)
Signal	Signal Pedestal	$640	$800	$490	$1,160	Each	3 (5)

Table 25: Signal Cost

Speed Trailer

Speeding in neighborhoods can create dangerous situations for pedestrians, particularly children. Speed trailers, which display the motorist speed and provide a warning if the speed limit is exceeded, as well as signs and reader boards can help education and awareness efforts and can be especially effective when coupled with enforcement efforts.

Speed trailers are sign boards that display the speed or passing vehicles and typically range in cost from $7,000 to $12,410 with an average cost of $9,510 (see Figure 28). Speed reader boards are similar to speed trailers, but are typically permanently installed.

Figure 28: Speed Trailer

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Speed Trailer	Speed Trailer	$9,480	$9,510	$7,000	$12,410	Each	6 (6)

Table 26: Speed Trailer Cost

Signs

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. Regulatory signs, such as STOP (see Figure 29), YIELD, or turn restriction signs such as NO TURN ON RED require compliant driver actions and can be enforced. Sign use and movement should be done judiciously, as overuse may breed noncompliance and disrespect.

Signs not included in the table but pertinent to pedestrian and bicyclists include (all costs are approximated and per unit): bike route signage ($160), "no turn on red" signage ($220 for a metal sign or $3,200 for an electronic sign), in-pavement yield paddles ($240), trail regulation sign ($160), and trail wayfinding/information sign (range from $530 to $2,150).

Figure 29: Stop Sign

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Sign	Stop/Yield Signs	$220	$300	$210	$560	Each	4 (4)

Table 27: Sign Cost

Striping

Striping costs, in this case, include bicycle and pedestrian symbols, textured pavement, yield/stop lines, and painted island/curb/sidewalks. For symbols, cost information is provided per unit, while striping and painted surfaces are given as linear and square feet, respectively.

Figure 30: Advance Stop/Yield Lines

Pavement Marking

Pavement markings cover a variety of pedestrian and bicycle treatment costs. Advance stop/yield lines (see Figure 30) improve the visibility of pedestrians to motorists and prevent multiple-threat crashes.[iv] They also encourage drivers to stop back far enough so a pedestrian can see if a second motor vehicle is not stopping and be able to take evasive action.

The advance stop or yield line should be supplemented with "Stop Here For Pedestrians" signs to alert drivers where to stop to let a pedestrian cross. The price will range depending on the material used and the type of line selected. Having island markings and painted curbs/sidewalks can alert pedestrians, bicyclists, and drivers of the presence of these items, and also help restrict parking. Painting a "bicycle box" (see Figure 31) will cost approximately $11.50 per square foot. "Striping" combines a number of related costs, such as: contraflow lanes, broken/solid white or yellow stripe, bicycle lanes, and bikeway centerlines. It also combines the wide assortment of widths and materials used for striping.

Figure 31: Bicycle Box

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Pavement Marking	Advance Stop/Yield Line	$380	$320	$77	$570	Each	3 (5)
Pavement Marking	Advance Stop/Yield Line	$10	$10	$4.46	$100	Square Foot	1 (4)
Pavement Marking	Island Marking	$1.49	$1.94	$0.41	$11	Square Foot	1 (4)
Pavement Marking	Painted Curb/Sidewalk	$1.21	$3.40	$0.44	$12	Square Foot	4 (5)
Pavement Marking	Painted Curb/Sidewalk	$2.57	$3.06	$1.05	$10	Linear Foot	2 (5)

Table 28: Pavement Marking Cost

[iv] A multiple-threat crash involves a driver stopping in one lane of a multilane road to permit pedestrians to cross, blocking the view of oncoming vehicles travelling in the same direction and causing a collision between the motorist and pedestrian.

Pavement Marking Symbols

Pavement marking symbol costs have been separated by the type of symbol. "Pedestrian Crossing" symbols notify pedestrians and/or motorists of places where pedestrians cross the street. "Shared Lane/Bicycle" symbols identify bicycle lanes and/or shared-lanes (see Figure 32). School crossing symbols highlight areas where motorists should be aware of children and increased pedestrian activity.

