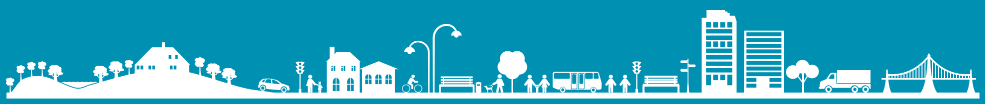

2017 State of New Jersey

Complete Streets Design Guide

DEPARTMENT OF TRANSPORTATION
THE STATE OF NEW JERSEY

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NJDOT and FHWA

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ABOUT THIS GUIDE

This guide is the third in a series of Complete Streets guides developed by the New Jersey Department of Transportation:

- *Making Complete Streets a Reality: A Guide to Policy Development*
- *A Guide to Creating a Complete Streets Implementation Plan*
- *Complete Streets Design Guide*

The New Jersey Complete Streets Design Guide presents tools and methodologies for designing Complete Streets in a variety of settings, with attention to the specific needs of each community. The guide can be used by municipal and state agency staff, design professionals, private developers, community groups, and others involved in the planning and design of streets in New Jersey. The guide is intended to inform all projects that impact the public right-of-way, including the construction of new streets and improvements to existing streets. Standards in this guide are a compilation of current best practice guidance and do NOT supersede any existing federal, state, or city laws, rules, or regulations.

CHAPTERS IN THIS GUIDE

Chapter 1: Complete Streets in New Jersey
Defines Complete Streets and the benefits that come from following the Complete Streets approach.

Chapter 2: Integrating Complete Streets into the Planning and Design Process
Provides guidance on adopting and implementing a Complete Streets policy, public policy changes that can help facilitate implementation, and strategies for integrating Complete Streets into the planning and design process.

Chapter 3: Complete Streets Toolbox—Policy and Design Guidance for Implementing Complete Streets
Provides guidance on a range of tools and treatment options that can be used to enhance a street's safety, mobility, access, and vitality. Where applicable, resources are cited for additional design guidance.

Chapter 4: Street Typologies
Describes the common types of streets found in New Jersey and provides guidance on how the toolbox fits into the context of these different streets.

NAVIGATING THIS GUIDE

Information Box

Supplemental information relating to the primary topic

Design Guidance

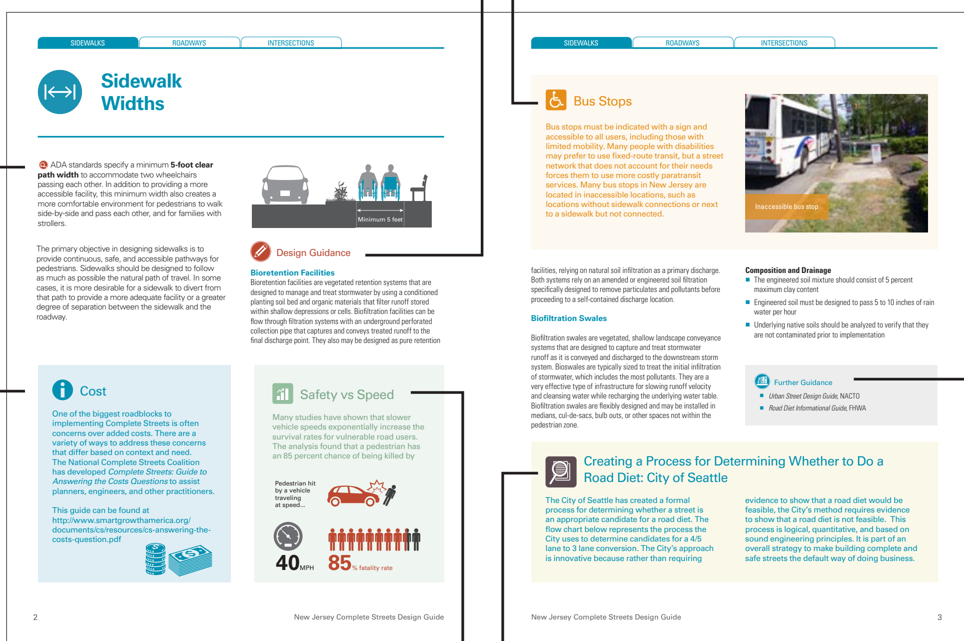
Quantitative and qualitative guidance for Complete Streets designs

Design Standard

In-text call-out for quantitative design standard

ADA Accessibility

Guidance on accessible design standards



SIDEWALKS ROADWAYS INTERSECTIONS

Sidewalk Widths

ADA standards specify a minimum **5-foot clear path width** to accommodate two wheelchairs passing each other. In addition to providing a more accessible facility, this minimum width also creates a more comfortable environment for pedestrians to walk side-by-side and pass each other, and for families with strollers.

The primary objective in designing sidewalks is to provide continuous, safe, and accessible pathways for pedestrians. Sidewalks should be designed to follow as much as possible the natural path of travel. In some cases, it is more desirable for a sidewalk to divert from that path to provide a more adequate facility or a greater degree of separation between the sidewalk and the roadway.

Design Guidance

Bioretention Facilities

Bioretention facilities are vegetated retention systems that are designed to manage and treat stormwater by using a conditioned planting soil bed and organic materials that filter runoff stored within shallow depressions or cells. Biofiltration facilities can be flow through filtration systems with an underground perforated collection pipe that captures and conveys treated runoff to the final discharge point. They also may be designed as pure retention

Cost

One of the biggest roadblocks to implementing Complete Streets is often concerns over added costs. There are a variety of ways to address these concerns that differ based on context and need. The National Complete Streets Coalition has developed *Complete Streets: Guide to Answering the Costs Questions* to assist planners, engineers, and other practitioners.

This guide can be found at http://www.smartgrowthamerica.org/documents/cs/resources/cs-answering-the-costs-question.pdf

Safety vs Speed

Many studies have shown that slower vehicle speeds exponentially increase the survival rates for vulnerable road users. The analysis found that a pedestrian has an 85 percent chance of being killed by

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SIDEWALKS ROADWAYS INTERSECTIONS

Bus Stops

Bus stops must be indicated with a sign and accessible to all users, including those with limited mobility. Many people with disabilities may prefer to use fixed-route transit, but a street network that does not account for their needs forces them to use more costly paratransit services. Many bus stops in New Jersey are located in inaccessible locations, such as locations without sidewalk connections or next to a sidewalk but not connected.

facilities, relying on natural soil infiltration as a primary discharge. Both systems rely on an amended or engineered soil filtration specifically designed to remove particulates and pollutants before proceeding to a self-contained discharge location.

Biofiltration Swales

Biofiltration swales are vegetated, shallow landscape conveyance systems that are designed to capture and treat stormwater runoff as it is conveyed and discharged to the downstream storm system. Bioswales are typically sized to treat the initial infiltration of stormwater, which includes the most pollutants. They are a very effective type of infrastructure for slowing runoff velocity and cleansing water while recharging the underlying water table. Biofiltration swales are flexibly designed and may be installed in medians, cul-de-sacs, bulb outs, or other spaces not within the pedestrian zone.

Composition and Drainage

- The engineered soil mixture should consist of 5 percent maximum clay content
- Engineered soil must be designed to pass 5 to 10 inches of rain water per hour
- Underlying native soils should be analyzed to verify that they are not contaminated prior to implementation

Further Guidance

- *Urban Street Design Guide,* NACTO
- *Road Diet Informational Guide,* FHWA

Creating a Process for Determining Whether to Do a Road Diet: City of Seattle

The City of Seattle has created a formal process for determining whether a street is an appropriate candidate for a road diet. The flow chart below represents the process the City uses to determine candidates for a 4/5 lane to 3 lane conversion. The City's approach is innovative because rather than requiring evidence to show that a road diet would be feasible, the City's method requires evidence to show that a road diet is not feasible. This process is logical, quantitative, and based on sound engineering principles. It is part of an overall strategy to make building complete and safe streets the default way of doing business.

New Jersey Complete Streets Design Guide 3

Sample Spread

Further Guidance

References to relevant guidelines and design manuals

Data

Data supporting Complete Streets approach

Case Study

Example application of Complete Streets practice

START HERE!

NJDOT Staff

- Integrate Complete Streets into project development (Chapter 2)
- Identify design options for new streets (Chapter 3)
- Identify design options for existing street resurfacing or reconstruction projects (Chapter 3)
- Understand how context influences the needs and design applications for each street (Chapter 4)

Local Engineers, Planners, Developers, and Design Professionals

- Understand the purpose and benefits of Complete Streets (Chapter 1)
- Understand municipal priorities, policies, and programs that promote Complete Streets (Chapter 2)
- Identify available design options that are appropriate to meet your goals (Chapter 3)
- Understand how context influences the needs of each street (Chapter 4)
- Explore funding resources to help turn your vision into reality (Chapter 5)

Community Groups

- Learn why Complete Streets is a growing and important movement in New Jersey (Chapter 1)
- Learn about programs that can help promote Complete Streets in your community (Chapter 2)
- Understand the toolbox of Complete Streets design options and how they might benefit your community (Chapter 3)
- Learn how different treatments can be applied to different types of streets in your town (Chapter 4)
- Identify funding sources and grants that are available to help your town implement projects (Chapter 5)

FLEXIBILITY IN DESIGN

A flexible approach to design is a critical component of Complete Streets. The preeminent design manuals (including AASHTO's *A Policy on Geometric Design of Highways and Streets Sixth Edition*, commonly referred to as the "*Green Book*") emphasize the need for flexibility, and many engineers and designers adopt this strategy. However, street designs often adhere to the maximum and most auto and highway-oriented designs and standards. Because of this, FHWA developed a guide called *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts* that is focused on the need and opportunities for design flexibility.

The key to achieving greater flexibility is understanding all the guidance documents available (including this one) and applying appropriate designs to achieve desired outcomes. For example, the AASHTO "*Green Book*" (where many engineers and designers derive the "standard" 12-foot lane) recognizes the need for flexibility and states that lane width can be tailored to fit the roadway environment.

AASHTO states that lane widths may vary from 10 to 12 feet on most arterials rather than stating that 12 feet is the recommended width for all roads. For lower classification roadways, narrower widths may be appropriate.

Another example of flexibility is the design of separated bicycle lanes. The AASHTO *Guide for the Development of Bicycle Facilities* does not include design guidance for these facilities; however, the NACTO *Urban Bikeway Design Guide* and the FHWA *Separated Bike Lane Planning and Design Guide* do. The lack of guidance in one guide does not mean that a design is not safe or free from liability. Nor does it provide an excuse to not implement a particular design. Engineers and designers should take advantage of all the guiding documents available when considering a particular treatment. **Designs should be considered that help achieve the desired outcomes of a project.**

FHWA Revised Rules

In May 2016, the FHWA revised its criteria for the 10 rules* controlling the design of projects on the National Highway System (NHS). Prior to the rule change, all 10 controlling criteria applied to ALL NHS facility types.

Under the new rule, ONLY "Design Loading Structural Capacity" and "Design Speed" apply to all NHS facility types. The remaining eight criteria are applicable only to "high-speed" NHS roadways.

This new rule provides greater flexibility in designing most roadways to the local context rather than rigid adherence to standards of highway design.

* *The 10 rules are: Design Speed, Lane Width, Shoulder Width, Horizontal Curve Radius, Superelevation Rate, Stopping Sight Distance, Maximum Grade, Cross Slope, Vertical Clearance, and Design Loading Structural Capacity.*

Streets for All Users: Accessible Design

Streets must accommodate safe travel for everyone, including those with disabilities. Many streets, however are difficult to access, navigate, cross, or do not provide adequate accommodations for people who use wheelchairs, have diminished vision or hearing, limited mobility, or even parents with strollers. Most people will face at least one of these challenges in their lifetime.

When a street is incomplete, it lacks adequate accommodations for users of all abilities. An incomplete street might feature unpaved, disconnected, narrow, or deteriorated sidewalks that not only impede travel for those with limited mobility but also makes wheelchair use almost impossible. The lack of a curb ramp or an incorrectly placed one can force a pedestrian into the street or significantly reduce mobility. Wide intersections that are designed for the quick movement of motorized traffic might not provide enough time for someone with a disability to cross safely.

Pedestrian signals that only use visual cues (or no pedestrian signal) can lead to challenging and/or dangerous situations for the visually impaired. Bus stops that are not connected to a sidewalk are not accessible to many pedestrians with disabilities, and might prevent them from getting to where they need to go. A construction project that closes a sidewalk and does not make alternate accommodations not only creates a new barrier for those with disabilities, but can lead to confusing or dangerous situations for the visually impaired. Many people with disabilities rely on sidewalks or public transit to travel (including for doctors' appointments, groceries, and exercise), and incomplete streets can make this almost impossible. As a result, many people with disabilities must rely on costly paratransit service or are unable to travel where they need to go.

Designing for accessibility not only benefits those with disabilities, limited mobility, or parents with baby strollers, but helps create a more complete and mobility-supportive built environment for all users. Complete and well-maintained sidewalk networks, accessible transit stops, properly placed and designed curb ramps, and other accessible features make it easier for all people to travel and provide a more dignified and aesthetically pleasing built environment.

Accessibility is not only a matter of good planning, it is also required by law that new and reconstruction projects be accessible to all users. This guide provides design standards for accessible design relating to sidewalks, intersections, signage, and transit, as well as resources for further information.

LEGISLATING DOCUMENTS

Pedestrian facility design and operation must comply with the following acts of Congress:

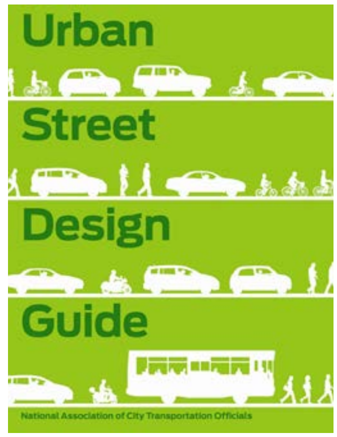
- Architectural Barriers Act (ABA) of 1968
- The Rehabilitation Act of 1973 (Section 504)
- The Americans with Disabilities Act (ADA) of 1990

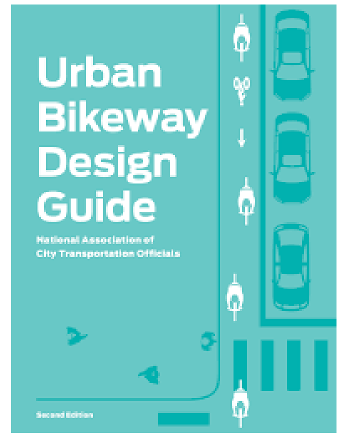
Look for this symbol throughout this guide for accessibility information.

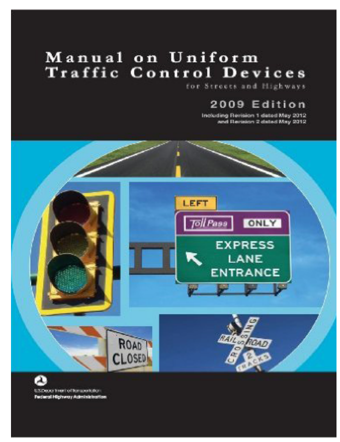
Beyond This Guide

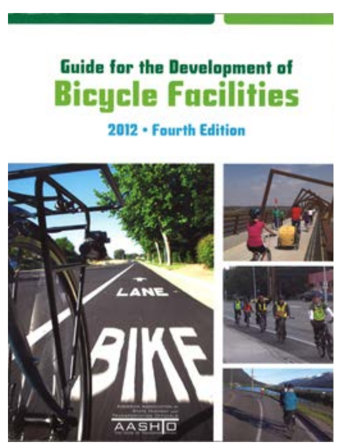
This design guide has been developed to supplement existing manuals and standards, including the *Manual on Uniform Traffic Control Devices* (MUTCD) and guidance issued by the National Association of City Transportation Officials (NACTO), the American Association of State Highway Transportation Officials (AASHTO), and the Federal Highway Administration (FHWA).

(Clockwise from top-left)
NACTO *Urban Street Design Guide*
NACTO *Urban Bikeway Design Guide*
MUTCD for Streets and Highways 2009
FHWA *Separated Bike Lane Planning and Design Guide*
AASHTO *Guide for the Development of Bicycle Facilities*
NACTO *Transit Street Design Guide*









Additional Guidance Documents

AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*

FHWA *Small Town and Rural Multimodal Networks*

Institute of Transportation Engineers (ITE) *Designing Walkable Urban Thoroughfares*

NJ Department of Transportation *New Jersey School Zone Design Guide*

NJ Department of Transportation *Roadway Design Manual*

01

Complete Streets in New Jersey

Complete Streets are streets designed for all users, all modes of transportation, and all ability levels. They balance the needs of drivers, pedestrians, bicyclists, transit riders, emergency responders, and goods movement based on local context.

The New Jersey Department of Transportation (NJDOT) adopted a Complete Streets policy in 2009, which can be found at **njbikeped.org** (along with an updated list of municipal and county policies). The policy requires that roadway improvement projects include safe accommodations for all users, including bicyclists, pedestrians, transit riders, and the mobility impaired. In its analysis of Complete Streets policies nationwide, the National Complete Streets Coalition has consistently ranked NJDOT's policy among the strongest in the nation (2010 through 2014), both overall and at the state level, out of the hundreds of jurisdictions that have adopted formal Complete Streets policies.

NJDOT has jurisdiction over less than 10 percent of roadway lane-miles in New Jersey. Therefore, to make an appreciable difference on the mobility and safety of all users, New Jersey's municipalities and counties must join the Complete Streets movement. With encouragement from NJDOT, over 130 local and county governments throughout New Jersey have also adopted Complete Streets policies as of February 2016. These policies are changing the way we design and use our streets and communities. This guide provides planning and design guidelines to support policy advancement and implementation of Complete Streets in New Jersey.

What are Complete Streets?

Increasingly, planners, engineers, decision makers, and citizens are recognizing the importance of designing and building Complete Streets. As defined by the National Complete Streets Coalition:

"Complete streets are designed and operated to enable safe access for all users. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities must be able to safely move along and across a complete street."

NJDOT adopted its nationally recognized policy in 2009 with the purpose of "[providing] safe access for all users by designing and operating a comprehensive, integrated, connected multi-modal network of transportation options." Through this policy, NJDOT seeks to make well-planned, well-designed, context-based streets an integral part of its transportation network. While there is no template for a Complete Street, typical elements may include accessible sidewalks and crosswalks, bicycle facilities, appropriate street widths and speeds, and transit facilities.

A critical component in the design of a Complete Street is that its accommodations be provided with the same level of detail and attention that has been afforded to the movement of automobiles and heavy vehicles. This means that sidewalks, bicycle lanes, and other elements be both comprehensive and interconnected. Complete Streets design elements emphasize safety, mobility, and accessibility for all modes and users. Under the Complete Streets policy, any new or retrofit projects must consider all modes and users in the design. Although Complete Streets may initially be designed and built as disconnected segments, the intent of the policy is to incrementally grow and develop community-wide networks of Complete Streets over time.

Complete Streets mean designing a street based on its unique context, including surrounding land use patterns, who uses the street, and user needs. Highways serve an important function in our transportation network, providing the highest level of efficiency for moving high traffic volumes over longer distances. However, the purpose and function of a street is different from that of a highway. Street design practices and principles should therefore also differ from those that guide highway development. This guide provides direction on how to implement street design principles that fit local context and support more livable, sustainable, and resilient communities.

Why Complete Streets?

The adoption of NJDOT's Complete Streets policy represented a significant shift in the Department's approach to street design. Central to this shift is the understanding that an auto-centric approach to street design has led to unfriendly (and at times unsafe) conditions for both motorized and non-motorized users in many locations in New Jersey. Fundamentally, this approach often reduces the function of a street exclusively to the movement of automobiles and trucks. However, our streets play a vital role in communities, connecting people of all ages, abilities, and modes, and supporting commerce and social interaction. How a street is designed has an underlying impact on the quality of life and economic vitality of its surroundings and the people that use it.

A Complete Streets approach to transportation planning has many benefits for all who live, work, and play in New Jersey:

- Health
- Safety
- Equity
- Economic Vitality
- Transportation Choices
- Environment
- Mobility
- Livability

Pedestrian mall on Washington Street in Cape May, NJ

Health

Street design has a major impact on health. Each additional hour spent driving per day is associated with a 6 percent increase in obesity, while each additional kilometer walked is associated with a 5 percent reduction in this likelihood.[1]

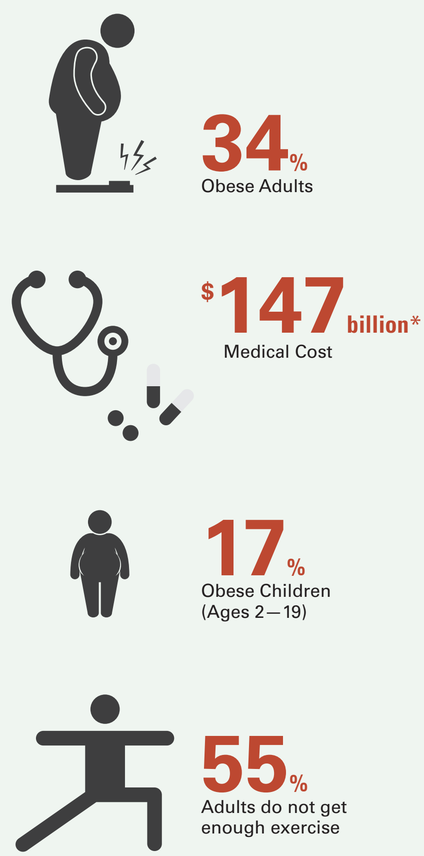
Complete Streets provide opportunities for active transportation by integrating features into street designs that facilitate and encourage walking, cycling, and transit use. One study found that residents are 65 percent more likely to walk in a neighborhood with sidewalks.[2] Other studies have shown similar effects where bicycle, pedestrian, and transit infrastructure correlate with higher rates of physical activity and lower rates of obesity.

Streets that are designed only for cars discourage other modes of transportation, including walking and bicycling. Even where sidewalks do exist, large gaps in the sidewalk network, wide intersection crossings, speeding traffic, poor maintenance, and the lack of adequate accommodations for the mobility impaired can make walking unpleasant or unsafe.

Obesity

"sitting is the new smoking"

According to the Centers for Disease Control and Prevention (CDC), more than one-third (34.0 percent) of U.S. adults are obese, with a related estimated annual medical cost of $147 billion in 2008 dollars. Childhood obesity is also a serious problem in the U.S., affecting about 17 percent[3] or 12.7 million U.S. children 2 to 19 years of age. According to the U.S. Department of Health and Human Services (HHS), one big factor in high obesity levels is inactivity. About 55 percent of the U.S. adult population falls short of recommended activity guidelines.[4]



* In 2008 dollars

Safety

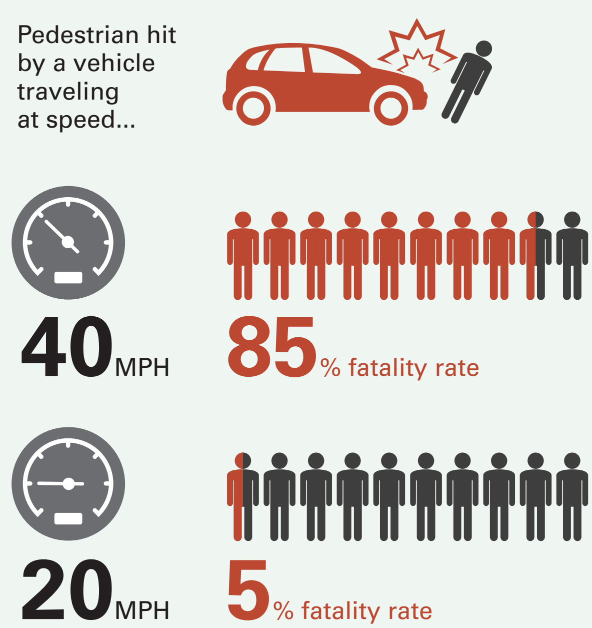
Street design can also have a significant impact on health from a safety perspective. Over the past 10 years in New Jersey, there has been an average of 140 fatal pedestrian crashes and 13 fatal cyclist crashes each year, accounting for 25 percent and 2 percent, respectively, of all fatal crashes in New Jersey.[5] One FHWA report demonstrates that pedestrian crashes are more than twice as likely to occur in places without sidewalks, while locations with sidewalks on both sides of the road have the fewest crashes.[6] In 2007 and 2008, more than 50 percent of all pedestrian fatalities in the U.S. occurred on arterial roadways, which are typically designed for the efficient movement of large volumes of automobiles.[7] However, in the United States, retail, commercial, and job centers are often located along these arterials and frequently lack appropriate pedestrian or bicycle infrastructure. More than 40 percent of these crashes occurred where there was no crosswalk available.[8] When retail, commercial, and job centers locate along these arterial roadways, there is a built-in demand (and sometimes necessity) for people to access these sites, regardless of whether they have access to a motor vehicle.

Fears over safety also discourage those with automobiles from using alternate modes of transportation and prevent many people without automobiles from accessing these sites. This is particularly prevalent among senior citizens and those with disabilities. For them, these stores and businesses are effectively inaccessible without an automobile.

Complete Streets design can improve pedestrian safety. The FHWA found that certain measures—sidewalks, raised medians, bus stop placement, traffic-calming measures, and treatments for those with limited mobility—all improve pedestrian safety.[9] One study found that installing raised medians and redesigning intersections and sidewalks reduced pedestrian risk by 28 percent.[10]

Safety vs Speed

Many studies have shown that slower vehicle speeds exponentially increase the survival rates for vulnerable road users. The analysis found that a pedestrian has an 85 percent chance of being killed by a vehicle traveling at 40 mph, but only a 5 percent chance of being killed by a vehicle traveling at 20 mph.[11]



Equity

One-third of Americans do not drive.[12] This group relies on alternate modes of transportation to reach their destinations, which is often critical for their livelihood. When suitable transportation options are not available, many residents are unable to access vital services and economic opportunity. For example, studies show that seniors may forgo doctor visits when they do not have access to a car. When transportation planners and engineers treat facilities for these users as optional add-ons or unnecessary expense, an unequal transportation system is created that ignores the needs of major segments of the population. Safe, comfortable, and affordable transportation options create a more equitable and economically mobile society.

The fundamental principle of Complete Streets is to design streets that are safe and comfortable for everyone, regardless of age, ability, ethnicity, income, or chosen travel mode. Incomplete streets have disproportional impacts on minorities, older adults, children, and low-income communities. These populations are often cut off from jobs, healthcare, friends, and family by incomplete streets. The pedestrian fatality rate for Latinos is over 60 percent higher than that of whites, while the rate for African-Americans is almost 75 percent higher.[13]

Low-income communities are also at a higher risk of pedestrian injury due to unsafe streets. The pedestrian fatality rate for counties where more than 20 percent of households have incomes below the federal poverty line is 80 percent higher than the national average.[14] Older adults also suffer disproportionate impacts. Nationally, adults over 65 represented 22 percent of all pedestrian fatalities from 2000 to 2009 despite only making up 13 percent of the total population.[15] Similarly, in New Jersey 14 percent of the population is over 65 (2009—2014 ACS), yet this age group accounts for 22 percent of all pedestrian fatalities.

New Brunswick, NJ

Economic Vitality

A growing body of data is increasing our understanding of the positive economic impact that Complete Streets can have on a community. Statewide, active transportation-related infrastructure, businesses, and events contributed an estimated $497 million to the New Jersey economy in 2011—nearly eight times the $63 million invested in infrastructure—supporting several thousand jobs and generating millions in tax revenue.[16]

Making streets more accommodating to walking, biking, or riding transit can stimulate local economic activity in a variety of ways. Residents of Dallas save an average of $9,026 per year by riding transit, while residents of Cleveland save an average of $9,576.[17] For large cities, the total savings for using alternate modes of transportation saves residents a lot of money each year, with a $2.3 billion total savings for residents of Chicago[18] and $19 billion for residents of New York City.[19] Money that is not spent on transportation can be spent in other ways, such as at restaurants and businesses, recapturing this money for local economies.

Local Business and Property Values

Improving access for pedestrians, bicyclists, and transit riders can benefit local businesses and property values. In one example, businesses along Valencia Street in San Francisco saw their sales increase by 60 percent following the addition of a bicycle lane.[20] In Washington, D.C., street design improvements along Barracks Row helped attract 40 new businesses and nearly 200 new jobs.[21] In Mountain View, California, the addition of sidewalk cafes and pedestrian space was followed by private investment of $150 million.[22] In Indianapolis, property values within one block of the 8-mile-long Cultural Trail increased nearly 150 percent between 2008 and 2015, which translates to an increase of $1 billion[23] in assessed property value. In New Jersey, Complete Streets improvements along South Park Street in Montclair supported an influx of new businesses and revitalization of the downtown.

South Park Street, Montclair, NJ
(photo credit: Montclair Farmers Market)

Transportation Choices

One of the fundamental goals of Complete Streets is to facilitate and encourage a variety of transportation choices beyond the personal automobile. Research shows that while many people might want to walk, bike, or take transit to their destinations, the lack of appropriate infrastructure or service makes these trips difficult or impossible. In fact, a national survey found that bicycle lanes were available for less than 5 percent of bicycle trips, and more than one-quarter of pedestrian trips were taking place on roads with neither sidewalks nor shoulders.[24] Other surveys have found that a lack of sidewalks and safe places to bike are a primary reason people give when asked why they don't walk or bicycle more.[25]

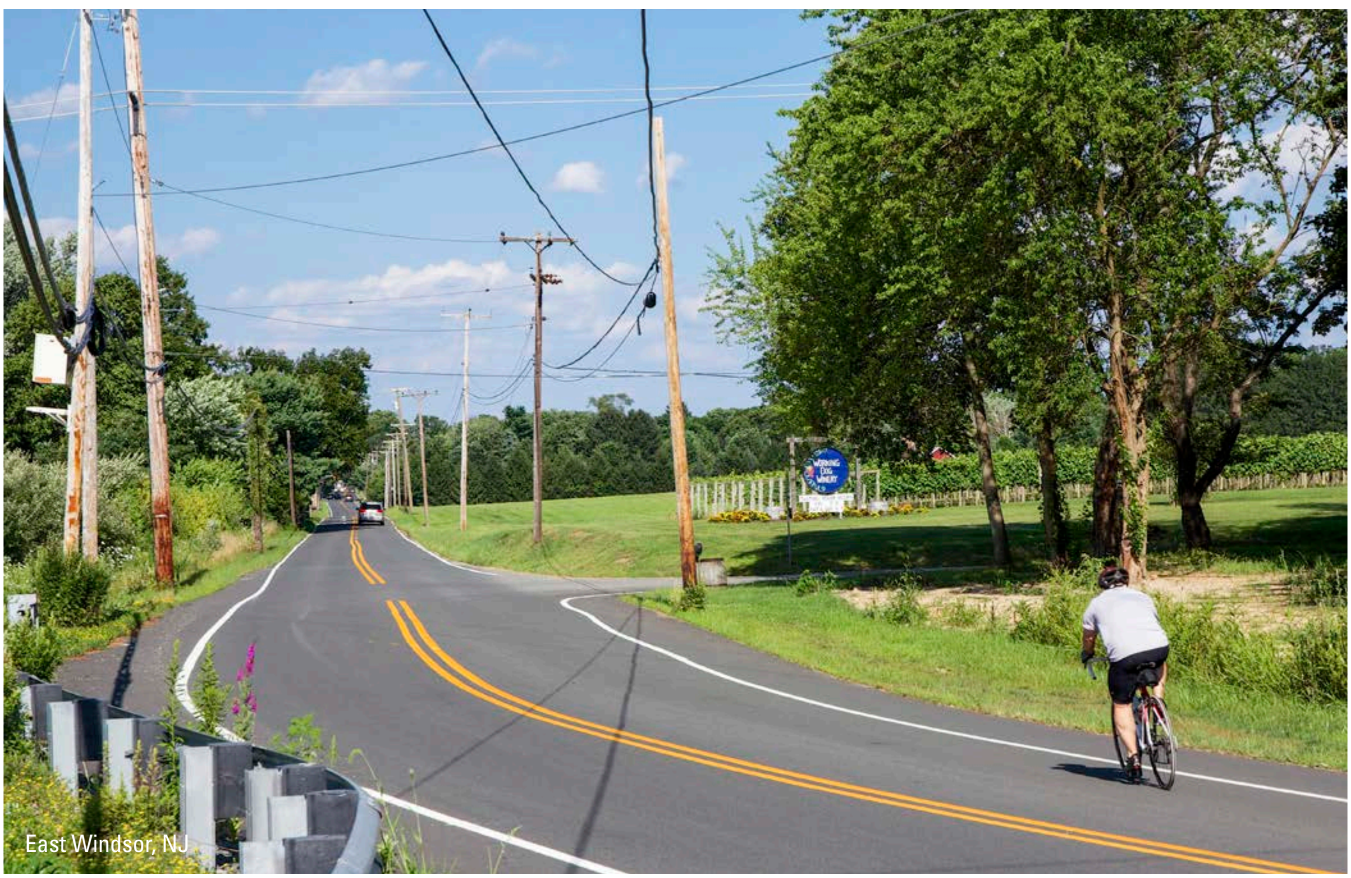
A Complete Street provides transportation choices not only to those who desire to travel by different modes but also for those that cannot drive and must use an alternate mode. Complete Streets make it possible for New Jersey's residents to drive less and use our streets to get around more easily on foot, bike, and public transit. The 2001 National Household Transportation Survey found that 50 percent of all trips in metropolitan areas are 3 miles or less and 28 percent of all metropolitan trips are 1 mile or less—distances easily traversed by foot or bicycle. Yet 72 percent of trips under 1 mile are now made by automobile, in part because of incomplete streets that make it unsafe or unpleasant to walk, bicycle, or take transit.[26] Complete Streets can help convert many of these short automobile trips to multi-modal travel.

Hamilton Train Station in Hamilton, NJ

Environment

Building Complete Streets can help create a more sustainable and healthier natural environment by facilitating more environmentally friendly modes of transportation and by as integrating sustainable infrastructure into street design. Even small changes in transportation behavior can have enormous impacts on the environment. More carbon dioxide (CO_2) is emitted in the United States' transportation sector than any other nation's entire economy except for China.[27] The 260,000 miles bicyclists ride daily in Philadelphia saves 747,450 tons of CO_2 from being emitted by cars.[28] Interestingly, when car travel restrictions reduced morning traffic by 23 percent during the 1996 Olympics in Atlanta, ozone concentrations decreased 28 percent and acute care visits for asthma decreased 41 percent.[29]

In addition to the environmental benefits a community may experience by encouraging the use of sustainable transportation modes for more trips (walking, bicycling, and transit), a Complete Streets approach emphasizes the integration of sustainable infrastructure into the design of a street. These elements include stormwater management techniques (such as rain gardens) that help reduce the impact of stormwater runoff (including pollutants) entering the water system and mitigate long-term capital infrastructure costs. Other sustainable design elements, such as street trees, help create cleaner air, provide shade that reduces energy consumption, reduce the heat island effect, and create a pleasant environment for all street users.



East Windsor, NJ

Mobility

Streets that are "complete" provide everyone with a choice of mobility options, allowing all users to travel to and from work, school, and other destinations with the same level of safety and convenience, whether or not they have mobility, vision, or cognitive disabilities. Many streets, however, are difficult to navigate, dangerous, or do not provide adequate accommodations for people who use wheelchairs, have diminished vision or hearing, limited mobility, or even parents with strollers. Most people will face at least one of these challenges in their lifetime.

Along incomplete streets, unpaved surfaces and disconnected, narrow, or deteriorated sidewalks discourage wheelchair travel, and the lack of a curb ramp can force a pedestrian into the street. Wide intersections designed to quickly move motorized traffic may not provide enough time for someone with a disability to cross safely. Pedestrian signals that use only visual cues can lead to dangerous situations for those with limited vision. A recent study found that blind pedestrians waited three times longer to cross the street and made many more dangerous crossings than sighted pedestrians.[30] Installing a bus stop sign in a patch of grass provides information to passengers, but without sidewalks and necessary curb ramps, these stops are inaccessible and an uncomfortable place to wait. Many people with disabilities may prefer to use fixed-route transit, but a street network that does not account for their needs forces them to use more costly paratransit service.

Complete and maintained sidewalk networks, accessible transit stops, properly placed and designed curb ramps, and other accessible designs make it easier for all people to travel and provide a more dignified and aesthetically pleasing built environment.

Livability

Complete Streets help create livable communities. Wide, attractive sidewalks and well-defined bicycle routes encourage healthy and active lifestyles. Creative re-purposing of street space helps connect the community by providing fun and attractive public space for residents and visitors to gather. A Complete Street enhances opportunities for people to participate in the social, cultural, and economic life of the community without using a car. Streets that are attractive and accessible for all users help define a community's identity, encourage a vibrant street life, and provide a sense of pride for residents and visitors.

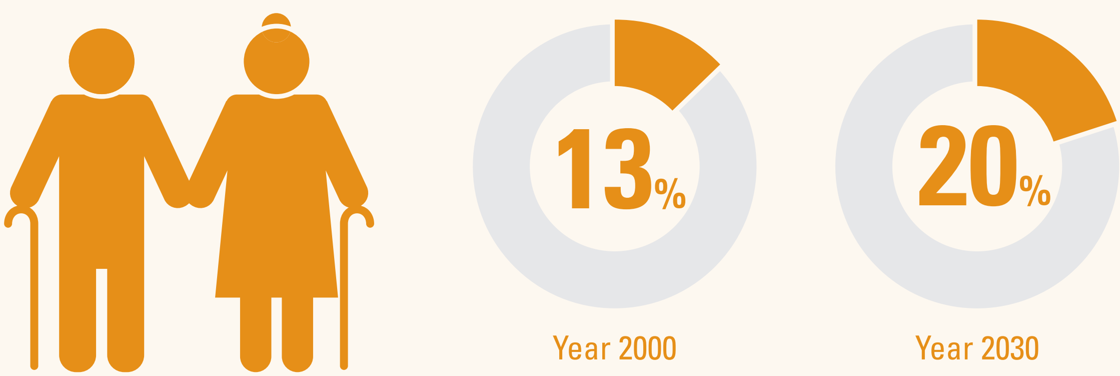

Communiversity, Princeton, NJ

Mobility

In New Jersey, the percentage of seniors in the population is projected to grow 51 percent between 2000 and 2030, from 13 percent to 20 percent of the state population.[31] As the population ages, the transportation system needs to adapt to maintain access and mobility for shifting demographics. Seniors are less likely to drive and often live in communities with few transportation alternatives. Combined with physical limitations, these factors can cause seniors to feel trapped in their homes and communities. Improving senior mobility is essential to maintaining a high quality of life for older adults. It ensures that seniors have safe access to their daily needs and activities, and enables seniors to "age in place" by maintaining independence and staying in their homes and communities.

The effects of aging amplify the impacts of physical barriers that may otherwise appear minor to younger, able-bodied pedestrians. As we age, walking speed and reaction time decrease, and physical mobility, vision, hearing, and cognition can deteriorate, causing various physical barriers to become insurmountable obstacles. The effects of aging can also leave seniors more vulnerable to severe pedestrian crashes. While seniors are involved in fewer total pedestrian crashes per capita in New Jersey, the fatality rate among seniors is significantly higher than the state average.

Percentage of senior population of the state population between 2000 and 2030*



*New Jersey Department of Labor and Workforce Development

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02

Integrating Complete Streets into the Planning and Design Process

Integrating Complete Streets principles into planning and design procedures can be a complex and challenging process. While there is no perfect, one-size-fits-all method to achieve successful integration, a number of tools are available to planners, engineers, and policy makers to make this process more straightforward and successful. Adopting a Complete Streets policy is a good first step to begin to change the transportation planning process. However, it is just that—the beginning. Much work remains to be done and additional actions may be necessary to fully implement the policy. This chapter discusses some of the actions that can be taken to achieve more consistent, effective, and long-term implementation of Complete Streets.

Ocean City, NJ

Implementing Complete Streets at the State Level

Since adopting its policy in 2009, NJDOT has worked hard to integrate the policy into its project development and delivery processes, effectively making Complete Streets the default way of doing business. NJDOT has updated its Capital Project Delivery process to include Complete Streets at every step, including revising wording to include "all roadway users," developing checklists for concept development and preliminary engineering, and requiring Office of Pedestrian and Bicycle Projects Subject Matter Expert sign off on all projects. The following strategies can assist NJDOT in continuing to implement its policy statewide.

Integrated Design from Project Inception

Integrating Complete Streets principles into design from project inception is critical to efficient and cost-effective project delivery and creating an optimal street design. Changes to the design late in the process can lead to contract change orders, costly rework, and a less cohesive overall design. Any design changes also need to be analyzed and go through regulatory review to avoid potential liability issues.

NJDOT's process of involving Subject Matter Experts (SMEs) at project kick-off is a vital element of integrated design. All relevant disciplines should be involved in problem (statement) screening and project scoping so that the process adequately assesses and captures the needs of all users and all modes and Complete Streets are integrated into the Project Statement.

As the project advances to Concept Development, a multi-disciplinary group of SMEs should continue to be involved to define the purpose and need so that it appropriately identifies the needs of all modes. Defining the needs of all users at this first step helps mitigate the potential for changes in scope at later phases. With a clear definition of the project purpose and need in place, the project team can develop integrated, multi-modal design alternatives that fit the context and address the needs of all users.

NJDOT's use of Complete Streets checklists also helps integrate Complete Streets principles into the capital project delivery process. Required for every project, these checklists help project managers evaluate the context of the project area and assess and understand the needs of different travel modes, ensuring the needs of all users are appropriately addressed as the project moves through design.

Ultimately, the Complete Streets checklist is one of many methods to achieve better integration of Complete Streets designs into project delivery. The primary consideration for any project at its inception should be how the project meets the community's needs and fits its context. This will help ensure that Complete Streets designs are more than just a series of elements but are part of an approach to create a project that best meets the needs of the local community.

Developing Complete Networks

Implementation of Complete Streets is not a uniform, one-size fits all process. Project needs and appropriate design treatments are driven by the unique context of each street and each community; therefore, each street may look slightly different depending on its function, surrounding land uses and development character, the needs and desires of the community it serves, and design constraints. Taking a network-based approach


Passaic County, NJ

to Complete Streets allows planners and engineers greater flexibility to work within project constraints. For example, in areas with space constraints and limited public right-of-way, it may not be feasible to adequately accommodate all users on all streets.

By viewing a street as part of a larger network, planners and engineers can identify parallel streets where a different balance of transportation modes helps provide mobility for all users and improve overall network efficiency. Effectively implementing the network approach requires coordination among local, county, and state jurisdictions in order develop a network plan, define the role of each street, and create appropriate accommodations for each mode.

Working with Limited Scope Projects

Limited scope projects provide a mechanism for NJDOT to effectively address deficiencies and extend the functional and structural life of the Department's assets. Unlike full-scope projects, limited scope projects do not have a preliminary engineering phase, creating a more streamlined project delivery process that supports quicker implementation. Limited scope projects include pavement resurfacing, bridge deck/superstructure replacement, sign structure installation, and drainage improvements, among others. These projects are typically limited to the exiting curb-to-curb width and by definition do not involve permitting, right-of-way, or utility impacts.