Costs will vary due to the type of paint used and the size of the symbol, as well as whether the symbol is added at the same time as other road treatments.

Figure 32: Shared Lane Marking

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Pavement Marking Symbol	Pedestrian Crossing	$310	$360	$240	$1,240	Each	4 (6)
Pavement Marking Symbol	Shared Lane/Bicycle Marking	$160	$180	$22	$600	Each	15 (39)
Pavement Marking Symbol	School Crossing	$520	$470	$100	$1,150	Each	4 (18)

Table 29: Pavement Marking Symbol Cost

Curb and Gutter

Curb and Gutters are used in conjunction with a number of other bicycle and pedestrian facility improvements, such as: sidewalks, bikeways, medians, islands, paths, curb extensions, bikeways, diverters, chicanes, and bulb-outs, among others. The cost can vary widely based on the scale of the project and whether the curb and/or gutter installation is in conjunction with other road treatments.

Infrastructure	Description	Median	Average	Minimum	Maximum	Cost Unit	Number of Sources (Observations)
Curb/Gutter	Curb	$18	$21	$1.05	$110	Linear Foot	16 (68)
Curb/Gutter	Curb and Gutter	$20	$21	$1.05	$120	Linear Foot	16 (108)
Curb/Gutter	Gutter	$23	$23	$10	$78	Linear Foot	4 (4)

Table 30: Curb/ Gutter Cost

Summary of Results

These tables and associated database provide up-to-date information on pedestrian and bicycle treatments. It is important to remember that the tables above are estimates of pedestrian and bicycle-related infrastructure costs and that infrastructure costs will likely differ substantially between communities and between states. Additionally, these costs may not always accurately reflect the current market price of materials, labor, mobilization, and other costs included in all situations. More detailed infrastructure cost information can be found in the larger database, located at bit.ly/pedbikecosts.

This database of costs is presented here for use by city planners, engineers, and other city officials. The ultimate goal of the database is to encourage bicycling and walking and to make bicycling and walking safer through the provision of relevant infrastructure. HSRC researchers hope that this cost database is used to simplify the process for implementing pedestrian and bicycle infrastructure and will help decision-makers understand the costs involved in sustaining and encouraging pedestrian and bicycle transportation. By making more informed decisions about the costs of pedestrian and bicycle infrastructure treatments, decision-makers will be able to dedicate funds to those treatments secure in the knowledge that a) these investments are often affordable and b) which treatment is the most cost-effective.

Additionally, this database will be available to both city transportation officials as well the general public, allowing anyone with an interest in non-motorized transportation the chance to research cost information.

Figure References

Figure 1: Dan Burden / www.pedbikeimages.org

Figure 2: Nate Baird / www.flickr.com

Figure 3: Reed Huegerich / www.pedbikeimages.org

Figure 4: "Chicanes," sfbetterstreets / www.sfbetterstreets.org

Figure 5: Thisisbossi / www.flickr.com

Figure 6: "Pedestrians: Strategies for Addressing the Problem" / http://safety.transportation.org/htmlguides/peds/description_of_strat.htm

Figure 7: Dan Burden / www.pedbikeimages.org

Figure 8: Dan Burden / www.pedbikeimages.org

Figure 9: Dan Burden / www.pedbikeimages.org

Figure 10: Designing for Pedestrian Safety / www.walkinginfo.org

Figure 11: Heather Bowden / www.pedbikeimages.org

Figure 12: Austin Brown / www.pedbikeimages.org

Figure 13: Dan Burden / www.pedbikeimages.org

Figure 14: Dan Burden / www.pedbikeimages.org

Figure 15: Jennifer Wampler / www.pedbikeimages.org

Figure 16: LA Wad / www.flickr.com

Figure 17: Ron Bloomquist / www.pedbikeimages.org

Figure 18: Laura Sandt / www.pedbikeimages.com

Figure 19: Dan Burden / www.pedbikeimages.com

Figure 20: BazzaDaRambler / www.flickr.com

Figure 21: City of Los Altos / www.ci.los-altos.ca.us/

Figure 22: CompleteStreets / www.flickr.com

Figure 23: FHWA-HRT-04-100. 2005.

Figure 24: Dan Burden / www.pedbikeimages.org

Figure 25: Dan Burden / www.pedbikeimages.org

Figure 26: Mike Cynecki / www.pedbikeimages.org

Figure 27: James Wagner / www.pedbikeimages.org

Figure 28: Town of Warrenton, VA / http://www.warrentonva.gov/

Figure 29: Mike Cynecki / www.pedbikeimages.org

Figure 30: Dan Burden / www.pedbikeimages.org

Figure 31: Laura Sandt / www.pedbikeimages.org

Figure 32: Lyubov Zuyeva / www.pedbikeimages.org

Appendix A – Links to Database and More Information

The final database, including more detailed information about the data source of each observation, is located at the following URL: bit.ly/pedbikecosts. It also includes more information regarding materials, classes, units, etc.

A summary page with additional resources and information can be found here: http://www.walkinginfo.org/library/details.cfm?id=4876

This paper can be downloaded directly by following this URL: http://katana.hsrc.unc.edu/cms/downloads/Costs-for-Pedestrian-Bicycle-Infrastructure-Improvements.xlsx

Appendix B – Glossary of Terms

Bicycle Boulevard
A bicycle boulevard is a low-speed street that has been designed to give priority to bicyclists as through-going traffic. They discourage non-local vehicular traffic and provide right-of-way and traffic control to bicyclists. A variety of traffic calming elements can be used to create these streets, such as diverters, curb extensions, and partial or full road closures.

Bicycle Lane
Bicycle lanes are designated travel lanes for bicyclists, separated from vehicular traffic by striping. For this database, the width is assumed to be five feet.

Bicycle Locker
A bicycle locker is a box or locker used to store a single bicycle. They are typically used in areas where parking is needed for an extended period of time yet where otherwise the bicycles could be damaged or stolen.

Bicycle Parking Stations
Bicycle parking stations are buildings or structures designed to provide secure bicycle parking, with sheltered bike racks secured by having on-site staff or a gate/door controlled by key or electronic card access. Facility designs range from a simple cage or shed to multi-level structures. Some also include other facilities, such as bicycle repair workstation, showers, and/or lockers.

Bicycle Racks
Bicycle racks are devices to which bicycles can be securely attached in order to prevent theft. General styles include: the Inverted U, Serpentine, Bollard, Grid and Decorative.

Bicycle Stairway Channel
A bicycle stairway channel is a pedestrian stairway with an included channel, which helps facilitate walking a bicycle up or down the stairs.

Bikeway Preparation
Bikeway preparation is what is required to prepare a site for a separated bicycle route, including excavation, grading, curb/gutter removal, and clearing and grubbing.

Bollard
Traffic bollards are used to keep pedestrians safe, slow and separate traffic, and limit vehicle access either temporarily or permanently.

Bus Racks
Bus racks are typically attached to the front of a bus to facilitate the transportation of bicycles for bus riders.

Chicanes
Chicanes are concrete islands that offset traffic, and create a horizontal diversion of traffic used to reduce the speed of vehicular traffic on local streets. Landscaped chicanes have the added benefit of adding more green landscaping to a street.

Chokers
Chokers are curb extensions that narrow a street by widening the sidewalks or planting strips, effectively creating a pinch point along the street. They can be created by bringing both curbs in, or by more dramatically widening one side at a midblock location.

Crossing Islands
Also known as center islands, refuge islands, pedestrian islands, or median slow points, crossing islands are raised islands placed in the center of the street at intersections or midblock crossings to help protect crossing pedestrians from motor vehicles.

Crosswalk
Striped crosswalks indicate a legal crossing for pedestrians, while natural unmarked crosswalks occur at the intersection of any two streets. Motorists often fail to yield to pedestrians at these crossing points and marked crosswalks are often installed to warn motorists to expect pedestrians and to indicate safe and comfortable crossing locations for pedestrians.