Limited scope projects require a different approach. The Complete Streets checklists used in the full scope projects are not applicable to limited scope projects due to the more focused issues and needs being addressed, tighter timeline, and spatial constraints. To fill this gap

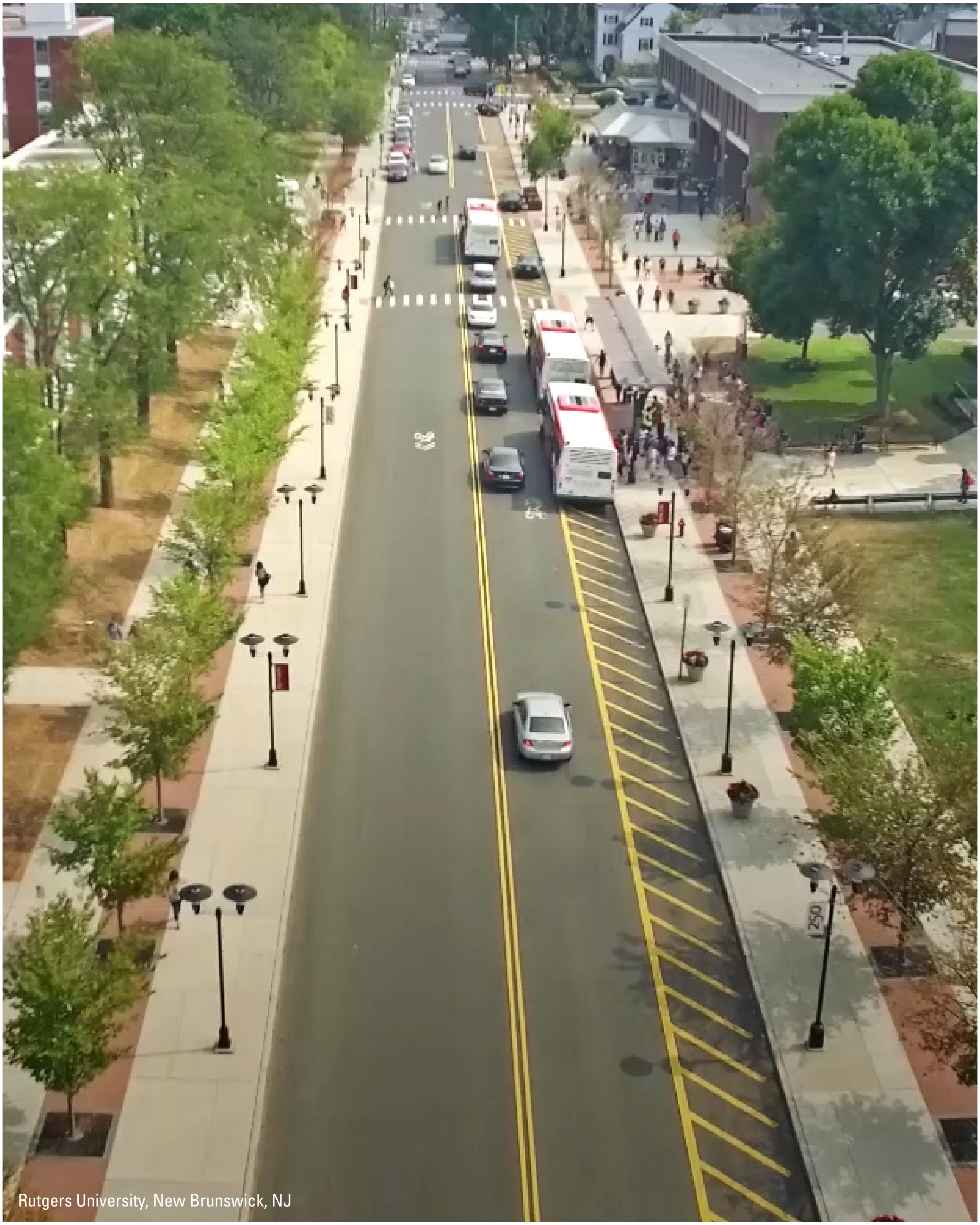
in the Complete Streets implementation process, a variation of the Complete Streets checklist should be developed that accommodates the unique needs and constraints of the limited scope project delivery process.

The refined checklist can still achieve Completes Streets goals, but within a more limited scope. It can help the project team identify opportunities for simple multi-modal improvements that do not impact the schedule or constraints of limited scope projects. This could include repairs to existing, deteriorating sections of sidewalk or incorporating bicycle lane projects into repaving projects.

A Complete Streets checklist for limited scope projects can also be used to identify additional project needs that can only be addressed outside of that project. These projects can be advanced through a new Problem Statement and graduate to the full-scope project delivery process, or broken out as separate, smaller projects with their own individual problem statements and advanced through the capital project delivery process.

Integrating with the NJDOT Project Prioritization Process

NJDOT's project prioritization process is driven largely by management systems data and quantitative information. Existing metrics capture many needs related to automobile travel. In order to incorporate the needs of pedestrians and bicyclists and associated projects into the project prioritization process, metrics for these modes should also be developed. These metrics might reflect safety issues or potential demand for improved bicycle or pedestrian access. Coordination with NJ TRANSIT can also incorporate the needs of transit riders into the process. The location of transit stops or bus routes, for example, may be factors in the prioritization of pedestrian or roadway improvements, respectively.



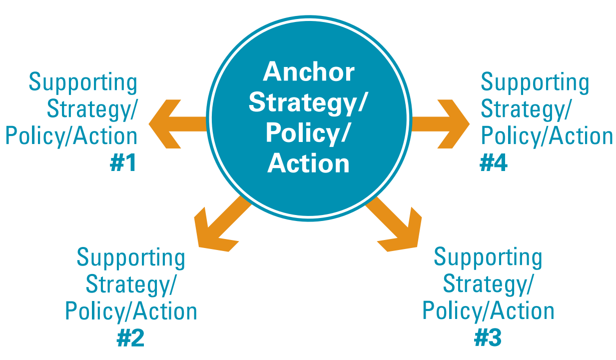
Rutgers University, New Brunswick, NJ

Implementing Complete Streets in Your Local Community

Implementation: There is No Silver Bullet!

Many communities interested in or actively trying to implement Complete Streets want to know: "What is the best or most effective action we can take to make our streets complete?" The answer is that there isn't any one action or policy that can fix every problem or even effectively change the status quo. Everything starts with context and the unique needs of the community. A multi-pronged strategy ensures effective and systematic implementation of Complete Streets. The strategies discussed in this section can be used to create a connected and coordinated effort to implement Complete Streets.

If it seems overwhelming to consider the many actions that need to be taken to do this, consider developing an anchor strategy or policy, and coordinating other strategies and policies around that anchor. For example, this anchor strategy can be the adoption of a Complete Street Policy, an update to a Comprehensive Plan, or both.



Crafting an Effective Complete Streets Policy

An effective Complete Streets policy lays the foundation for the implementation process. Policy adoption formally acknowledges the benefits and importance of planning, designing, and maintaining a street network that balances the needs of all users and all modes. It marks an institutional shift in how the state, county, municipality, or other entity views its streets and integrates and codifies Complete Streets principles into daily business and operations.

A strong and effective Complete Streets policy has six key elements:

- Statement of purpose and intent, describing the goals, visions, and desired outcome of the policy
- Definition of users and modes, stipulating whose needs are to be considered in the implementation of Complete Streets
- Stipulation of the types of improvements covered by the policy
- Reference to design standards that will be followed when implementing the policy
- Definition of the exemptions process, clearly identifying legitimate instances when the policy would not be applied
- Implementation plan to provide guidance on how the plan will be put into practice

Additional guidance on creating and adopting a Complete Streets policy, including a model policy template, can be found in NJDOT's *Making Complete Streets a Reality: A Guide to Policy Development*.

Beyond the Policy: Integrating Complete Streets into the Planning and Design Process

The adoption of a Complete Streets policy is intended to ensure that future street projects consider the needs of all travelers, regardless of age, ability, or mode of transportation. But what happens after a policy is adopted? The transportation planning process can be complex, and existing procedures are reflective of an entrenched method of doing business. Because of this, implementation of a Complete Streets policy can often be very difficult in many communities. Three key actions should be considered in order to achieve more effective and consistent implementation of the Complete Streets policy:

I. Change the way decisions are made

II. Involve stakeholders and members of the community

III. Redefine how you measure success

I. Change the Way Decisions are Made

Complete Streets is a process, not a specific product. Complete Streets provides an approach to identifying, analyzing, and developing solutions to transportation issues. Changing the everyday processes that guide decision-making lies at the heart of successful Complete Streets initiatives. While changing these processes can be challenging, it is essential to successful implementation.

The following are strategies to help integrate Complete Streets into the decision-making process:

- Develop a Complete Streets Checklist
- Integrate it into the Comprehensive Plan and Zoning
- Align Plans, Programs, and Funding
- Create a Formal Implementation Plan
- Review and Update Roadway Design Guidance

Cost

One of the biggest roadblocks to implementing Complete Streets is often concerns over added costs. There are a variety of ways to address these concerns that differ based on context and need. The National Complete Streets Coalition has developed *Complete Streets: Guide to Answering the Costs Questions* to assist planners, engineers, and other practitioners.

This guide can be found at http://www.smartgrowthamerica.org/documents/cs/resources/cs-answering-the-costs-question.pdf

Develop a Complete Streets Checklist

A Complete Streets Checklist is intended to ensure that projects comply with the Complete Streets policy. Development and implementation of a checklist should be included as a requirement of the policy. The Complete Streets Checklist reinforces the policy by formalizing a multimodal approach to roadway planning, design, and construction. It assists planners and engineers in evaluating the current and future functions of a street, the needs of all users of the street, the street's context, and existing conditions and facilities for all modes.

The Complete Streets Checklist should be used during the Concept Development and Preliminary Engineering phases to ensure that the developed alternatives comply with the policy. NJDOT's checklists are available online (www.state.nj.us/transportation/eng/completestreets/implementation.shtm) and additional examples are available through the National Complete Streets Coalition (www.smartgrowthamerica.org/complete-streets). Any checklist should include a list of design elements to be addressed, a place to indicate whether the element was included, and a description of how it was included or, if there was an exemption, why this exemption was made. The checklist should be signed off by the project manager.

Integrate it into the Comprehensive Plan and Zoning

A Comprehensive Plan represents and outlines the goals and priorities of a community. Integrating Complete Streets into the Comprehensive Plan is an absolutely essential step for implementation. Most traditional master plans include a Circulation Element, which often focuses almost exclusively on vehicular circulation. The Comprehensive Plan should be updated to reflect the goals of the Complete Streets policy. This includes taking a more comprehensive approach to the transportation element. The Town of Morristown did this when it updated its Comprehensive Plan in 2014, replacing the Circulation Element with a Mobility Element. This updated section included detailed goals, objectives, and strategies for achieving more livable streets. The plan also coordinated the Land Use and Mobility Elements to more accurately and effectively address this important relationship.

Zoning ordinances and building codes should also be updated to reflect the needs of all roadway users. The purpose of this is to ensure that new developments, parks, and other facilities are built, retrofitted, or maintained in such a way that integrates Complete Streets and the overarching goals of the community. For example, where site planning and design standards stipulate requirements for vehicle parking and vehicular access, provisions should also be required for bicycle parking and bicycle and pedestrian access. The development review process ensures that these standards are adhered to, Complete Streets principles are followed, and accommodations for all users are included in new infrastructure.

Align Plans, Programs, and Funding

Complete Streets integration does not stop with the Comprehensive Plan. All guiding documents of a community should be aligned and coordinated—including those focusing on bicycle and pedestrian mobility, the Comprehensive Plan, and, importantly, the Transportation Improvement Plan, which guides funding priorities. Complete Streets priorities should also be integrated into other plans, including housing, recreation, and redevelopment plans, as well as any other guiding documents that influence how things are built or maintained.

Vision Zero

Vision Zero is a road safety policy developed in Sweden in the mid-1990s. The guiding principle of this policy is that no traffic-related deaths are acceptable and that safety should be the top priority of the transportation system. Many cities in the United States have adopted Vision Zero policies, setting goals and strategies for achieving zero traffic-related fatalities. Common strategies for achieving the goals of Vision Zero include lowering travel speeds through design and lower speed limits, increasing penalties for reckless driving, and implementing many of the other strategies found in this guide. Vision Zero is based on the principle that traffic fatalities are preventable and not inevitable and it is the responsibility not only of roadway users but also designers and engineers to prevent these unnecessary tragedies.

Further Guidance

More information on the Vision Zero initiative can be found at http://www.visionzeroinitiative.com/

Create a Formal Implementation Plan

An implementation plan is an effective tool that can maintain momentum generated during policy development and formalize a process for implementation of Complete Streets. The creation of an implementation plan should involve staff and decision makers who are involved in the planning, design, construction, and maintenance of the jurisdiction's streets. This may include planners, engineers, maintenance and public works staff, and other key stakeholders. An implementation plan provides an opportunity to assess current decision-making practices; review relevant documents (including subdivision codes, design guidance, checklists, decision trees, etc.); and to assign responsibility and timelines for integrating Complete Streets into those existing documents and procedures.

An implementation plan should include:

- An assessment of the street design process, transportation infrastructure, and network gaps
- Guidance on street design, including standards, best practices, and an evaluation of how street users are served by different design elements
- Complete Streets Checklist

There are many good examples of Complete Streets implementation plans available. The National Complete Streets Coalition has recommended the following as model examples for Complete Streets implementation plans:

- California Department of Transportation: *Complete Streets Implementation Action Plan*
- Minnesota Department of Transportation: *Complete Streets Implementation Work Plan*
- Vermont Agency of Transportation: *Complete Streets Guidance Document*
- Saint Paul, Minnesota: *Complete Street Plan*

In New Jersey, Essex County developed its Complete Streets Implementation Action Plan in 2014. This plan focuses on the transportation planning process and the process for applying the Complete Streets Checklist. The City of Newark developed its Complete Streets Design Guidelines and Implementation Plan in 2016, which focuses on providing street design guidance and the Complete Streets Checklist. The Borough of Chatham adopted its Complete Streets Policy Plan in 2012 along with its Complete Streets policy. The plan includes a Complete Streets Checklist; performance measures for evaluating implementation; guidelines on street design elements to retrofit the municipal street network with Complete Streets in mind; and information on education, public involvement, and funding strategies and resources to support implementation. These guides are good local examples of implementation plans that fit the needs of different-sized jurisdictions.

How to Prioritize Project Funding

The National Cooperative Highway Research Program (NCHRP) Report 803 presents the "ActiveTrans Priority Tool (APT)," a step-by-step methodology for prioritizing improvements to pedestrian and bicycle facilities, either separately or together as part of a "Complete Streets" evaluation approach. The methodology is flexible, allowing the user to assign goals and values that reflect those of the agency and the community. It is also transparent, breaking down the process into a series of discrete steps that can be easily documented and communicated to the public.

The report is useful to planners and other staff responsible for the most effective allocation of scarce resources to where they will provide the most benefit. The report can be found at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_803.pdf

Review and Update Roadway Design Guidance

An outdated design manual is often the most significant barrier to implementing Complete Streets. In many jurisdictions, the highway design manual is the go-to reference for all transportation projects. Some common strategies that are often used to overcome outdated or automobile-focused design guidance includes:

- Writing or rewriting street design guidelines
- Choosing existing guidance documents that reflect national best practices
- Adopting NACTO or similar design guidance
- Updating subdivision and zoning codes

Developing a community-specific design manual might be appropriate for some communities. The process of writing design guidelines can become an educational process for all involved, helping local officials and staff better understand the needs of their community. Many innovative design manuals go beyond traditional roadway functional classifications to create new street typologies based on surrounding land-use context. This sort of approach can help local planners and engineers better understand context and design need.

Writing a design manual is not necessary for many communities and may not be feasible. A variety of national and state design resources are already available that local municipalities can apply to achieve desired outcomes on a given street. Chapter 3 of this design guide provides guidance on best practices for a variety of design elements and focus areas, as well as suggested resources for further guidance. This guide, along with the guides listed below, should be considered acceptable design guidance and applied where appropriate:

- *A Policy on Geometric Design of Highways and Streets*, 6th Edition, AASHTO
- *Guide for the Development of Bicycle Facilities*, 4th Edition, AASHTO
- *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, 1st Edition, AASHTO
- *Manual on Uniform Traffic Control Devices*, FHWA
- *Bicycle Facilities and the Manual on Uniform Traffic Control Devices*, FHWA
- *Separated Bike Lane Planning and Design Guide*, FHWA
- *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts*, FHWA
- *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice*, ITE
- *Public Rights of Way Accessibility Guidelines*, U.S. Access Board
- *Urban Bikeway Design Guide*, National Association of City Transportation Officials
- *Urban Street Design Guide*, National Association of City Transportation Officials
- *Transit Street Design Guide*, National Association of City Transportation Officials

Do We Need to Write a Design Manual?

Many communities assume that they must re-write their design manuals; however, such re-writes can be expensive and time-consuming. Ultimately, determining exact design specifications is less important than achieving clarity in how design decisions are made. Focus should be given to introducing more flexibility in design practices than might already be in place. No design manual can be completely applicable to each unique situation or challenge, and there are often multiple design options and design tools to achieve the same goal for a street.

II. Involve Stakeholders and Members of the Community

Decisions about transportation and other public works projects are guided by public input and feedback from different community stakeholder groups. A lack of broad support can hinder or obstruct Complete Streets implementation. The key to this challenge is to formalize an inclusive decision-making process. In many communities, Complete Streets projects become derailed or delayed by silos within and between different agencies. Often a project will even make it far along in the process before running up against opposition from a key decision maker or stakeholder. It is of utmost importance to create an inclusive process involving decision makers and stakeholders at the outset of a project, conduct outreach to these groups on the overall and continuing goals and benefits of Complete Streets, and explain how a specific project fits into the larger network and needs of the community.

The following are a few methods that have proven successful in involving the community in the decision-making process and building support for Complete Streets:

- Complete Streets Committee
- Workshops
- Road Safety Audits
- Education and Training
- Advocates, Volunteers, and Community Action
- Engage the Creative Community

Complete Streets Committee

One common method for formalizing an inclusive implementation process is the establishment of a Complete Streets Committee. The intention of this Committee is to involve relevant stakeholders throughout the entire transportation planning and decision-making process and achieve more buy-in, support, and coordination between various actors. A Complete Streets Committee should be comprised of representatives and officials from various local agencies, including planning, engineering, police, fire, public works, elected officials, and other stakeholders and decision makers. While it may include several members who participate on a voluntary basis, a Complete Streets Committee should not be a purely volunteer committee. Participants should include those who are directly involved in the transportation planning process and have the authority to make decisions. The Complete Streets Committee should be directly involved in the preparation and review of requests for proposals, review of roadway projects, and ensure that the Complete Streets checklist is appropriately administered. If an exemption was made to the Complete Streets policy, the Committee should document how and why this occurred.

Workshops

Workshops provide a forum to both educate and collect input from the general public, decision makers, and/or project stakeholders. Conducting workshops throughout the life cycle of a project is an effective tool for:

- Developing plans that are reflective of community needs
- Demonstrating an open process and support for plan outcomes
- Involving decision makers, stakeholders, and other contributors in an on-going process

Workshops may serve several purposes and be structured in different formats. Some workshops are primarily an educational tool to share information on best practices for design or on the benefits and implementation of Complete Streets, such as NJDOT's Complete Streets workshop series. Other workshops may include a design charrette or field walk of the project area, which allows stakeholders to view and assess the project area firsthand; collaborate and share ideas with the project team, other stakeholders, and decision makers; brainstorm potential design solutions; and provide input on design concepts developed by the project team.

Workshops might not be appropriate for every project or community. An extensive public involvement process that is conducted in conjunction with the development of a redevelopment plan, bicycle and/or pedestrian plan, or other Complete Streets planning document can also demonstrate community input and support for future initiatives. Regardless of the size or context of the project, workshops provide an opportunity to communicate directly with those who have influence on or interest in a project.

Road Safety Audits

A road safety audit is a community-driven process that can generate momentum and support for action. It provides an opportunity for a diverse group of decision makers and stakeholders to jointly visit a problem spot or corridor and assess existing conditions. A checklist is often used during the audit for participants to keep track of problem areas, deficient or missing infrastructure, and other observations. The audit is an effective educational and outreach tool. Participants are given the opportunity to not only observe deficiencies, but understand why it might be imperative to take action. It is a collaborative process that helps participants and decision makers see and experience the problem spot or corridor from the perspective of other participants, revealing issues they might not otherwise detect.

The end product of an audit is data and information that documents existing deficiencies and the participation of a wide cross-section of stakeholders. This information can help document project need and build consensus and support for action.

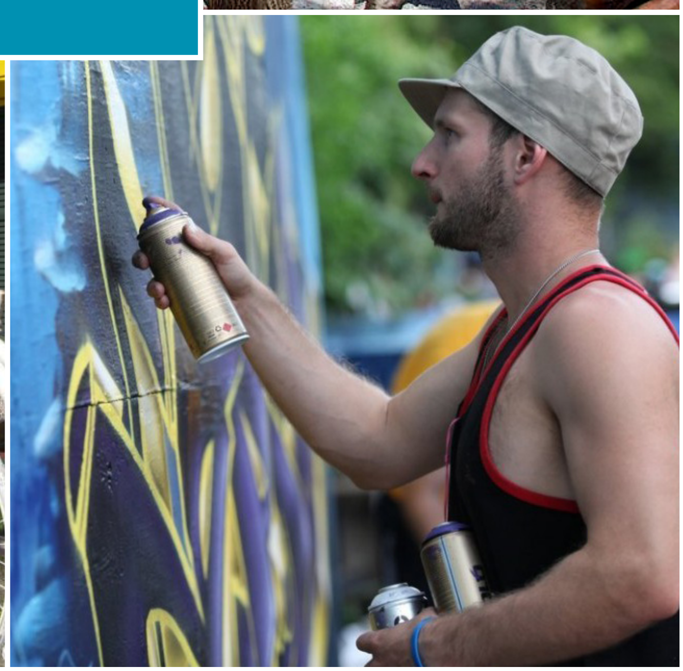
Photos (clockwise)

“Montclair Community Street Quilt” project in Montclair, NJ (photo credit: Project for Public Spaces)

Parklet in Princeton, NJ

Trenton “Fresh Jam” in Trenton, NJ (photo credit: nj.com)

Creative “Bike Fence” in Lambertville, NJ



Education and Training

Education is an extremely important component of a successful Complete Streets program. Planners, engineers, consultants, decision makers and agencies need a thorough understanding of new procedures. Officials should receive on-going education to understand the community benefits of Complete Streets and how the general Complete Streets goals will be translated into built projects. Educating the public about design options they can consider to improve or transform their streets, as well as how changes to their streets fit into the larger street network and impact and benefit the community as a whole, is essential for successful implementation. Common education strategies include, but are not limited to, the following activities:

- Host Complete Streets workshops for staff and consultants, with auxiliary sessions for community leaders and the public
- Take advantage of professional development training opportunities and webinars offered by NJDOT, Metropolitan Planning Organizations, professional organizations, and transportation non-profits
- Provide on-the-job training for staff, including informal and interdepartmental activities such as brown bag lunch presentations
- Lead walking audits and bicycle rides for decision-makers, staff, and the public
- Engage the community through formal public engagement activities and project-based meetings

Advocates, Volunteers, and Community Action

Interested residents and stakeholders are effective allies in building community support for a project and advocating with decision makers. Working with these stakeholders and involving them throughout the process can help advance a project more quickly and efficiently. On smaller-scale projects, such as minor park improvements or trail projects, advocates and volunteers can also assist with implementation. They may be able to provide private funding resources to support construction or volunteer labor to reduce project costs.

Engage the Creative Community

Good streets are the outdoor living room for many communities. Engaging the creativity and passion of a community can enliven streets and give residents a sense of ownership and pride. There are many examples throughout New Jersey where residents have transformed their community through collective creativity and action. In Princeton, a parklet along Witherspoon Street was designed and built by local artists in conjunction with the Princeton Arts Council and the mayor. In Montclair, a neighborhood came together to help improve safety by creating the "Montclair Community Street Quilt," a patchwork of painted intersections throughout the community. From artist built parklets, to painted intersections, to art along trails, to painted trash bins, to building murals, a community can create unique and exciting places in many different ways.

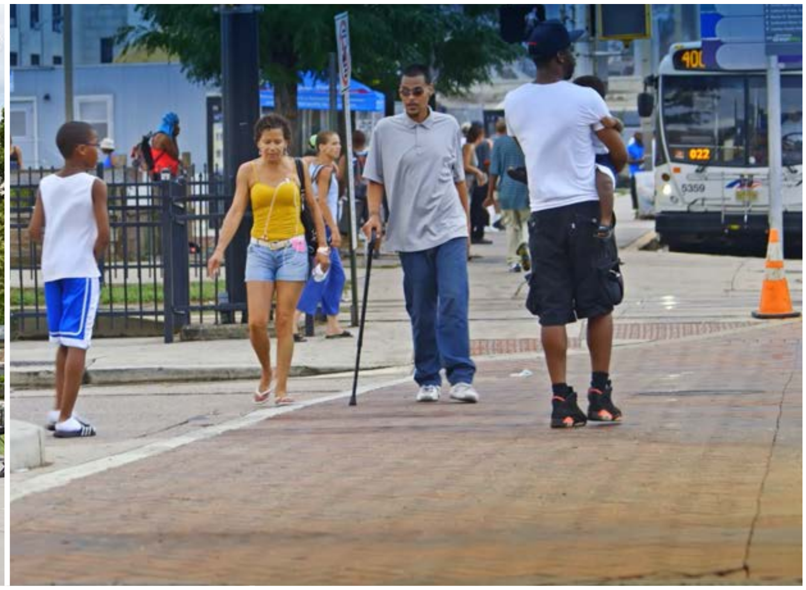
Further Guidance

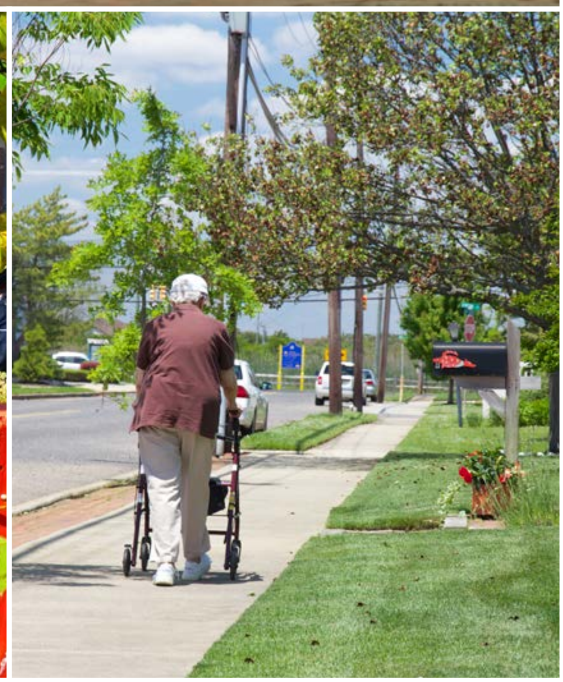
ArtPride New Jersey—ArtPride New Jersey advances, promotes, and advocates for the arts as essential to the quality of life of every citizen and to the economic vitality of New Jersey.

Creative New Jersey—Creative New Jersey is dedicated to fostering creativity, innovation, and sustainability by empowering cross-sector partnerships in commerce, education, philanthropy, government, and culture in order to ensure dynamic communities and a thriving economy.

The National Consortium for Creative Placemaking—The National Consortium for Creative Placemaking is led by a national steering committee that includes leaders from a wide variety of organizations in the fields of arts, community, and economic development and is dedicated to building the capacity of artists, public officials, citizen activists, planners, researchers, and everyone who seeks to achieve high-quality creative placemaking.

Project for Public Spaces—Project for Public Spaces is a nonprofit planning, design, and educational organization dedicated to helping people create and sustain public spaces that build stronger communities.





Photos (clockwise)

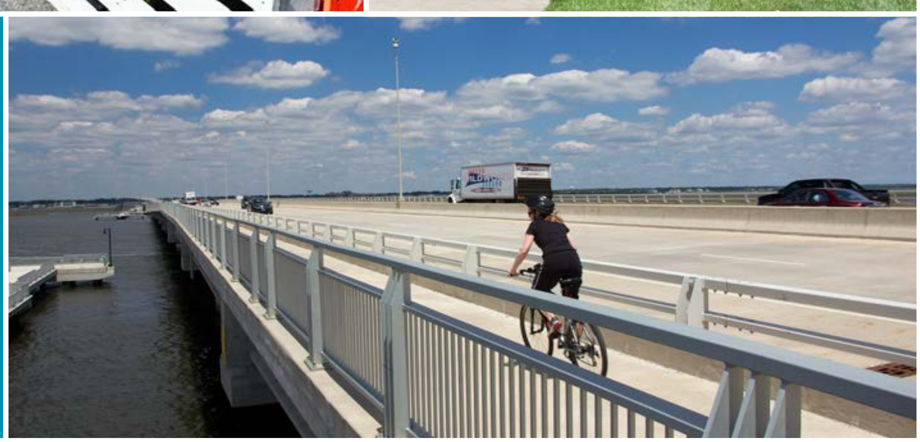
Military Park, Newark, NJ

Camden, NJ

Ocean City, NJ

NJ Route 52 Bridge, Ocean City, NJ

"Parking Day", New Brunswick, NJ



III. Redefine How You Measure Success

Creating new ways to measure success for transportation projects, and of the transportation system as a whole, is essential to not only ensure that projects are on the right track but that future Complete Streets investments are made based on this success. While traditional performance measures tend to focus primarily on vehicle throughput (level of service), an updated metric might look at crash reduction, reduced vehicle miles traveled, or shifts in mode share to walking, biking, and/or transit trips as measures of success. Common activities to measure success include:

- Count the number of new or repaired facilities each year (e.g., blocks of sidewalks)
- Track crashes and injuries for all types of roadway users
- Track use of street facilities by different modes (e.g., number of people walking)
- Conduct project-level "before" and "after" studies

A Complete Streets approach means shifting the focus of transportation projects from being concerned primarily with vehicle flow to a broader view of all current and potential users of a street and how the function of a street influences is influenced by surrounding land uses, economic factors, and travel behavior. Performance measures should be established that reflect and therefore incentivize taking this broader view. For example, the City of San Francisco has switched from using level of service to measure project success to using reduction in vehicle miles traveled. This switch changes the focus of future improvement projects from improving traffic by maximizing vehicle throughput to improving traffic by reducing private automobile use.

A Complete Streets approach also means thinking beyond the street itself and how the community as a whole functions. Metrics that are not directly tied to transportation can therefore be used to measure the success of a project. Potential indicators include:

- Stakeholder satisfaction (e.g., user and resident feedback)
- Public health (childhood obesity, diabetes)
- Economic vitality (sales tax revenue, property values)
- Environmental benefits (e.g., trees planted, reduction in impervious cover, decrease in stormwater flow into street sewer system)

Winning Funding

A well-defined process can improve success for winning grants and other available funding sources.

Identify Potential Funding Sources

Demonstrate Planning Process

Leverage Funding Opportunities

Demonstrate Local Consensus

New Brunswick, NJ

03

Complete Streets Toolbox

Policy and Design Guidance for Implementing Complete Streets

This chapter describes the building blocks that make up a street and how they work together to transform our streets into vibrant places and activity centers. The operation, look, and feel of a street are the product of a series of design decisions for each street element, as well as considerations about how those elements relate to each other.

The toolbox is organized into three sections that reflect the primary physical spaces of a street network:

- SIDEWALKS
- ROADWAYS
- INTERSECTIONS

Within each area of the street network, a myriad of treatments are available to planners, engineers, and designers. The toolbox provides a primer on common design treatments and their typical applications, design considerations, and how they impact different modes.

Sidewalks should be part of a continuous network and connected with crosswalks at roadway intersections. They should be safe, comfortable, and attractive facilities that provide accommodations for people of all ages and abilities.

Madison, NJ

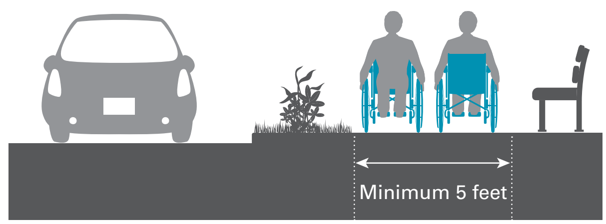
SIDEWALKS

Sidewalks are an extension of the street system. They are the primary conduit for pedestrian travel and fundamental to facilitating residential, commercial, and social activity in urban, suburban, and rural communities. Sidewalks provide access between buildings and provide space for dynamic street life. Sidewalks, particularly in commercial and downtown areas, form the foundation for a vibrant community. Lively sidewalks are venues for people to participate in face-to-face activities and support businesses. Sidewalks should be part of a continuous network and connected with crosswalks at roadway intersections. They should be safe, comfortable, and attractive facilities that provide accommodations for people of all ages and abilities.

The choice of sidewalk form, material, and width is determined by its context, surrounding density, mix of activities, and travel needs. While ubiquitous in urban environments, sidewalks in rural areas are less common, often more informal and fragmented, and serve a specific function, such as linking neighborhoods to a school or village center.

Sidewalk Widths

ADA standards specify a minimum **5-foot clear path width** to accommodate two wheelchairs passing each other. In addition to providing a more accessible facility, this minimum width also creates a more comfortable environment for pedestrians to walk side-by-side and pass each other, and for families with strollers.



Sidewalks should be constructed as wide as possible to accommodate foot traffic and improve pedestrian comfort, given available street right-of-way. Sidewalk width should support the surrounding street context, land uses, and current and future pedestrian demand—the greater the density, demand, and mix of activities, the wider the sidewalks should be. Downtown and commercial areas, for example, generally require wider sidewalks. No existing sidewalk should be reduced in width in the course of street widening projects. Opportunities for widening sidewalks and narrowing cartway width should always be considered whenever roads are reconstructed.

Sidewalks

The sidewalk is the basic unit of mobility within our transportation system. Every sidewalk should be accessible and well maintained. In order to maintain accessibility, a sidewalk must be:

- Accessible by ALL users
- Adequate width
- Safe to use
- Continuous and connected

PEDESTRIAN ZONE

The pedestrian zone is the area of the sidewalk that is reserved for pedestrian travel. This area should be free of all obstacles, protruding objects, or vertical obstructions. The pedestrian zone should be at least 6 to 10 feet wide in high pedestrian volume areas, which allows pedestrians to walk side by side or pass one another. The pedestrian zone should never be less than 4 feet wide, which is the minimum width required for people using a guide dog, crutches, and walkers. Wheelchair users need about 4 feet to turn around or 5 feet to pass another wheelchair. If a pedestrian zone is 4 feet wide, additional space should be provided to allow passing at intervals no greater than 200 feet.

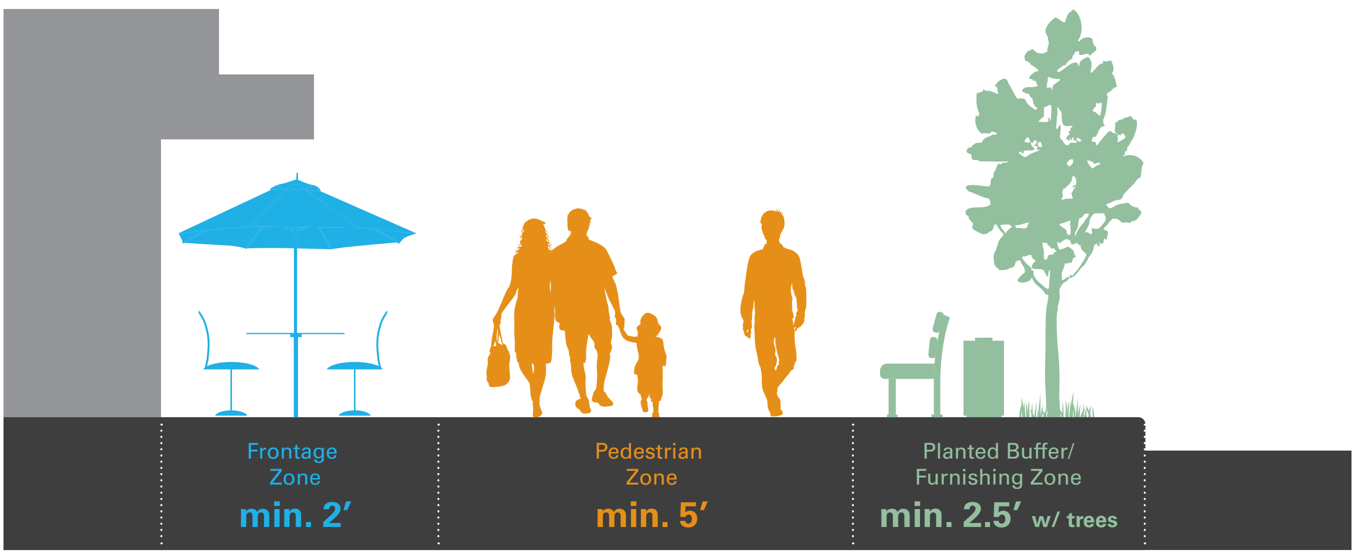
Montclair, NJ

Sidewalk Zones

The primary objective in designing sidewalks is to provide continuous, safe, and accessible pathways for pedestrians. Sidewalks should be designed to follow as much as possible the natural path of travel. In some cases, it is more desirable for a sidewalk to divert from that path to provide a more adequate facility or a greater degree of separation between the sidewalk and the roadway.

Design Guidance

Many reference guides describe the sidewalk as having three distinct elements or functions: the **Frontage Zone**, the **Pedestrian Zone**, and the **Planted Buffer/Furnishing Zone**. Given the diversity of contexts throughout New Jersey, the needs and therefore design standards differ greatly around the state.



Frontage Zone

In locations where buildings are adjacent to the sidewalk, the frontage zone provides a buffer between passing pedestrians and opening doors and other architectural elements. The frontage zone keeps the pedestrian zone safe and clear of obstacles and obstructions.

Pedestrian Zone

The pedestrian zone is the area of the sidewalk that is intended specifically for pedestrian travel. The pedestrian zone should be free of any physical obstructions, including street furniture, plantings, and surface utilities. The quality of the sidewalk surface in the pedestrian zone is extremely important and must meet accessibility standards referenced on page 34. The material should be smooth, level, and have minimal gaps or rough surfaces.

Planted Buffer/Furnishing Zone

Where there is sufficient space, a planted buffer/furnishing zone should be established to delineate space for objects that would otherwise obstruct pedestrian movement, as well as provide a buffer for pedestrians from the adjacent roadway. This zone is where street trees, stormwater elements, street lights, signage, hydrants, benches, trash and recycling receptacles, parking meters, signal and lighting control boxes, utility poles, and other potential obstructions should be located.

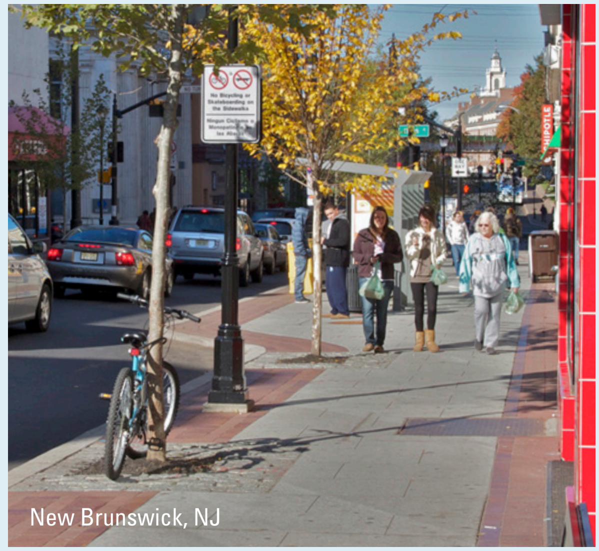
Sidewalk Context and Width

The desired width of the various sidewalk zones depends on the context of the facility. In many contexts in New Jersey, a sidewalk is not adjacent to a building and therefore does not require a "frontage zone." However, where there are utilities or furnishing elements on a sidewalk, they should always be placed out of the pedestrian zone.

Where the sidewalk zones do exist, they should adhere to the following minimums:

- Frontage zone—**min 2 feet**
- Pedestrian zone—**min 5 feet**
- Planted buffer/furnishing zone—**2.5 feet (with trees)**

The above dimensions are recommended minimums. In many contexts, sidewalks require greater width to accommodate all users. In locations with high pedestrian volumes, sidewalk widths of **8 feet or greater** should be considered. The examples to the right demonstrate well designed sidewalks in a variety of contexts.



New Brunswick, NJ

Morristown, NJ

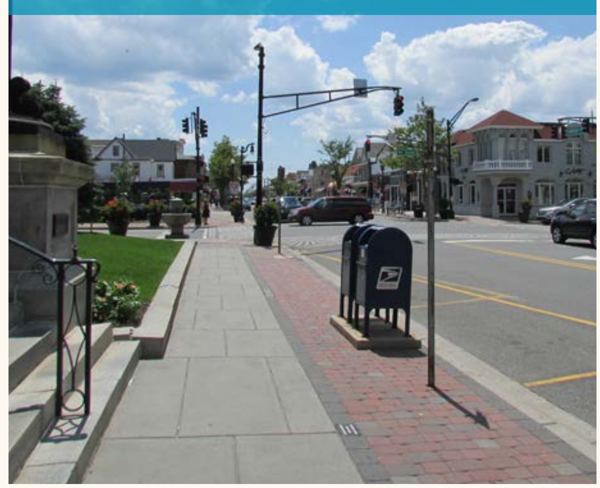
Surface Materials

The choice of surface materials for sidewalks, plazas, or other spaces where pedestrians walk can have a significant impact on accessibility. Sidewalk materials generally consist of concrete or asphalt; however, tile, stone, and brick are also frequently used. Although these materials provide an aesthetic benefit, they can lead to grooves or odd spacing that can catch wheelchair castors or create a tripping hazard for pedestrians, especially those with vision or mobility disabilities. Decorative surfaces may also create a vibrating, bumpy ride that can be uncomfortable or painful for those in wheelchairs.

- Brick or cobblestone are not recommended surface materials for the pedestrian zone. Creative alternatives include using these materials as trim or decorative elements in the furnishing zone or using colored concrete.
- Surface materials should be slip resistant. A broom finish on concrete can help increase slip resistance.
- Causes of vertical rises in texture include:
  - Tree roots pushing upward
  - Uneven transitions from street to gutter to ramp
  - Heaving or settling due to frost
  - Buckling due to improper sub-base preparation
- Surface texture should not include more than a ¼-inch rise for every 30 inches.
- A ¼ to ½ -inch rise should be beveled with a maximum grade of 50 percent.
- If there is a greater than ½-inch rise, the surface should be leveled or a ramp should be installed with a maximum grade of 8.3 percent.

While materials such as slate (as shown here) or cobblestone are aesthetically appealing, they can lead to tripping hazards, becomes slippery when wet, and/or impede mobility for those using a wheelchair.

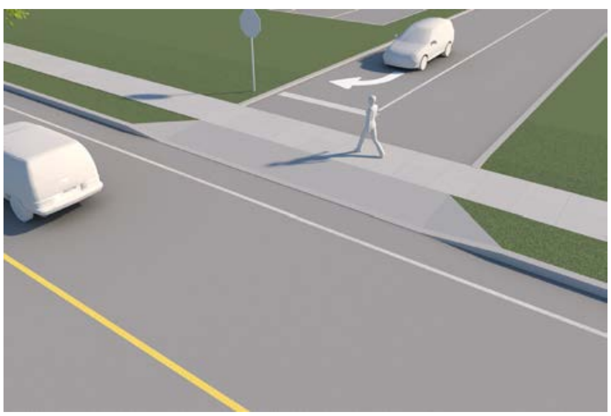
A preferred treatment (shown in this photo from Ocean City, NJ) is to provide a level concrete pedestrian zone and use brick as a decorative treatment in the furnishing zone.