Curb and Gutter
Curb and Gutters are used in conjunction with a number of other bicycle and pedestrian facility improvements, such as: sidewalks, bikeways, medians, islands, paths, curb extensions, bikeways, diverters, chicanes, and bulb-outs, among others.

Curb Extensions
Curb extensions extend the sidewalk or curb line out into the parking lane, which reduces the effective street width. They are often also known as chokers or bulb-outs.

Curb Ramp
Curb ramps provide access between the sidewalk and roadway for people using wheelchairs, strollers, walkers, crutches, handcarts, bicycles, or who have mobility impairments that make it difficult to step up and down high curbs.

Diverter
A diverter is an island built at a residential street intersection that prevents certain through and/or turning movements. There are four primary types of diverters, namely diagonal, star, forced turn, and truncated diverters. A diagonal diverter breaks up cut-through movements and forces right or left turns in certain directions. A star diverter consists of a star-shaped island placed at the intersection, which forces right turns from each approach. A truncated diagonal diverter is a diverter with one end open to allow additional turning movements.

Fence/Gate
Fencing and gating can help separate pedestrians and cyclists from roadways and railroad tracks, and can also be used in the construction of pedestrian/bicyclist paths, bridges, and overpasses.

Flashing Beacons
Flashing beacons are typically used in conjunction with pedestrian crossings to provide an enhanced warning for vehicles to yield to pedestrians. Rectangular rapid flash beacons (RRFBs) differ from regular flashing beacons in that RRFBs have a rapid strobe-like warning flash, are brighter, and can be specifically aimed.

Gateway
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.

Lighting
Adequate roadway lighting enhances the safety of all roadway users, while pedestrian-scale lighting improves nighttime security and enhances commercial districts.

Median
Medians are defined as raised islands placed in the center of a roadway in order to separates opposing streams of traffic and limit turning movements. Medians facilitate pedestrian crossings, improve pedestrian visibility to motorists, slow motor vehicle speeds, and provide space for lighting and landscaping.

Mid-Block Crossing
Often installed in conjunction with other safety and traffic calming features, particularly advance yield lines, in-pavement yield/stop signs, raised pedestrian crossings, or Rectangular Rapid Flash Beacons or Pedestrian Hybrid Beacons, mid-block crossings can affect substantial improvements in pedestrian safety, while also having traffic calming effects. Mid-block crossings are striped crosswalks away from intersections and are very helpful in the vicinity of transit stops or in other areas where pedestrians are likely to cross the road often.

Overpass/Underpass
Pedestrian Overpasses and Underpasses completely separate pedestrians from vehicular traffic and provide safe pedestrian accommodation over often impassable barriers, such as highways, railways, and natural barriers such as rivers.

Path
Multi-use paths are the safest pedestrian facilities and provide pedestrian mobility options away from the roadway. Often accommodating both pedestrians and bikes, multi-use paths are usually at least eight feet in width, can be both paved and unpaved, and are used for both recreation and transportation purposes.

Pavement Marking
Pavement markings cover a variety of pedestrian and bicycle treatment costs, including advance stop/yield lines, island markings, painted curbs/sidewalks, and symbols.

Pedestrian Hybrid Beacon
The Pedestrian Hybrid Beacon, otherwise known as the High Intensity Activated Crosswalk (HAWK) signal, is a special type of beacon to warn and control vehicles to allow pedestrians to safely cross a road or highway at a marked midblock crossing location. Developed by the City of Tucson, Arizona in the 1990s, the pedestrian hybrid beacon is comprised of three signal sections, overhead pedestrian crosswalk signs, pedestrian detectors, and countdown pedestrian signal heads.

Railing
Pedestrian railings provide an important safety benefit on walkways with steep inclines or on stairs and also buffer the pedestrian path from vehicular traffic.

Raised Crosswalk
Raised crosswalks are similar to a raised intersection, with ramps on each side elevating the road to the level of the sidewalk, though only the width of a crosswalk, usually 10 – 15 ft.