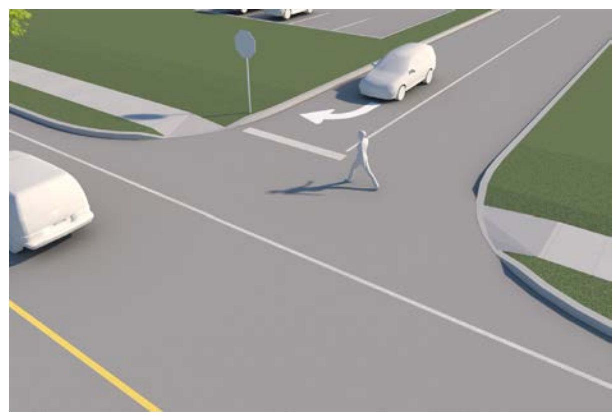
Driveways

Drivers must yield to pedestrians, and proper driveway design should reinforce, not hinder, this hierarchy. The design of driveways should provide a continuous and level pedestrian zone across the vehicular path, encouraging drivers to stop for pedestrians on the sidewalk. Driveways should not be designed as intersections, where the sidewalk is interrupted by the driveway. The public sidewalk has the right-of-way over private crossings. Pedestrians are the vulnerable user in their relationship with motor vehicles. As with other types of intersections and crossings where pedestrians must interact with motor vehicles, design should make pedestrian right-of-way clear and obvious to motorists.

Driveway—Good



Driveway—Bad



Driveways should be designed for continuous and level pedestrian passage. Proper driveway design, such as in the above left, increases the visibility of pedestrians, encouraging drivers to stop. Driveways designed as intersections, such as in the above right, feature an interrupted crosswalk. This can reduce pedestrian visibility and increase the likelihood that drivers will not stop for pedestrians.

Slope

Steep grades and cross slops can be hazardous for all users but particularly those with limited mobility. Both powered and manual wheelchairs can become unstable or difficult to control on sloped surfaces. Sidewalk design should avoid steep grades and cross slopes where possible.

GRADE

While grades are often difficult to control along the sidewalk because of environmental factors, designers should make every effort to provide as level a surface as possible.

- Sidewalk grade should not exceed 5 percent.
- Building ramps permit a maximum rise of 30 inches for each run, with a maximum slope of 8.3 percent. Where exceeded, a level landing should be provided. The level landing should not exceed 2 percent in any direction. Landings should be at least 5 feet by 5 feet to allow wheelchair users to stop without blocking pedestrians.

CROSS SLOPE

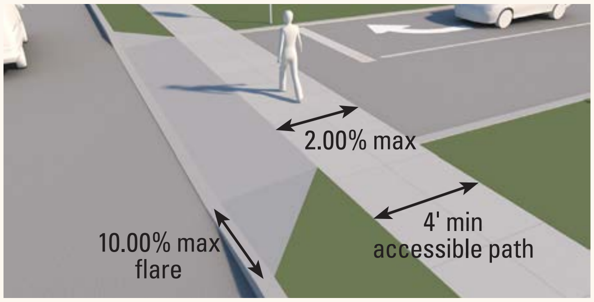
Severe cross slopes require wheelchair users and other pedestrians to work against gravity to maintain their balance and can cause wheelchair users to veer toward the curb and onto the street.

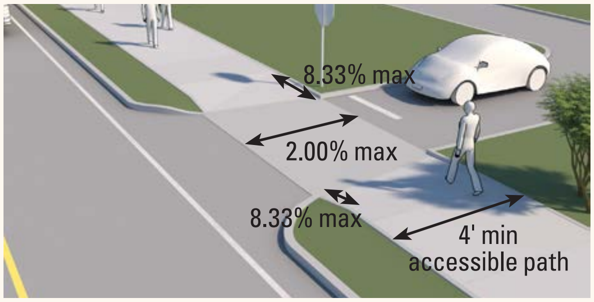
- The maximum cross slope permitted by ADA Accessibility Guidelines (ADAAG) is 2 percent.
- For sidewalks with steep cross slops, designers can create a level area of at least 3 feet within the pedestrian zone OR increase the height of the curb (which might require more complex curb ramp design).
- Cross slope is often an issue where driveways are built into the sidewalk.

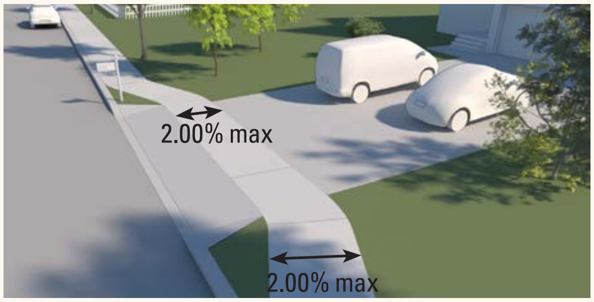
DRIVEWAYS

Driveways that intersect with a sidewalk must be designed to not compromise good pedestrian design practice. Pedestrians using wheelchairs and other walking aids can be put at risk of becoming unstable and falling because of poorly designed driveways. According to ADAAG, driveways should be designed with the following guidance:

- Cross slope should not exceed 2 percent.
- Changes in level or grade should be flush with a ¼-inch maximum gap in surface rise.
- The slope of the driveway apron flare should not exceed 10 percent.







Street Trees

Trees, shrubs, and other landscape plantings play an important role in making a street complete. Tree canopies can help make a street comfortable and sustainable, help to define the character of the street and provide shade, act as a buffer from traffic, reduce the heat island effect and energy consumption, and help to absorb and cleanse stormwater. Trees and other landscape plantings also absorb greenhouse gases and help filter airborne pollutants, while enhancing not only the visual aesthetic character of a street, but also by dramatically improving the physical environment of the corridor.

Tree selections and planting locations for Complete Streets projects must be performed by a registered landscape architect or botanist with the requisite knowledge and experience with establishing trees in urban environments. Depending upon available above-grade space, the landscape architect will select trees based upon their known performance characteristics and forms, ranging from tree crowns that may be narrow to wide spreading.

While plant material is an integral component of streetscape character, landscape plantings must be well planned and maintained to prevent obstructions for motorists or pedestrians, interference with building facades or roadway appurtenances, or impacts to underground utilities. The reality is also that some locations should not be planted due to space restrictions. These restrictions include space for the tree's crown development and adequate soil volume, including good soil structure for root development to support desired tree growth.

Tree roots do not successfully establish in highly compacted soils due to poor soil structure, which limits access to air and water, thus resulting in the tree's diminished growth and eventual mortality. It is vital that the landscape architect, often along with a soil scientist, evaluate and test existing soils during the design process, and certainly in advance of tree plantings.

Two potential scenarios can occur with existing soils:

- They may be readily modified by the incorporation of organic material, such as composted leaves
- They may need to be removed in their entirety and replaced with a designed planting soil

Following the evaluation of soil testing results, planting soil is often needed to provide adequate soil volumes and proper soil structure to enable trees to grow to their typical and desired sizes. The planting soil will also benefit installation of shrubs and ground covers if included in the Complete Streets design.

An additional consideration during the design process is the inclusion of subsurface drainage to facilitate the removal of excess water from the tree planting soil. It is possible that water will move through the planting soil but not through the soil beneath the planting soil zone because of its denser and/or compacted nature, thus potentially causing root decay and mortality. This subsurface drainage, running the length of the planting soil zone, and accomplished with a perforated pipe, can be connected to the existing storm sewer system of the street.

Design Guidance

Research during the past 25 to 30 years regarding the performance of street trees and trees planted in urban environments has resulted in methods and innovations in tree planting design to support root growth, thus resulting in improved tree growth and performance. These methods and innovations increase the volume and quality of the soil and can physically support sidewalks.

Open Soil Trench

An open soil trench is a continuous trench filled with planting soil. The width and depth of the trench will vary based upon the horizontal space available and the height of the tree root balls to be planted. Tree trenches can be located within a sidewalk's furnishings zone or within street medians.

Sidewalks should be flush with the edges of soil trenches to avoid tripping hazards. The adjacent sidewalk can be pitched toward the open soil trench to provide a stormwater benefit. However, the landscape architect should consider the quality of the potential stormwater runoff in light of deleterious materials, such as deicing salts, which could have a very negative impact upon plant growth.

Open soil trenches are typically used in residential environments where foot traffic is low and crossing of the soil trench surface is minimal. An open soil trench is not recommended in areas with high-turnover curbside parking.

Open soil trenches can provide trees with a large amount of uncompacted soil and the best chance of thriving in the urban environment. These planting zones also provide opportunities to include shrubs and ground covers, and to use mulch to increase moisture retention and minimize volunteer growth.

Covered Soil Trench

A covered soil trench follows similar design guidance to the open soil trench but features a structural support. This design allows the soil trench to support a large canopy while also accommodating pedestrian traffic on the paved surface. Covered tree trenches should be covered with pavement but allow passive irrigation to reach the soil. Permeable pavement is a common treatment option to allow infiltration of rainfall.

Whether a permeable or impermeable pavement surface is selected for a particular design, the landscape architect will need to consider a means to support the pavement for pedestrian and, in some instances, vehicle use for periodic maintenance. Current support systems in use include concrete structures, structural soil, and plastic structural cells.

Tree Pits

Tree pits should be used where space would not allow the use of an open or covered soil trench or individual "bump-outs" within on-street parking locations. A tree pit should be generous in size. Tree pits have historically been constructed at 4 feet by 4 feet and 5 feet by 5 feet, and the result in many cases is that the trees rapidly outgrow the soil volume and the pavement opening, creating upheavals of adjacent pavement surfaces. However, many communities are now constructing tree pits 4 or 5 feet wide by 8 or 12 feet long, or even larger when space allows.

Soil volumes provided for tree pits should be generous (at least the size of the tree pit opening), and every attempt should be made to increase this soil volume when practicable, following current tree soil volume guidelines.

Other Considerations

Soil Panels and Break-Out Zones

When planting trees in urban conditions, it is important to provide adequate rooting space for the tree's ultimate crown development. Soil panels and break-out zones should be investigated as they can provide this necessary rooting space.

Soil panels are contiguous volumes of soil, connected to the tree pits, into which tree roots can penetrate, grow, and extend themselves. Soil panels can be placed beneath sidewalks and paving. As tree roots grow through these soil panels they may enter a break-out zone or a large volume of soil some distance from, but adjacent to, the sidewalk tree pit or soil trench. These break-out zones can be included in the site design or occur in an adjacent open lawn or planting bed. Break-out zones provide additional soil volumes for tree root growth and establishment.

Ground Cover Plantings

It is recommended that hardy ground covers be planted upon the surface of tree pits and fully mulched. These plantings will enhance the appearance and minimize volunteer growth within the tree pit, as well as provide a visual and physical queue that the tree pit is not part of the pedestrian walking surface.

An additional element to further protect the tree pit from pedestrians and dogs is the introduction of an 18-inch to 24-inch height ornamental metal element around three of the tree pit's sides when immediately adjacent to a roadway curb, and all four sides when the curb is at least 2 feet away from the closest edge of the tree pit. It is imperative to preclude soil compaction and deleterious materials/liquids within these tree planting zones.

Flexible Pavement

Flexible pavement is a flexible porous paving technology that is a cost-effective solution for keeping more level surfaces in constrained areas near trees. Flexible pavement bends but does not crack, making it an ideal treatment near tree roots. Washington D.C., has used flexible pavement effectively in hundreds of locations in situations such as those shown in the photo. Flexible pavement is an appropriate treatment for many constrained areas to maintain a passable surface and prevent cracking. While the cost of installing flexible pavement can be three to five times as high as traditional concrete, installation generally occurs in limited segments and costs can be recouped over time through reduced need for maintenance or replacement.

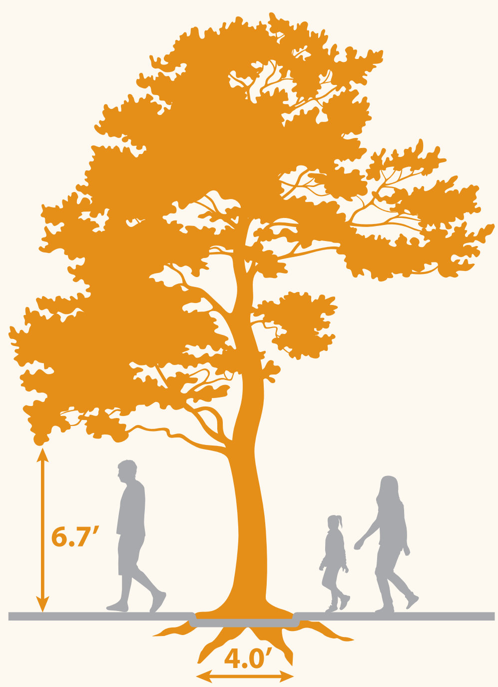
Further Guidance

- National Complete Streets Coalition, http://www.smartgrowthamerica.org/complete-streets
- *High Performance Infrastructure Guidelines: Best Practices for the Public Right-of-Way*, New York City Department of Design + Construction and the Design Trust for Public Space, 2005.
- *Philadelphia Complete Streets Design Handbook*, www.philadelphiastreets.com
- *Urban Street Design Guide*, National Association of City Transportation Officials, Island Press, 2013.
- *Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses, Sixth Edition*, Michael A. Dirr, Stipes Publishing, 2009.
- *Up By Roots: Healthy Soils and Trees in the Built Environment*, James Urban, International Society of Arboriculture, 2008.
- *Urban Soil in Landscape Design*, Phillip J. Craul, John Wiley & Sons, 1992.
- *Urban Soils: Applications & Practices*, Phillip J. Craul, John Wiley & Sons, 1999.
- *Trees in the Urban Landscape: Site Assessment, Design, and Installation*, Peter J. Trowbridge & Nina L. Bassuk, John Wiley & Sons, 2004.
- *Soil Design Protocols for Landscape Architects and Contractors*, Timothy A. Craul and Phillip J. Craul, John Wiley & Sons, 2006.
- *Principles and Practice of Planting Trees and Shrubs*, Gary W. Watson & E.B. Himlick, International Society of Arboriculture, 1997.
- *The Landscape Below Ground: Proceedings of an International Workshop on Tree Root Development in Urban Soils*, Edited by Dr. Gary W. Watson & Dr. Dan Neely, International Society of Arboriculture, 1994.
- *The Landscape Below Ground: Proceedings of an International Workshop on Tree Root Development in Urban Soils*, Edited by Dr. Gary W. Watson & Dr. Dan Neely, International Society of Arboriculture, 1998.
- *A Guide for Maintaining Pedestrian Facilities for Enhanced Safety*, FHWA.

Street Trees

Street trees generally improve the pedestrian experience, enhance the streetscape, provide shade and a buffer between pedestrians and motor vehicle traffic, and can have a traffic-calming effect. However, improperly planted and maintained trees can cause sidewalk cracks and changes in level that can make the sidewalk impassible. When trees do not get enough water or do not have enough space to grow, their roots will seek new water sources and expand up into the sidewalk. Low-hanging branches and lack of tree maintenance can also be a hazard for pedestrians, particularly those with vision impairments.

- Most trees need a minimum area of 4 feet by 4 feet
- Tree branches should be maintained to hang no lower than 6.7 feet



Street Furniture

Street furniture encompasses a variety of amenities that can enhance the aesthetics and functionality of the sidewalk environment. Well designed and placed street furniture makes the sidewalk a more comfortable, convenient, and inviting place. Benches and other seating options can facilitate gathering, provide a place for rest, or create an attractive spot to have lunch or coffee from a nearby business. Well distributed and maintained trash bins help keep a street clean. Appropriately located bicycle parking encourages more people to bicycle by making parking more convenient. Conversely, improperly laid out street furniture can obstruct and clutter the sidewalk environment and impede pedestrian mobility and accessibility. Street furniture should generally be installed in the furnishing zone or in a curb extension, and should not protrude into or hinder circulation within the pedestrian zone.


Madison, NJ

Seating

Seating comes in a variety of temporary and permanent forms, including chairs, benches, seating walls, or planters. Seating helps create a more inviting environment and encourages active public spaces.

Design Guidance

Permanently installed seating should not interfere with building entrances, loading zones, parked vehicles, access to fire hydrants, or other potential conflicts.

ADA requirements for seating include:

- 3-foot minimum on each side of the bench
- 5-foot minimum from fire hydrants
- 1-foot minimum from any other amenity, utility, or fixture
- 5-foot minimum clear path in front of the bench located at the back of the sidewalk, facing the curb
- 5-foot minimum clear path behind a bench when located at the front of the sidewalk facing the curb

Further Guidance

- *Boston Complete Streets Design Guide*
- *Philadelphia Complete Streets Design Guide*
- *Newark Complete Streets Design Guidelines and Implementation Plan*

Bicycle Parking

Providing adequate, secure bicycle parking is an important measure to accommodate and encourage cycling as an alternative travel mode. Proper parking facilities increase the convenience of cycling for commuting, utilitarian, or recreational purposes while also alleviating the threat of theft.

Design Guidance

The typical parked bicycle is 6 feet long and 2 feet wide, making bicycle parking space efficient and easy to locate. Parking should be conveniently located, well lit, and easily visible for cyclists arriving at a destination. A variety of bicycle parking racks are available. Based on guidelines from the Association of Pedestrian and Bicycle Professionals (APBP), a bicycle rack should meet the following requirements:

- Be intuitive to use
- Support the bicycle upright by its frame in two locations
- Enable the frame and one or both wheels to be secured
- Support bicycles without a diamond-shaped frame and horizontal top tube (e.g., step-through frames)
- Allow both front-in and back-in parking with a U-lock through the frame and front or rear wheel
- Resist the cutting or detaching of any rack element with hand tools

Older style racks, such as the “comb”/“schoolyard,” “toast,” and “wave” are not recommended because they do not properly support the bicycle frame, generally do not facilitate locking of the frame to the rack, and frequently cause interference between the handlebars of adjacent bicycles when the rack is near capacity. Recommended racks include the “inverted U,” “A,” and “post and loop.”

Bicycle racks should also be properly spaced to allow easy, independent access to each bicycle.

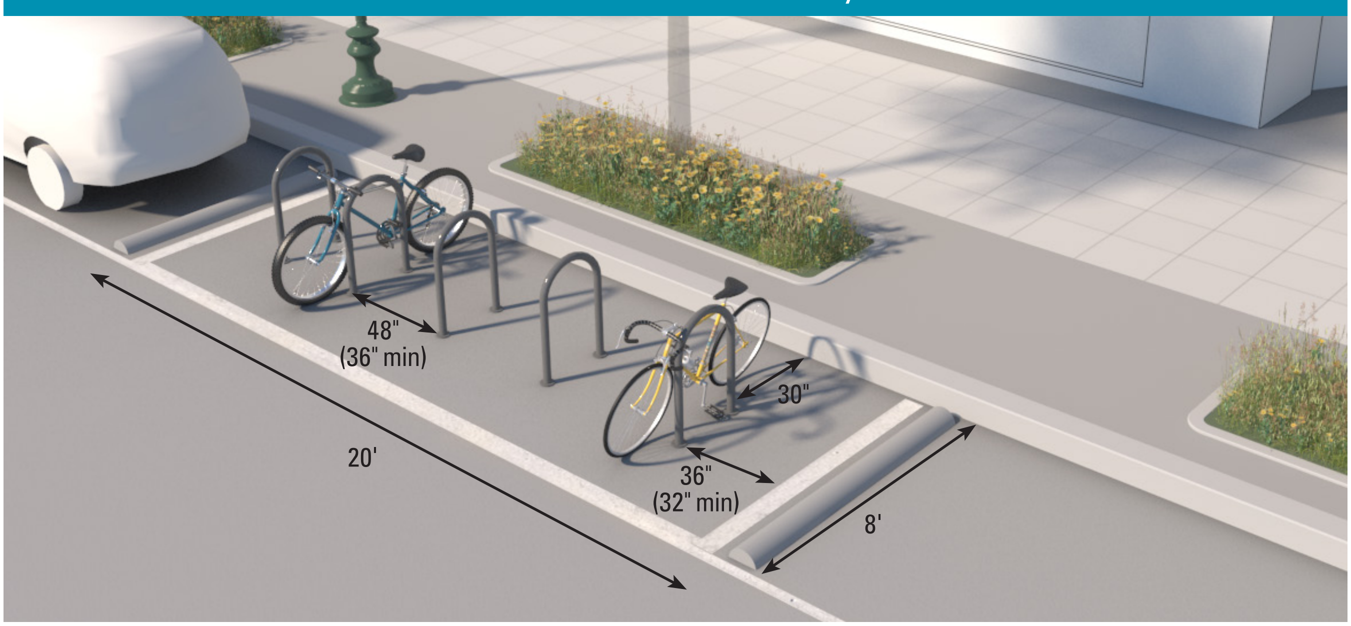
Bicycle Corrals

Bicycle corrals are rows of bicycle racks installed in the curbside lane of the street instead of the sidewalk. Bicycle corrals provide ample bicycle parking without occupying sidewalk space and are a good treatment in locations where bicycle parking is desired but sidewalk space is limited. Bicycle corrals can also help “daylight” an intersection by preventing motor vehicles from parking close to intersections, beyond designated spaces.