Raised Intersection
Raised intersections are essentially speed tables for the entire intersection, with ramps on each vehicle approach, which elevate the entire intersection to the level of the sidewalk.

Roundabout
Roundabouts are circular intersections designed to eliminate left turns by requiring traffic to exit to the right of the circle. They are usually installed to reduce vehicular speeds, improve safety at intersections through eliminating angle collisions, help traffic flow more efficiently, reduce operation costs when converting from signalized intersections, and help create gateway treatments to signify the entrance of a special district or area.

Separated Bikeway
Separated bikeways are paths completely separated from vehicular traffic and used exclusively by pedestrians and bicyclists, with crossflow minimized. For this database, the path width is assumed to be eight feet.

Sidewalk
Sidewalks are the most basic pedestrian facility and provide a safe area within the public right-of-way for pedestrian travel.

Signed Bicycle Routes
Signed bicycle routes are roads where bicyclists and motor vehicles are not separated. Shared-use of the street is indicated with signing.

Signals for Drivers and Pedestrians
Signals serve the important function of guiding and regulating traffic and help reduce conflicts between different road users.

Signs
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. Regulatory signs, such as STOP, YIELD, or turn restriction signs such as NO TURN ON RED require compliant driver actions and can be enforced.

Speed Bumps
Speed bumps are typically smaller than speed humps with a more extreme grade, which forces automobiles to more significantly reduce speeds.

Speed Humps
Speed humps are paved (usually asphalt) and are approximately 3 to 4 in. high at their center. They are used to slow traffic in neighborhoods and extend the full width of the street with height tapering near the drain gutter to allow unimpeded bicycle travel.

Speed Table
Speed tables are very long and broad speed humps, or flat-topped speed humps, where sometimes a pedestrian crossing is provided in the flat portion of the speed table. The primary use of speed tables is to calm traffic in neighborhoods.

Speed Trailer
Speed trailers, which display the motorist speed and provide a warning if the speed limit is exceeded, as well as signs and reader boards can help education and awareness efforts and can be especially effective when coupled with enforcement efforts.

Street Closure
Full and partial (half) street closures are the ultimate way of discouraging automobile through traffic, while still allowing pedestrian and bicycle traffic. Typically, full street closures close the street entirely to vehicles, while partial street closures restrict turning movements onto streets, without having to create one-way streets.

Street Furniture
Street furniture often serves as a buffer between the sidewalk and the roadway, providing an important safety benefit to pedestrians. Including trees, benches, bus shelters, newspaper racks, kiosks, and other pedestrian amenities, street furniture also serves to create a more pleasant and attractive environment for pedestrians.

Appendix C – Cost Information by State

Table 21: Cost Information Frequency by State

State	Number of Treatments
AL	30
AK	6
AZ	1
AR	21
CA	146
CO	80
CT	1
DE	0
DC	0
FL	75
GA	44
HI	0
ID	5
IL	4
IN	24
IA	63
KS	38
KY	41
LA	21
ME	11
MD	1
MA	104
MI	29
MN	115
MS	0
MO	16
MT	15
NE	86
NV	0
NH	1
NJ	26
NM	57
NY	24
NC	68
ND	9
OH	161

State	Number of Treatments
OK	33
OR	78
PA	0
RI	21
SC	49
SD	0
TN	0
TX	24
UT	0
VT	60
VA	32
WA	13
WV	0
WI	101
WY	2
National	5
Unknown	6
Total	1747

Appendix D - Complete Table of Infrastructure Costs

The tables presented in this paper are summarized in the table below.

Infrastructure	Description	Median	Average	Minimum Low	Maximum High	Cost Unit	Number of Sources (Observations)
Bicycle Parking	Bicycle Locker	$2,140	$2,090	$1,280	$2,680	Each	4 (5)
Bicycle Parking	Bicycle Rack	$540	$660	$64	$3,610	Each	19 (21)
Bikeway	Bicycle Lane	$89,470	$133,170	$5,360	$536,680	Mile	6 (6)
Bikeway	Concrete Bicycle Path	$182,870	$179,340	$91,420	$343,700	Mile	2 (6)
Bikeway	Signed Bicycle Route	$27,240	$25,070	$5,360	$64,330	Mile	3 (6)
Bikeway	Signed Bicycle Route with Improvements	$241,230	$239,440	$42,890	$536,070	Mile	1 (6)
Bollard	Bollard	$650	$730	$62	$4,130	Each	28 (42)
Chicanes	Chicane	$8,050	$9,960	$2,140	$25,730	Each	8 (9)
Crosswalk	High Visibility Crosswalk	$3,070	$2,540	$600	$5,710	Each	4(4)
Crosswalk	Striped Crosswalk	$340	$770	$110	$2,090	Each	8 (8)
Crosswalk	Striped Crosswalk	$5.87	$8.51	$1.03	$26	Linear Foot	12 (48)
Crosswalk	Striped Crosswalk	$6.32	$7.38	$1.06	$31	Square Foot	5 (15)
Curb/Gutter	Curb	$18	$21	$1.05	$110	Linear Foot	16 (68)
Curb/Gutter	Curb and Gutter	$20	$21	$1.05	$120	Linear Foot	16 (108)
Curb/Gutter	Gutter	$23	$23	$10	$78	Linear Foot	4 (4)
Curb Extension	Curb Extension/ Choker/ Bulb-Out	$10,150	$13,000	$1,070	$41,170	Each	19(28)
Curb Ramp	Truncated Dome/Detectable Warning	$37	$42	$6.18	$260	Square Foot	9 (15)
Curb Ramp	Wheelchair Ramp	$740	$810	$89	$3,600	Each	16 (31)
Curb Ramp	Wheelchair Ramp	$12	$12	$3.37	$76	Square Foot	10 (43)
Diverter	Diverter	$22,790	$26,040	$10,000	$51,460	Each	5 (6)
Diverter	Partial/Semi Diverter	$15,000	$15,060	$5,000	$35,000	Each	3 (4)
Fence/Gate	Fence	$120	$130	$17	$370	Linear Foot	7 (7)
Fence/Gate	Gate	$510	$910	$330	$1,710	Each	5 (5)
Flashing Beacon	Flashing Beacon	$5,170	$10,010	$360	$59,100	Each	16 (25)
Flashing Beacon	RRFB	$14,160	$22,250	$4,520	$52,310	Each	3 (4)
Gateway	Gateway Sign	$350	$340	$130	$520	Each	3 (4)
Gateway	Structure	$15,350	$22,750	$5,000	$64,330	Each	5 (6)
Pedestrian Hybrid Beacon	Pedestrian Hybrid Beacon	$51,460	$57,680	$21,440	$128,660	Each	9 (9)
Island	Median Island	$10,460	$13,520	$2,140	$41,170	Each	17 (19)