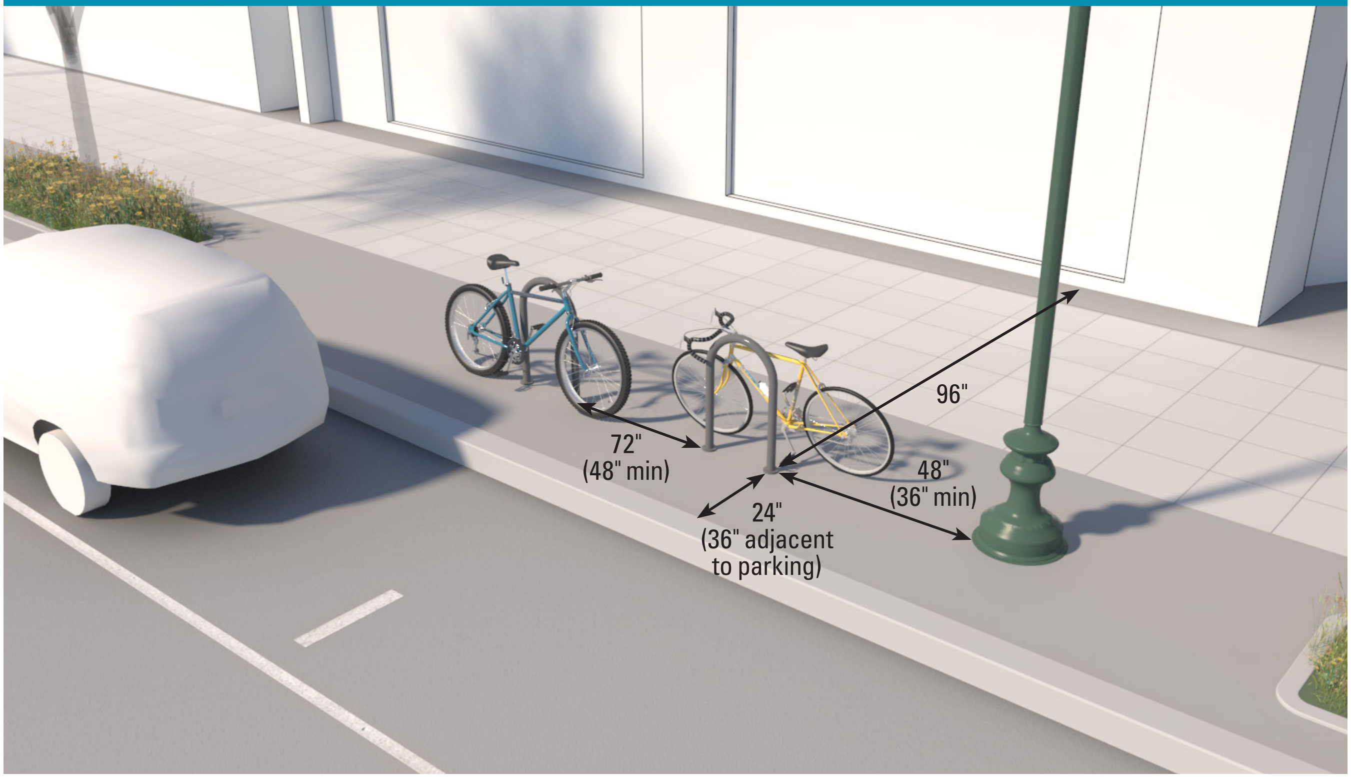
Further Guidance

- *Essentials of Bicycle Parking,* APBP
- *Bicycle Parking: Standards, Guidelines, Recommendations,* San Francisco Municipal Transportation Agency

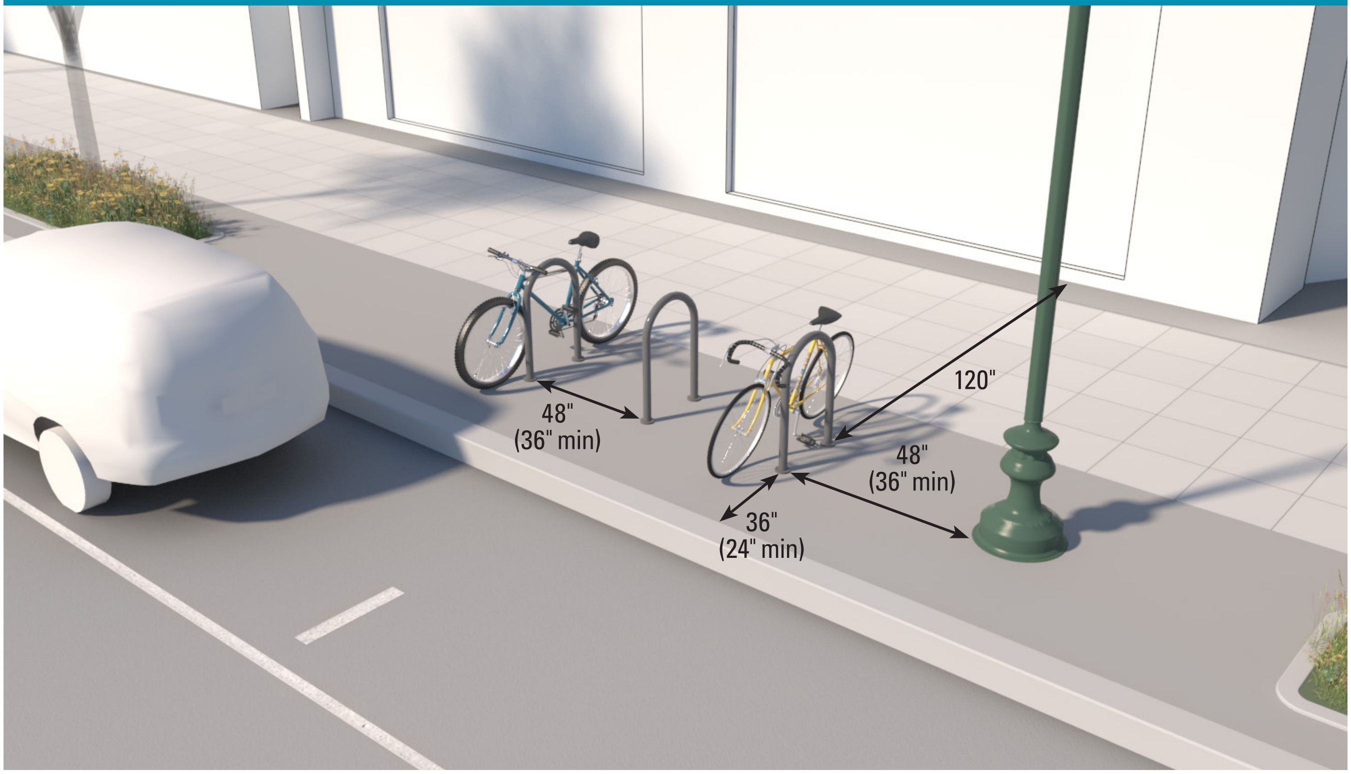
Recommended Dimensions for Bicycle Corrals



Recommended Dimensions for Racks Parallel to Curb



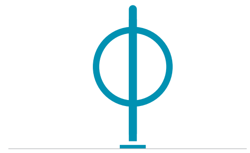
Recommended Dimensions for Racks Perpendicular to Curb



Recommended Bicycle Rack Designs

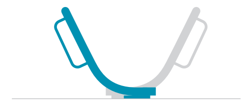
Inverted U

Common style appropriate for many uses; two points of ground contact. Can be installed in series on rails to create a free-standing parking area in variable quantities. Available in many variations.



Post and Ring

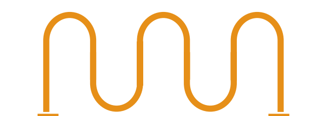
Common style appropriate for many uses; one point of ground contact. Compared to inverted-U racks, these are less prone to unintended perpendicular parking. Products exist for converting unused parking meter posts.



Wheelwell Secure

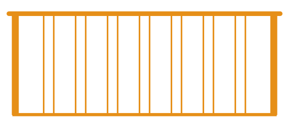
Includes an element that cradles one wheel. Design and performance vary by manufacturer; typically contains bikes well, which is desirable for long-term parking and in large-scale installations (e.g., campuses); accommodates fewer bicycle types and attachments than the other two styles.

Racks to Avoid



Wave

Not intuitive or user-friendly; real-world use of this style often falls short of expectations; supports bicycle frame at only one location when used as intended.

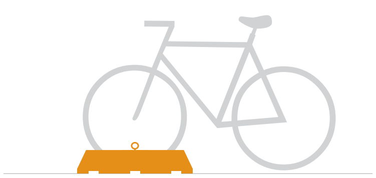


Schoolyard (comb)

Does not allow locking of frame and can lead to wheel damage. Inappropriate for most public uses but useful for temporary attended bicycle storage at events and in locations with no theft concerns.

Spiral

Despite possible aesthetic appeal, spiral racks have functional downsides related to access, real-world use, and the need to lift a wheel to park.

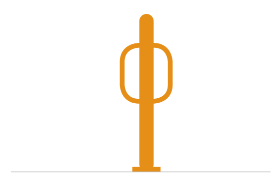


Wheelwell

Racks that cradle bicycles with only a wheelwell do not provide suitable security, pose a tripping hazard, and can lead to wheel damage.

Coathanger

This style has a top bar that limits the types of bicycles it can accommodate.



Bollard

This style typically does not appropriately support a bicycle's frame at two separate locations.

Images and descriptions courtesy of APBP *Essentials of Bicycle Parking*

Bus Shelters

Bus shelters provide a place for passengers to wait and sit in comfort and security, protected from the elements. Quality bus shelters are necessary for maintaining a high quality level of transit service that is attractive and dignified for passengers. While bus shelters may not be necessary at every bus stop, seating and route information should be considered at all stops.

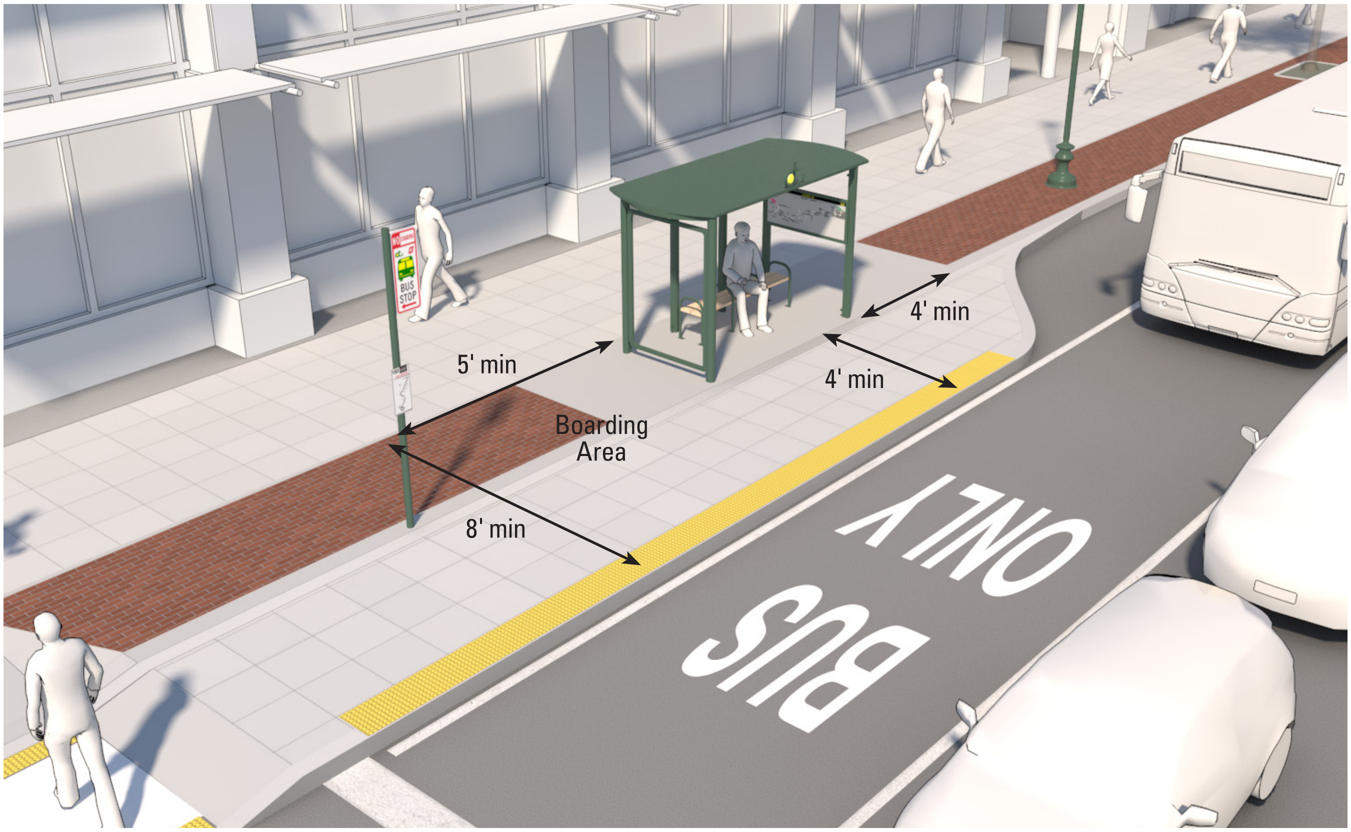
Highland Park, NJ

Design Guidance

- Bus shelters should include seating, lighting, and travel information.
- Travel information is a very important amenity for riders and should include, at a minimum, route and schedule information. Where possible, real-time arrival and departure information should be included, as well as local area maps and wayfinding information.
- Bus shelters should be maintained regularly and kept free of debris and graffiti.
- All bus stops should be ADA-compliant and accessible for all users.
- Stops should provide ample room for riders to gather while providing a clear path for pedestrians.
- Stops should not impede pedestrian flow while maintaining ADA-compliant access.
- Transit stops may be located on curb extensions or floating islands but must be accessible by a level surface or ADA-compliant curb ramp.

Further Guidance

- *Transit Street Design Guide,* NACTO



Bus Stops

Bus stops must be indicated with a sign and accessible to all users, including those with limited mobility. Many people with disabilities may prefer to use fixed-route transit, but a street network that does not account for their needs forces them to use more costly paratransit services. Many bus stops in New Jersey are located in inaccessible locations, such as locations without sidewalk connections or next to a sidewalk but not connected.

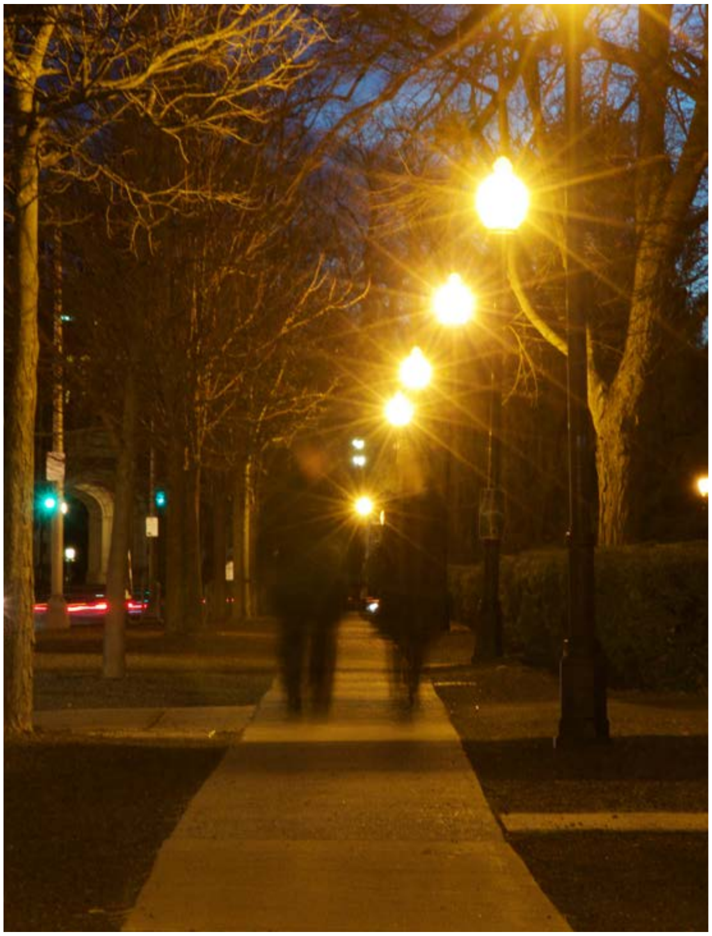
Inaccessible bus stop

Street Lights

Pedestrian-scale lighting should be provided near transit stops, crossings, commercial areas, or other locations where night-time pedestrian activity is likely. Pedestrian-scale lighting, such as street lamps, help to illuminate a sidewalk and improve pedestrian safety, security, and comfort. Street lights should be energy efficient, evenly spaced, and focused downward to reduce light pollution. Lighting fixtures should reflect the character and urban design of the street type. Properly designed and installed pedestrian-scale lighting can both help define a streetscape and create a sense-of-place in a community.

Crosswalk without Street Lights

Crosswalk with Street Lights



Pedestrian-scale lighting (shown on the left in Princeton, NJ) helps create a pleasant and safe place to walk at all times of day.

Different variations of pedestrian-scale lighting (shown here on the right, also in Princeton, NJ) can be used to lessen the impact of ambient light.

Sidewalk Maintenance

Sidewalks are prone to damage caused by environmental conditions as well as overgrowth from vegetation within and outside of the public right-of-way. Keeping sidewalks in a state of good repair is an essential part of maintaining accessibility. Sidewalks in poor repair can limit access for many users and can be a health and safety issue for pedestrians, especially those with limited mobility. When sidewalks are in poor condition, tripping hazards can develop and pedestrians can be compelled to travel in the street.

Stormwater Management

A variety of sustainable stormwater management techniques help to collect, treat, and slow runoff from impervious roadways, sidewalks, and building surfaces. Urban development generally includes a generous amount of pollution-generating and non-pollution-generating impervious surfaces that change natural drainage patterns. This often results in flooding issues and the need for expensive drainage flow control storage and water quality treatment facilities. Impervious surfaces, such as concrete and asphalt, prevent rainwater from being absorbed at the source. As a result, stormwater flows (including pollutants) enter the pipe network and are discharged into receiving water bodies or become an additional burden to municipal wastewater systems.

Innovative stormwater management techniques can help reduce the impact of development by managing stormwater at the source and mimicking natural or pre-development conditions. These techniques are sustainable, generally less expensive, and can add aesthetic and ancillary social benefits to the built environment. In addition, these techniques can help reduce pollution to rivers and other water bodies, decrease flooding, increase groundwater recharge, and reduce energy consumption. The following are examples of stormwater management techniques that can easily be implemented and should be considered as primary best management practices (BMPs) where technically feasible. They can be used within the public right-of-way or as part of a private development to offset the impacts of impervious development.


Highland Park, NJ

Design Guidance

Bioretention Facilities

Bioretention facilities are vegetated retention systems that are designed to manage and treat stormwater by using a conditioned planting soil bed and organic materials that filter runoff stored within shallow depressions or cells. Biofiltration facilities can be flow-through filtration systems with an underground perforated collection pipe that captures and conveys treated runoff to the final discharge point. They also may be designed as pure retention facilities, relying on natural soil infiltration as a primary discharge. Both systems rely on an amended or engineered soil filtration specifically designed to remove particulates and pollutants before proceeding to a self-contained discharge location.

Biofiltration Swales

Biofiltration swales are vegetated, shallow landscape conveyance systems that are designed to capture and treat stormwater runoff as it is conveyed and discharged to the downstream storm system. Bioswales are typically sized to treat the initial infiltration of stormwater, which includes the most pollutants. They are a very effective type of infrastructure for slowing runoff velocity and cleansing water while recharging the underlying water table. Biofiltration swales are flexibly designed and may be installed in medians, cul-de-sacs, bulb outs, or other spaces not within the pedestrian zone.

Composition and Drainage

- The engineered soil mixture should consist of 5 percent maximum clay content.
- Engineered soil must be designed to pass 5 to 10 inches of rain water per hour.
- Underlying native soils should be analyzed to verify that they are not contaminated prior to implementation.

Slope

Biofiltration swales must be designed to allow water to move along the surface at a specific velocity and treatment surface area. Ideal slopes are 4:1 with a maximum 3:1 slope and a maximum velocity of 2 to 3 feet per second.

Curbs

Curb cuts should be at least 18 inches wide. Cuts may be spaced from 3 to 15 feet apart depending on tributary areas and the profile of the roadway gutter. Curb cut systems should allow for a drop in grade between the street and the finished grade of the biofiltration swale that prevents runoff surcharge and blockage and is sized for the expected sediment storage depth.

Flow-Through Planters

Flow-through planters may also be considered small bioretention facilities. These are hard-edged stormwater management facilities with an impermeable base. Flow-through planters treat water by allowing runoff to soak through its soil and filter into an underdrain system that conveys filtered runoff to a downstream discharge point.

Composition and Drainage

- The engineered soil mixture should consist of 5 percent maximum clay content and 10 percent organic matter by weight.
- Planters must be designed to drain within 24 hours.

Location

Flow-through planters should not be located in constrained areas next to buildings, areas with limited setbacks, poorly draining soils, steep slopes (>4 percent), or areas with contaminated soils.

Pervious Strips

Pervious strips are long, linear landscaped areas of permeable pavement or gravel that capture and slow runoff. Pervious strips provide some infiltration but far less than a biofiltration swale. Pervious strips are an inexpensive step in stormwater management but are less effective than other BMPs for treating a street's full water event. They are also subject to a much higher maintenance cycle due to the lack of ability to incorporate an upstream pre-settlement chamber that prevents clogging of permeable and gravel voids.

Locations

- Pervious strips can be integrated with sidewalks, medians, curbs, and other features
- Pervious strips require long, continuous spaces to treat and filter pollutants
- Pervious strips require a maintenance plan that is specific to the location of the strip to account for numerous outside factors that will affect performance and frequency of maintenance

Slopes

A maximum 2 percent gentle side slope should be used to direct flow into the facility. Additionally, facilities greater than 5 percent typically are not suitable to pervious applications unless specific design criteria are used that are unique to the geography and topography.

Rain Gardens

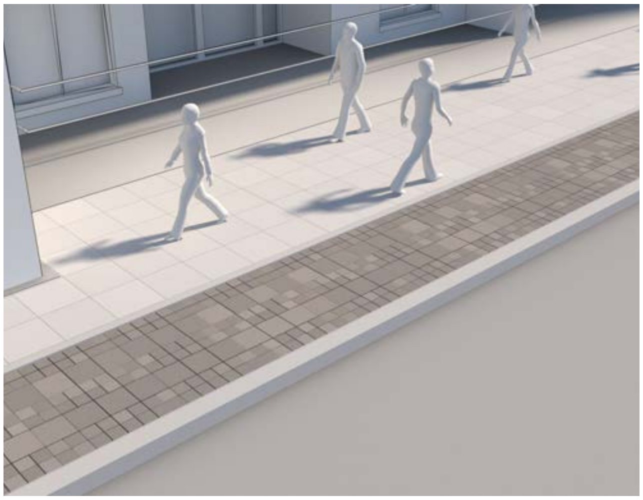
Rain gardens are planted depressions or holes that allow rainwater runoff from impervious surfaces to be absorbed. Native plants are recommended for rain gardens because of their tolerance for local climate, soil, and water conditions. Native plants also have deep and variable root systems that enhance water filtration.