Infrastructure	Description	Median	Average	Minimum Low	Maximum High	Cost Unit	Number of Sources (Observations)
Island	Median Island	$9.80	$10	$2.28	$26	Square Foot	6 (15)
Lighting	In-pavement Lighting	$18,250	$17,620	$6,480	$40,000	Total	4 (4)
Lighting	Streetlight	$3,600	$4,880	$310	$13,900	Each	12 (17)
Median	Median	$6.00	$7.26	$1.86	$44	Square Foot	9 (30)
Overpass/ Underpass	Wooden Bridge	$122,610	$124,670	$91,010	$165,710	Each	1 (8)
Overpass/ Underpass	Pre-Fab Steel Bridge	$191,400	$206,290	$41,850	$653,840	Each	5 (5)
Path	Boardwalk	$1,957,040	$2,219,470	$789,390	$4,288,520	Mile	5 (5)
Path	Multi-Use Trail - Paved	$261,000	$481,140	$64,710	$4,288,520	Mile	11 (42)
Path	Multi-Use Trail - Unpaved	$83,870	$121,390	$29,520	$412,720	Mile	3 (7)
Pavement Marking	Advance Stop/Yield Line	$380	$320	$77	$570	Each	3 (5)
Pavement Marking	Advance Stop/Yield Line	$10	$10	$4.46	$100	Square Foot	1 (4)
Pavement Marking	Island Marking	$1.49	$1.94	$0.41	$11	Square Foot	1 (4)
Pavement Marking	Painted Curb/Sidewalk	$1.21	$3.40	$0.44	$12	Square Foot	4 (5)
Pavement Marking	Painted Curb/Sidewalk	$2.57	$3.06	$1.05	$10	Linear Foot	2 (5)
Pavement Marking Symbol	Pedestrian Crossing	$310	$360	$240	$1,240	Each	4 (6)
Pavement Marking Symbol	Shared Lane/Bicycle Marking	$160	$180	$22	$600	Each	15 (39)
Pavement Marking Symbol	School Crossing	$520	$470	$100	$1,150	Each	4 (18)
Signal	Audible Pedestrian Signal	$810	$800	$550	$990	Each	4 (4)
Signal	Countdown Timer Module	$600	$740	$190	$1,930	Each	14 (18)
Signal	Pedestrian Signal	$980	$1,480	$130	$10,000	Each	22 (33)
Signal	Signal Face	$490	$430	$130	$800	Each	3 (6)
Signal	Signal Head	$570	$550	$100	$1,450	Each	12 (26)
Signal	Signal Pedestal	$640	$800	$490	$1,160	Each	3 (5)
Pedestrian/Bike Detection	Furnish and Install Pedestrian Detector	$180	$390	$68	$1,330	Each	7 (14)
Pedestrian/Bike Detection	Push Button	$230	$350	$61	$2,510	Each	22 (34)
Railing	Pedestrian Rail	$95	$100	$7.20	$690	Linear Foot	29 (83)
Raised Crossing	Raised Crosswalk	$7,110	$8,170	$1,290	$30,880	Each	14 (14)

Page **43** of **45**

Infrastructure	Description	Median	Average	Minimum Low	Maximum High	Cost Unit	Number of Sources (Observations)
Raised Crossing	Raised Intersection	$59,160	$50,540	$12,500	$114,150	Each	5 (5)
Roundabout/ Traffic Circle	Roundabout/ Traffic Circle	$27,190	$85,370	$5,000	$523,080	Each	11 (14)
Sidewalk	Asphalt Paved Shoulder	$5.81	$5.56	$2.96	$7.65	Square Foot	1 (4)
Sidewalk	Asphalt Sidewalk	$16	$35	$6.02	$150	Linear Foot	7 (11)
Sidewalk	Brick Sidewalk	$60	$60	$12	$160	Linear Foot	9 (9)
Sidewalk	Concrete Paved Shoulder	$6.10	$6.64	$2.79	$58	Square Foot	1 (11)
Sidewalk	Concrete Sidewalk	$27	$32	$2.09	$410	Linear Foot	46 (164)
Sidewalk	Concrete Sidewalk - Patterned	$38	$36	$11	$170	Linear Foot	4 (5)
Sidewalk	Concrete Sidewalk - Stamped	$45	$45	$4.66	$160	Linear Foot	12 (17)
Sidewalk	Concrete Sidewalk + Curb	$170	$150	$23	$230	Linear Foot	4 (7)
Sidewalk	Sidewalk	$34	$45	$14	$150	Linear Foot	17 (24)
Sidewalk	Sidewalk Pavers	$70	$80	$54	$200	Linear Foot	3 (4)
Sign	Stop/Yield Signs	$220	$300	$210	$560	Each	4 (4)
Speed Trailer	Speed Trailer	$9,480	$9,510	$7,000	$12,410	Each	6 (6)
Speed Bump/Hump /Cushion/Table	Speed Hump	$2,130	$2,640	$690	$6,860	Each	14 (14)
Speed Bump/Hump /Cushion/Table	Speed Bump	$1,670	$1,550	$540	$2,300	Each	4 (4)
Speed Bump/Hump /Cushion/Table	Speed Table	$2,090	$2,400	$2,000	$4,180	Each	5 (5)
Street Furniture	Street Trees	$460	$430	$54	$940	Each	7(7)
Street Furniture	Bench	$1,660	$1,550	$220	$5,750	Each	15 (17)
Street Furniture	Bus Shelter	$11,490	$11,560	$5,230	$41,850	Each	4 (4)
Street Furniture	Trash/Recycling Receptacle	$1,330	$1,420	$310	$3,220	Each	12 (13)