Location

A rain garden requires an area where water can collect and infiltrate.

Composition

The bioretention mixture should typically contain 60 percent sand and 40 percent compost (Washington State University Studies).



Permeable Pavement

Permeable paving materials allow stormwater runoff to infiltrate through the material into the ground instead of being diverted as runoff into the storm drain systems. In addition to reducing runoff, permeable pavement traps pollutants, reducing the environmental impact of runoff and the need for expensive filtration and water conveyance systems. Permeable, or porous, paving can be used on roads, walking paths, and even lots that are subject to light vehicular traffic. Permeable pavement is typically laid on top of an infiltration bed and subgrade soil. Examples of permeable materials are described below.

Permeable Asphalt

Permeable asphalt is produced and placed using the same methods as conventional asphalt concrete; it differs in that fine aggregates are omitted from the asphalt mixture. The remaining large, single-sized aggregate particles leave open voids that give the material its porosity and permeability. Generally, porous asphalt pavements are designed with a subsurface reservoir that holds water that passes through the pavement, allowing it to evaporate and/or percolate slowly into surrounding soils. Permeable asphalt is best suited in lower traffic areas, such as parking lots or residential streets. Site placement can always have a large impact on operations and maintenance. When placed near a landscaped hill or any other area with high debris movement, permeable asphalt can easily become clogged and require frequent maintenance or replacement.

Permeable Concrete

Permeable concrete is similar to permeable asphalt and is designed to have more void spaces that allow air and water to pass through the material.

Interlocking Concrete Pavers

Interlocking concrete pavers are concrete (or stone) units with open, permeable spaces between the units. They can bear both light and heavy traffic.

Maintaining Permeable Stormwater Pavement

Permeable pavement requires different levels of maintenance and may include:

- Annual inspection of materials
- Periodic replacement of sand, gravel, or vegetation
- Periodic vacuuming of pavement to unclog sand or debris

Maintenance is extremely important to the life of the asset and should be considered prior to installation. Once permeable surfaces become clogged, they lose their effectiveness and can become unrecoverable. This is particularly true with permeable asphalt. Planted treatments can have far less operations and maintenance costs than permeable paving; however, they require additional space for placement.

Construction Testing and Materials

ASTM provides guidance on the type of testing for material density, placement, and durability. However, standard industry testing of in place materials continues to be developed.

Further Guidance

- *Urban Streets Design Guide,* NACTO

Parklet on Witherspoon Street in Princeton, NJ

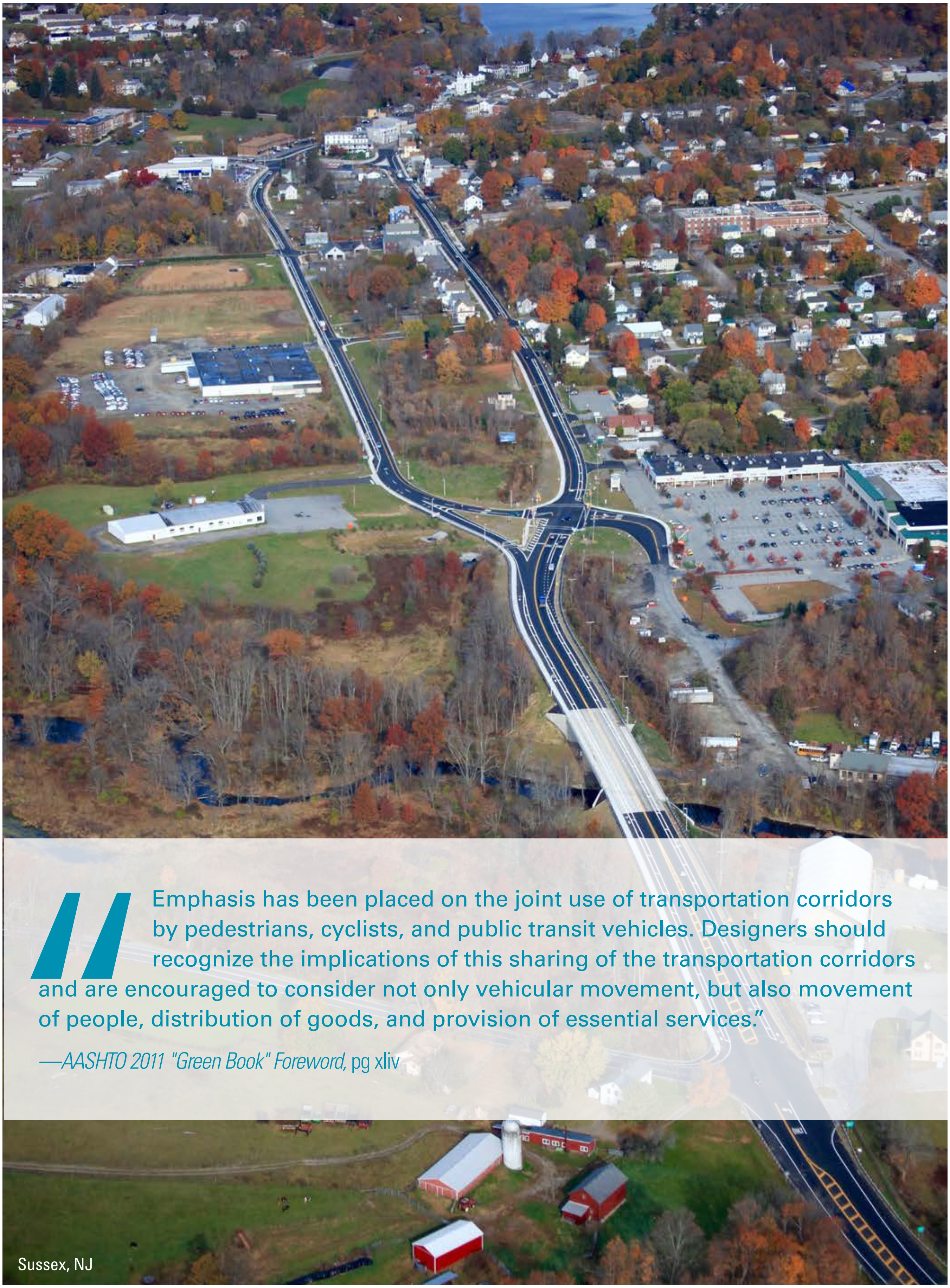
Parklets

A parklet is a sidewalk extension that provides more space and amenities for people using the street. Parklets are typically installed in parking lanes and use one or more on-street parking spaces. A parklet re-purposes part of the street into a public space for people and is intended as an aesthetic enhancement to the streetscape. Parklets also provide public amenities such as seating, bicycle parking, art, and plantings. They are often funded and maintained by local businesses, residents, and/or community organizations because they can provide both a public amenity and a benefit to local businesses by offering outdoor seating for customers.

Further Guidance

- *San Francisco Parklet Manual*
- *Urban Street Design Guide,* NACTO

Recommended Dimensions for Parklets



> Emphasis has been placed on the joint use of transportation corridors by pedestrians, cyclists, and public transit vehicles. Designers should recognize the implications of this sharing of the transportation corridors and are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services."
>
> —*AASHTO 2011 "Green Book" Foreword,* pg xliv

Sussex, NJ

ROADWAYS

Road design is governed by detailed and comprehensive guides and standards, such as the *Manual of Uniform Traffic Control Devices* (MUTCD) and AASHTO's *A Policy on Geometric Design of Highways and Streets Sixth Edition* (referred to in this document as the *"Green Book"*). The FHWA emphasizes that a flexible approach to bicycle and pedestrian facility design is needed to achieve increased implementation. FHWA encourages agencies to appropriately use these guides and other resources to help fulfill the aims of the 2010 *US DOT Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations,* which states:

" ...DOT encourages transportation agencies to go beyond the minimum requirements, and proactively provide convenient, safe, and context-sensitive facilities that foster increased use by bicyclists and pedestrians of all ages and abilities, and utilize universal design characteristics when appropriate."

Planning and engineering guidance can and should enhance, not impede, multimodal safety and mobility. Complete Streets seeks to bring vehicular flow and throughput into balance with safety, mobility, and access considerations.

Design Speed

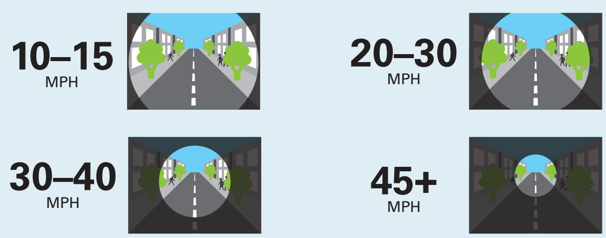
Speed is a critical factor in the occurrence of crashes and the severity of their outcomes. Street design in the latter half of the 20th century was grounded in highway design principles that focused on forgiving driver error and accommodating higher travel speeds. The highway design approach bases design speed and posted speed on the 85th-percentile of how fast drivers are driving rather than how fast they should drive. Designing for faster speed increases the frequency of crashes and their severity. This approach accommodates and encourages speeding and reckless driving behavior, and puts drivers who are driving the speed limit and other roadway users at greater risk. Higher design speeds also have a very negative impact on urban areas and degrade the pedestrian environment by mandating larger curb radii, wider travel lanes, and generous clear zones to accommodate higher vehicular speeds. Designing for desired travel speed can help lower travel speeds, reduce crash severity, and otherwise improve the built environment for all users.

Design speed should be selected based on the context, and roadway elements should be selected and designed to support that speed. Where there are higher volumes of pedestrians, bicyclists, and transit users, roadway design should encourage a lower speed differential between modes. On most urban roads, a target speed of between 10 and 30 mph is appropriate.

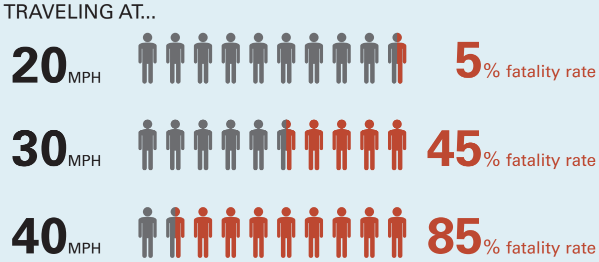
Speed and Safety

Motor vehicle speed has a dramatic impact on pedestrian fatalities. A pedestrian struck by a motor vehicle traveling 40 mph has an 85 percent chance of death. At 30 mph, this chance falls to 45 percent. At 20 mph, the fatality rate drops to just 5 percent.

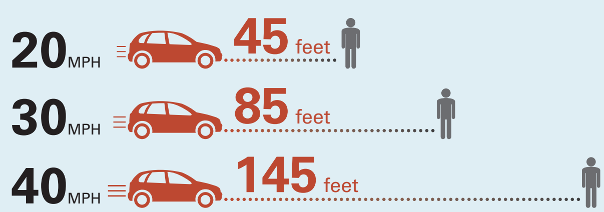
VISIBILITY
TRAVELING AT...



HIT BY A VEHICLE
TRAVELING AT...



STOPPING DISTANCE FOR A VEHICLE
TRAVELING AT...



SLOW

Traffic Calming Features

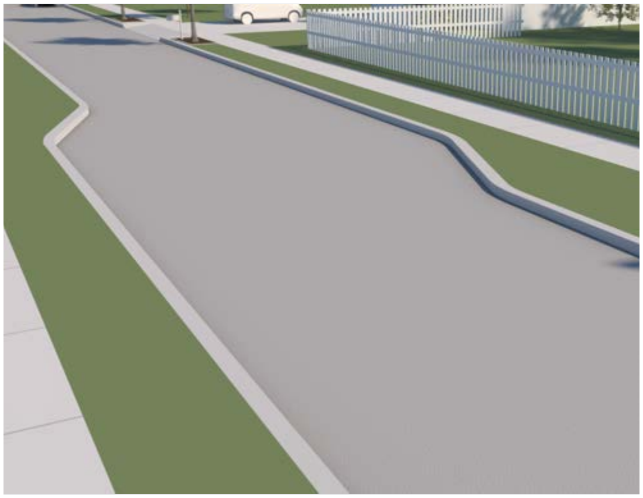
The following design techniques can help achieve lower travel speeds and safer motor vehicle traffic. Some of these techniques alter the configuration of the roadway, while others change how people psychologically perceive and respond to a street. These techniques should be considered in appropriate contexts.

Curb Extensions

Curb extensions visually and physically narrow the roadway at intersections and mid-block locations. Curb extensions are generally used where there is on-street parking to shorten the pedestrian crossing distance. A curb extension should generally be **1 to 2 feet narrower** than the parking lane, and the length at least the width of the crosswalk (but preferably extended to the advanced stop bar).

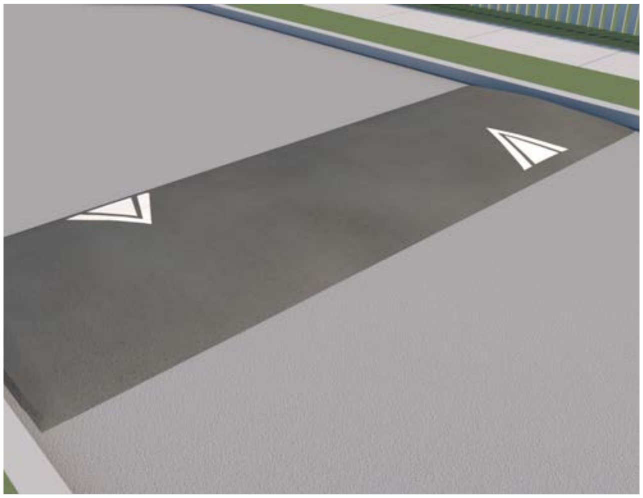
Neckdowns

Neckdowns create pinch points by extending the curbline to narrow the roadway, which deters motorists from operating at high speeds on local streets and significantly expands the sidewalk realm for pedestrians.



Chicanes

Chicanes are a series of raised or delineated curb extensions, edge islands, or parking bays that are placed on alternating sides of a street to form an S-shaped bend in the roadway. Chicanes reduce vehicle speeds by requiring drivers to shift laterally through narrow travel lanes.

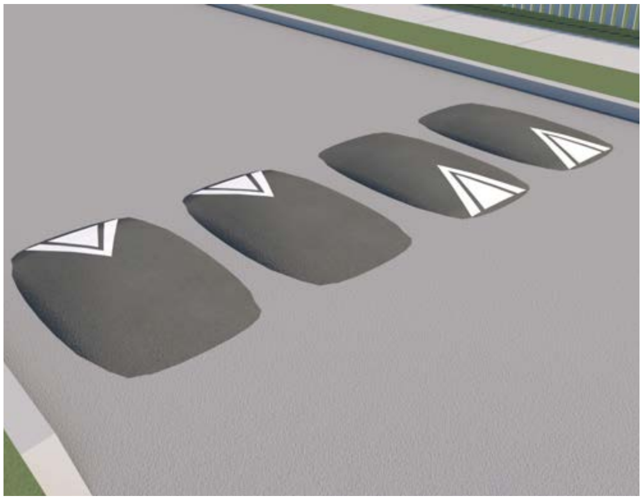


Speed Humps

Speed humps are typically **3 to 4 inches high** and **12 to 14 feet long**, and are designed with an intended vehicle speed of 15 to 20 mph. Humps are often referred to as “bumps” on signage and by the general public.

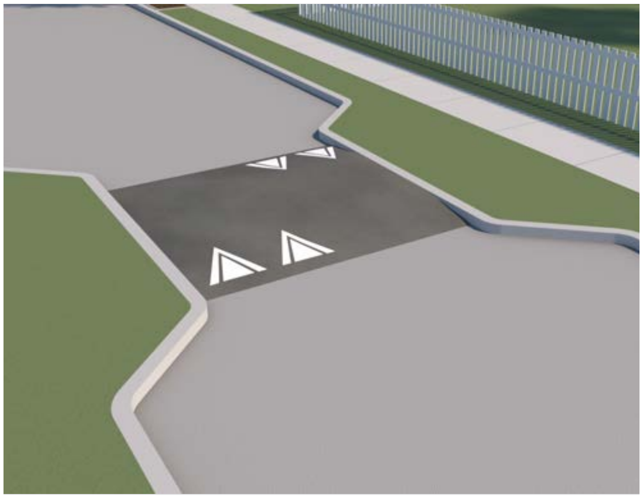
Center Islands

Center islands create pinch points for traffic by narrowing the width of the travel lanes and reducing pedestrian crossing distances. A center island causes a small amount of deflection without blocking driveway access. Center islands impede high-speed left turns and keep drivers in the correct receiving lane.



Speed Cushions

Speed cushions are speed humps or speed tables that include wheel cutouts that allow larger vehicles to pass unaffected but reduce passenger vehicle speeds. They are often used on key emergency response routes to allow emergency vehicles to pass unimpeded while causing the typical passenger vehicle to slow down. Speed cushions should be used with caution, however, as drivers will often seek out the space in between the humps.



Speed Tables

Speed tables are longer than speed humps and have a flat top, with a **height of 3 to 3.5 inches** and a **length of 22 feet**. Intended vehicle operating speeds range from 25 to 35 mph, depending on the spacing. Speed tables may be used on collector streets, transit, and/or emergency responder routes.

Signal Progression

Traffic signals timed to a street's target speed can create lower and more consistent speeds along a corridor with less frequent stops and starts.

On-Street Parking

On-street parking narrows the street and slows traffic by creating friction for moving vehicles.

Further Guidance

- *Urban Street Design Guide,* NACTO
- *Urban Bikeway Design Guide,* NACTO
- *Roadway Design Manual,* NJDOT

"Won't reducing speed limits increase the length of my commute?"

Probably not. Travel time is primarily determined by factors such as traffic signals, congestion, double-parked vehicles, and turning vehicles. In other words, intersections and traffic conditions determine travel time in most situations, not speed limits. In many cases, reduced speed limits can lead to improved travel times and reduced congestion by reducing stacking and bottlenecks at intersections. Signals should be timed appropriately to encourage lower and more moderate speeds in developed areas.

Travel Lanes

Travel lane width has a large impact on the design speed of a roadway. Traditionally, roads have been designed with wider travel lanes (11 to 13 feet) to create a forgiving buffer for drivers, particularly in high-speed environments where narrower lanes might feel uncomfortable. However, the unintended consequence of this is that wider lanes actually encourage higher travel speeds, which has a negative impact on safety and the urban environment. A growing body of research has shown wider travel lanes to correlate with higher vehicle speeds. Many engineers and planners have also assumed that lanes narrower than 12 feet decrease traffic flow. However, recent research has demonstrated that there is no measurable difference in urban street capacity between a 10- or 12-foot lane. **Lane widths of 10 feet** are appropriate in urban areas and have a positive impact on the safety of a street without impacting traffic operations. Along routes that have high truck and/or bus volumes, 11-foot travel lanes may be used. For multi-lane roadways where transit or freight are present, the wider lane should be the curbside lane while the inside lane is designed at the minimum possible width.

Research has shown that narrower travel lanes can effectively manage speeds without decreasing safety. Narrower lanes also decrease crossing distances for pedestrians at intersections and mid-block crossings, are cheaper to construct, and require less impervious pavement, therefore reducing the need for additional stormwater management.

Further Guidance

- *Urban Street Design Guide,* NACTO

Know how to use the "Green Book": Understand your context!

> "The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions. It is not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Minimum values are either given or implied by the lower value in a given range of values. The larger values within the ranges will normally be used where the social, economic, and environmental (S.E.E.) impacts are not critical."
>
> —AASHTO 2011 "*Green Book" Foreword,* pg xliii

Allocating Use of Street Space

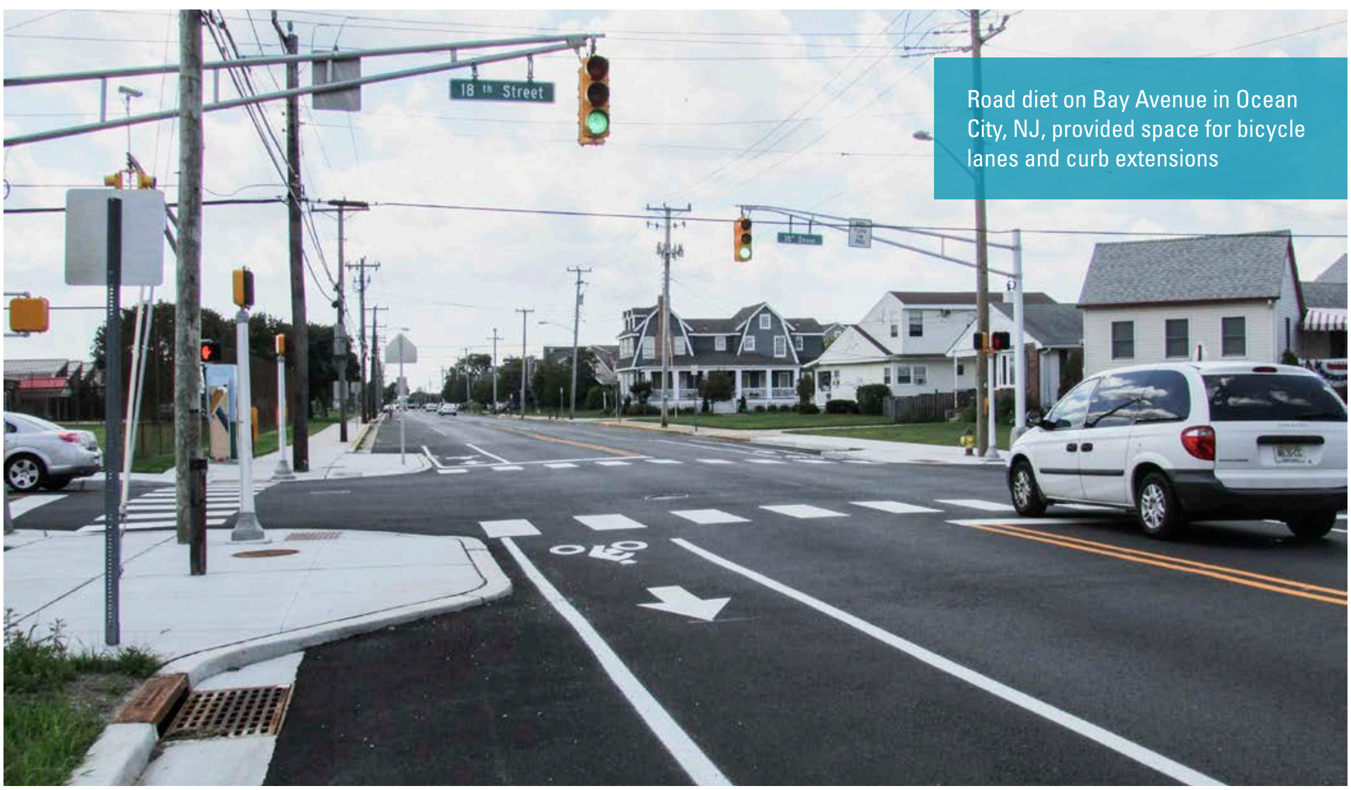
The configuration, width, and allocation of space to travel, parking, and bicycle lanes have a large impact on how New Jersey's streets meet the mobility needs of the state's residents, visitors, and businesses. The primary goal of Complete Streets is to equitably accommodate users of all modes and abilities. Decisions made regarding the allocation of space on a roadway impact how the street accommodates these various modes. A Complete Streets policy requires that during road reconstruction and resurfacing projects, an assessment is conducted to ensure that the design appropriately accommodates all users. This assessment should include examining the feasibility of reallocating space in the roadway to better accommodate pedestrians, bicycles, and transit vehicles.