Other Resources

1. Federal Highway Administration. (2011). *2009 National Household Travel Survey*. Retrieved from http://nhts.ornl.gov. Accessed May 7, 2013.
2. Federal Highway Administration. (2004). *PEDSAFE: Pedestrian Safety Guide and Countermeasures Selection System*. (FHWA-SA-04-003). Washington D.C.: U.S. Government Printing Office.
3. Federal Highway Administration. (2010). *Safety Effectiveness of the HAWK Pedestrian Crossing Treatment*. Washington D.C.: U.S. Government Printing Office.
4. Federal Highway Administration. (2012). *Traffic Management: Diverters*. Retrieved from http://safety.fhwa.dot.gov/saferjourney/library/countermeasures/36.htm. Accessed August 10, 2012.

Endnotes

[1] Pedestrian and Bicycle Information Center. (2010). National Bicycling and Walking Study: 15 Year Status Report. Washington D.C.: Federal Highway Administration.
[2] National Highway Traffic Safety Administration. (2012). *Traffic Safety Facts 2010 Data: Bicyclists and Other Cyclists*. (DOT-HS-811-624). Washington D.C.: NHTSA's National Center for Statistics and Analysis
[3] National Highway Traffic Safety Administration. (2012). *Traffic Safety Facts 2010 Data: Pedestrians*. (DOT-HS-811-625). Washington D.C.: NHTSA's National Center for Statistics and Analysis.
[4] U.S. Department of Transportation, Federal Highway Administration. (2009). 2009 National Household Travel Survey. Retrieved from http://nhts.ornl.gov. Accessed May 15, 2013.
[5] Dill, Jennifer. (2009). *Bicycling for Transportation and Health: The Role of Infrastructure*. Journal of Public Health Policy 30, pp. S95-S110.
[6] Flusche, Darren. (2012). *Bicycling Means Business: The Economic Benefits of Bicycle Infrastructure.* League of American Bicyclists; Alliance for Biking & Walking.
[7] Clifton, Kelly; Morrissey, Sara; Ritter, Chloe. (2012). *Business Cycles: Catering to the Bicycling Market*. TR News 280, pp. 26-32.
[8] Lindsey, Greg; Man, Joyce; Payton, Seth; Dickson, Kelly. (2004). "Property Values, Recreation Values, and Urban Greenways." *Journal of Park and Recreation Administration* V22(3), pp.69-90.
[9] New York City Department of Transportation. (2011). *2011 Sustainable Streets Index*. Retrieved from http://www.nyc.gov/html/dot/html/about/ssi.shtml. Accessed May 12, 2013.
[10] Sandt, Laura; Pullen-Seufert, Nancy; Lajeunesse, Seth; Gelinne, Dan. (2012). "Leveraging the Health Benefits of Active Transportation: Creating an Actionable Agenda for Transportation Professionals." *TR News 280,* pp. 18-25.
[11] Bureau of Labor Statistics. (2012). *Consumer Price Index – All Urban Consumers* [Data File]. Retrieved from http://www.bls.gov/cpi/home.htm#data. Accessed July 20, 2012
[12] Bid Express Secure Internet Bidding. (2012). *Bid Tabulation Sheets* [Data File]. Retrieved from https://www.bidx.com/. Accessed June 15, 2012.
[13] Federal Highway Administration. (2006). *BIKESAFE: Bicycle Safety Guide and Countermeasures Selection System*. (FHWA-SA-05-006). Washington D.C.: U.S. Government Printing Office.