Two basic methods should be reviewed during a road reconstruction or resurfacing project to optimize the allocation of street space:

- Road Diet
- Lane Diet

Further Guidance

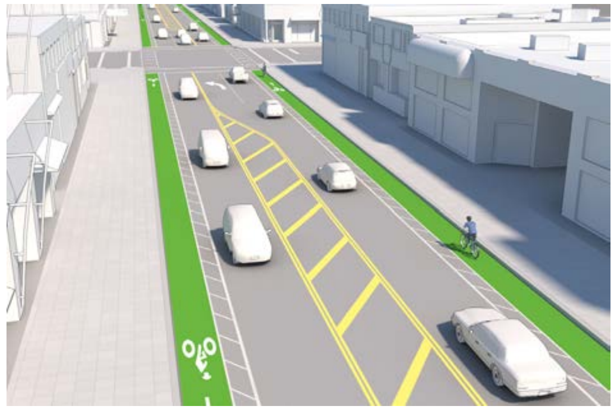
- *Urban Street Design Guide,* NACTO
- *Road Diet Informational Guide,* FHWA



Road diet on Bay Avenue in Ocean City, NJ, provided space for bicycle lanes and curb extensions

Road Diet—Before

Road Diet—After



A road diet is a reduction in the number of lanes on a roadway. In the above example, a four-lane roadway is converted to a three-lane roadway, including a center turning lane and the addition of buffered bicycle lanes.

Road Diet

Where there is excess capacity, a road diet is used to reduce the number of travel lanes and reallocate space for other modes of travel, often bicycle lanes. An analysis should be conducted to determine whether excess capacity exists. Road diets generally occur on roadways with extra capacity and therefore should not have a negative impact on traffic.

Benefits

- Lower and more consistent vehicle speeds
- Reduced crash rates
- Improved pedestrian safety
- Accommodation of other modes of travel

Applications

Typical applications of a road diet occur on four-lane undivided roadways, which can be converted to a three-lane cross section (one lane in each direction with a center turn lane or center median), or multi-lane streets with extra capacity where one or more lanes could be removed.

Researchers have found that road diets can reduce overall crash frequency by 19 to 43 percent.[32] Road diets can help reduce crashes by removing travel lanes and reallocating the space to accommodate turning vehicles in separate lanes or turn bays, which makes driver behavior more predictable and reduces weaving.

Reallocation of Space

Space that is captured by the reduction in lanes can be re-purposed for a variety of uses, including the implementation of bicycle lanes or on-street parking. For reconstruction projects, a road diet provides an opportunity to widen sidewalks, create curb extensions, plant street trees, implement stormwater management treatments, or install street furniture.

Lane Diet—Before

Lane Diet—After

A lane diet is a reduction in travel lane width. In the above example, four wide lanes are narrowed to provide space for the addition of a standard bicycle lane.

Lane Diet

In cases where there are wide travel lanes (12 feet or greater), a lane diet should be considered to narrow the lanes to 10 to 11 feet. On a four-lane roadway, for example, a lane diet can recapture 10 feet of space by reducing 12.5-foot lanes to 10 feet, enough for two 5-foot bicycle lanes. Reduced lane widths can also encourage slower vehicle speeds and reduce pedestrian crossing widths without reducing vehicle capacity.

Benefit

- Reduce vehicle speeds
- Reduce pedestrian crossing distances
- Provide space for other modes of travel, including bicycle lanes or wider sidewalks

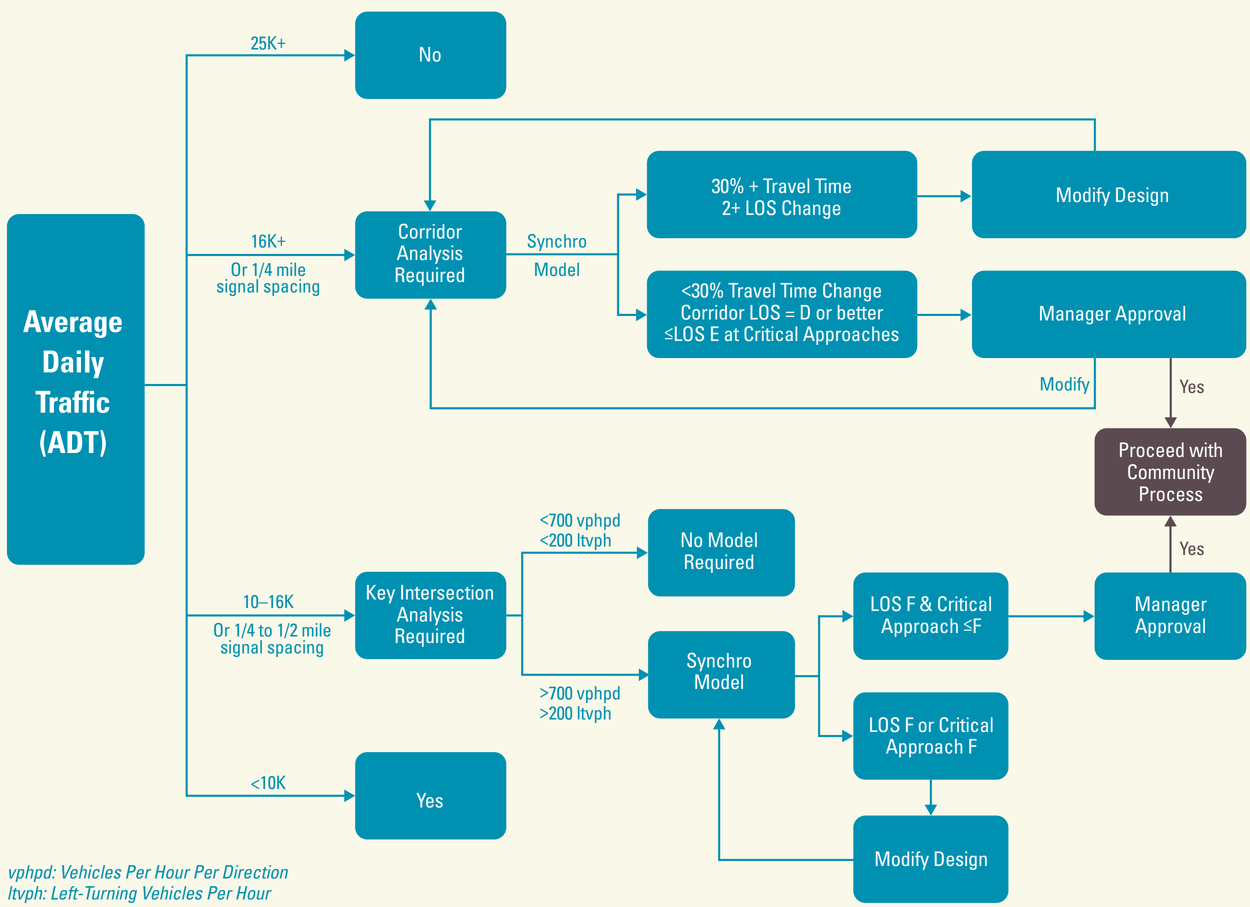
Applications

Typical applications of a lane diet are on streets with lanes wider than 10 feet, streets with wide parking lanes, or streets with wide center turn lanes.

Creating a Process for Determining Whether to Do a Road Diet: City of Seattle

The City of Seattle has created a formal process for determining whether a street is an appropriate candidate for a road diet. The flow chart below represents the process the City uses to determine candidates for a 4/5 lane to 3 lane conversion. The City's approach is innovative because rather than requiring evidence to show that a road diet would be feasible, the City's method requires evidence to show that a road diet is not feasible. This process is logical, quantitative, and based on sound engineering principles. It is part of an overall strategy to make building complete and safe streets the default way of doing business.

City of Seattle Modeling Flow Chart for Road Diets (from 4 or 5 lanes to 3 lanes)



vphpd: Vehicles Per Hour Per Direction
ltvph: Left-Turning Vehicles Per Hour

On-Street Parking

On-street parking can enhance a street by providing a buffer element between vehicles and the pedestrian realm. For streets with bicycle lanes or cycle tracks, on-street parking can separate motorists from cyclists, increasing the sense of safety for both cyclists and pedestrians. On-street parking provides convenient access to adjacent land uses and offers a desirable parking option for visitors arriving by car since it offers the shortest possible time between stopping and shopping.

Design

The inclusion of on-street parking in the design of a Complete Street provides an opportunity to increase the number of available parking spaces across the municipality while simultaneously narrowing the roadway. It is important that the benefits of on-street parking are only implemented using appropriate design elements that avoid negative consequences, such as reduced sight lines and blocked crosswalks.

Parallel Parking

Parallel parking is the traditional arrangement for on-street parking that requires the least amount of roadway space and is the most compatible for streets with higher speeds. Road diets, which are often employed on roads that have excess travel lanes for the level of vehicle traffic volume and often have safety issues for people traveling by bicycle or on foot, are easily implemented through the incorporation of parallel parking.

Head-out Angle Parking

Head-out angle parking is acceptable on low-speed collector streets as long as the extra curb-to curb width is not achieved at the expense of sidewalk width. Head-out angle parking enhances the safety of the street because when exiting the space, drivers have an increased line of site of oncoming vehicles, bicyclists, and pedestrians when reentering the travel lane. In addition, head-out angle parking eliminates the risk of dooring cyclists on roads where bicycle traffic is frequent. This design approach is useful in narrowing the width of the roadway.

Parking Management

The space that is dedicated to parking cannot be used for bicycle lanes and the very presence of parking encourages driving; therefore, parking needs to be carefully managed and incorporated into policies and programs to effectively maintain the principles of Complete Streets.

Pricing

One important management tool is ensuring, wherever appropriate, that on-street parking be properly priced through meters, kiosks, or residential parking permits. Metered or time-restricted parking should be used to provide short-term parking for retail customers and visitors while discouraging long-term parking.

Temporary Zones and Uses

Space that is specifically allocated for commercial loading and unloading activities allows the movement of deliveries and goods to operate smoothly, regardless of the street function. Designated loading zones are one approach to providing convenient access to storefronts, reducing the likelihood of double parking, which causes obstructions to other users on the street. Furthermore, parking spaces may provide more than just storage areas for cars. Alternative curbside uses can transform the space for temporary uses, such as food trucks and market stands.

Shared Parking

Shared parking, or parking utilized jointly among different businesses and facilities in the area, can be used to take advantage of peak parking characteristics that vary by time of day, day of week, and/or season of year. Since the majority of parking spaces are only used part time, shared parking arrangements significantly reduce the amount of land devoted to meeting parking needs.

Application

The presence of on-street parking is not a requirement nor does it make a street more or less complete. Rather, on-street parking should be seen as a possible consideration for Complete Streets and should be properly designed to maintain the safety and accessibility benefits that on-street parking can provide.

On-street parking should be located based on the characteristics of the street, the needs of adjacent land uses, and applicable local policies and plans for parking management. While on-street parking generally supports retail businesses and slows and buffers people from vehicle traffic, each parking space is valuable real estate that can be used for other design elements, such as curb extensions, landscaping, and bus and bicycle facilities, including bicycle parking. These alternate uses can often provide a greater mobility or economic benefit than on-street parking.

Minimum Parking Requirements

Most municipalities throughout New Jersey (and the United States) set minimum parking requirements for new buildings. This practice, which has been commonplace since the 1950s, is intended to ensure that new development doesn't overwhelm the public parking supply (either on-street or a public parking lot). However, requiring all new buildings to provide ample off-street parking has many negative impacts on cities and towns. Minimum parking requirements:

- Spread development over a larger area, reducing density, and encouraging or even necessitating car ownership and use
- Subsidize car ownership by transferring the cost of parking away from the user
- Degrade urban design by encouraging people to build surface lots and garages rather than inviting storefront and residential facades
- Reduce walkability by reducing density and encouraging active driveways and curb cuts rather than other street features such as trees and street furniture
- Increase the costs of development, which is passed on to consumers through higher prices for goods from commercial establishments and higher housing costs (recent research estimates that in 12 U.S. cities in 2012, the average cost of an above-ground parking structure was $24,000 per space and for an underground structure, $34,000 per space[33])

Fundamentally, minimum parking requirements are based on the assumption that the demand for parking does not depend on its price and therefore the supply of parking should not depend on the cost. By decoupling the cost of parking from the user, the demand for parking is inflated and justifies further increases to the supply of parking. As a result, a number of cities across the United States have been considering the removal of minimum parking requirements, and in some cases, replacing these with maximum parking allowances. In some cities, building developers provide amenities such as transit passes, on-site car sharing services, and bicycle parking in lieu of off-street parking spaces.

Further Guidance

More information on the impacts of off-street parking requirements can be found in *The High Cost of Free Parking* by Donald Shoup.

Design Vehicle

Engineers and planners should prioritize the mobility needs of a street's most vulnerable users (including pedestrians, bicyclists, or senior citizens) rather than the largest possible vehicle. While it is important to account for the challenges of moving larger vehicles (especially emergency vehicles), these infrequent challenges should not supersede the safety and comfort of the majority of daily street users. By designing for the largest vehicle, overall and everyday street safety is reduced by creating streets that accommodate and encourage higher vehicle speeds and longer pedestrian crossing distances.

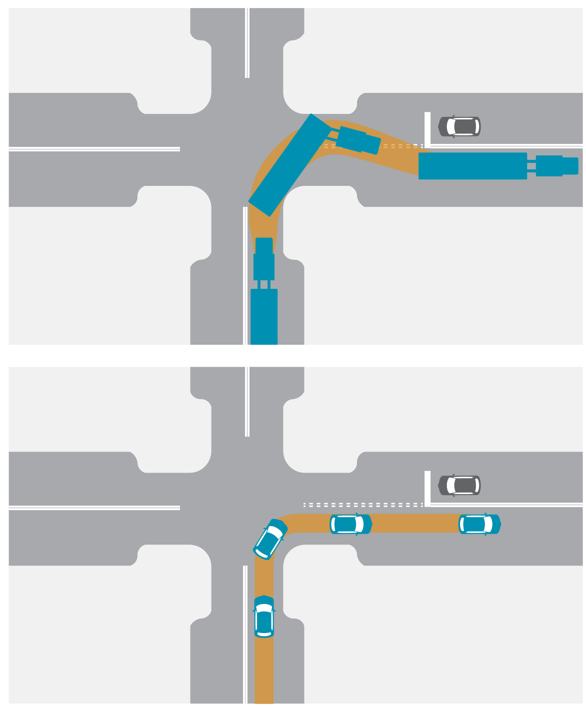
Strategies

- Larger vehicles can be accommodated at intersections with narrower turning radii by moving the stop bar on the receiving street back to allow for wider turns.
- As municipalities and other jurisdictions replace their fleet vehicles, they should consider purchasing smaller or more appropriate vehicles that match the context of their streets.

Further Guidance

- *Urban Street Design Guide,* NACTO

Controlling Turn Speeds and Recessed Stop Bars



Allowing vehicles that infrequently make turning movements to use the whole intersection allows the entire intersection to become more compact, reducing turning speeds of regular vehicles to 12 to 15 mph. A recessed stop bar prevents conflicts with opposing traffic.

Design Hour

Similar to the principles of the design vehicle, streets are often designed for a peak demand only present for an hour or two of the entire day. A street's uses, demands, and activities, however, change throughout the course of a day. A street at rush hour has different needs than a street at lunch hour. While it is important to understand the needs of the peak period, the design of a street should seek to balance the needs and functions of different time periods.

Vibrant urban areas are active throughout the entire day. When a street is designed purely to accommodate peak-hour vehicle volumes it might fail to provide a safe and attractive environment throughout the remainder of the day, resulting in a street that is overbuilt and not reflective of the surrounding context. The following strategies should be considered when evaluating and designing a street.

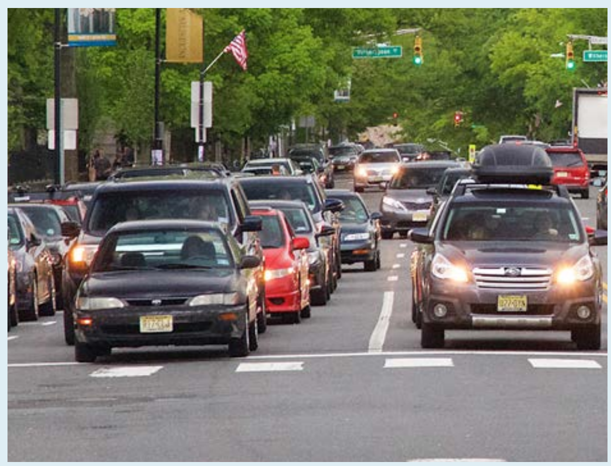
Strategies

- Travel times between origins and destinations tend to be similar across different routes within the network, meaning that if one route becomes congested, users will often choose a different route. Consider the ability of a whole network to move and diffuse traffic at the peak period and throughout the day.
- Consider strategies to channel and disperse traffic throughout the network toward preferred routes. This can include turn restrictions and 1-way to 2-way conversions.
- Consider the peak-hour activities of pedestrians and bicyclists in addition to motor vehicles. In New Jersey's more urban areas, the volumes of non-motorized modes might be similar to motorized modes, yet are often not considered when planning for peak-hour travel.
- Collect multi-modal data over the 2 to 3 hours of peak traffic to better understand traffic behavior throughout the entire peak period.
- Use performance measures that demonstrate overall corridor travel times rather than specific intersection peak level of service.
- If using ITE's Trip Generation standards, ensure that trips are assigned to multiple modes based on existing mode splits or anticipated mode splits. Consider using multi-modal level-of-service to more accurately understand and plan for travel impacts of development (discussed in detail on page 143).

Congestion

For many residents of New Jersey, roadway congestion is a daily concern that impacts their lives in many ways. These impacts can range from when and where trips are made, time spent commuting, lost productivity, and overall frustration. Designing streets only for the automobile discourages the use of different modes of travel and increases roadway congestion. According to the FHWA, half of all trips in metropolitan areas are 3 miles or less and over a quarter are 1 mile or less. In rural areas, 30 percent of all trips are less than 2 miles, yet the vast majority of these trips are made by automobile.[34]

A Complete Streets approach increases transportation choices—walking, bicycling, and transit—and encourages the use of alternate modes of transportation. According to the U.S. Department of Transportation (USDOT), about 44 percent of all vehicle trips made during the morning peak are not commuting trips but are rather for shopping, going to the gym or school, or running errands.[35] These trips are often short and could be made by alternate forms of transportation. A Complete Street provides a safe and comfortable environment to accommodate these alternate modes.



Design Year

Public officials, transportation planners, and engineers routinely make investments and recommendations that consider how infrastructure will respond to future growth and development. These investments and recommendations should reflect a set of goals and intended outcomes, coordinated with land use controls. The design year often used for roadway projects represents an estimation of future traffic demand and volume based on travel demand models and methods that often assume steady traffic growth. These projections often stand at odds with recent policy, demographic, and travel trends. While travel demand projections are an evolving field, their estimates should be qualified by intended outcomes and goal-driven policies.

Strategies

Traffic Growth Projections

In most places, traffic projections are based on a regional transportation model, which is calibrated to estimate existing and future transportation levels based on land use, transportation investments, and other factors. A recent study referenced by NACTO that investigated the post-construction accuracy of traffic forecasts found that traffic on roads in urban settings (arterials and collectors) was often significantly overestimated.[36]

Long-term trends have indicated that traffic volumes have leveled off following years of steady growth. Despite this, many travel models assume 1 to 2 percent annual growth in vehicle volumes. Many models also underestimate the potential benefits of improved land use decisions, growth in other modes, and overall shifts in mobility choices. Future analysis should therefore begin with a vision for the future function of the street or area and identify design treatments (or land use decisions, if applicable) that will achieve that goal.

Induced Demand

A study conducted by ITE found that between 50 and 100 percent of new roadway capacity is absorbed by traffic three or more years after expansion. The *Handbook of Transportation Engineering* notes that urban highway capacity expansion often fails to significantly improve travel times or speeds due to latent demand.[37]

The principle of induced demand means that the addition of roadway capacity along a particular route induced travelers to choose that route, thereby utilizing most or all of the additional capacity. Further, expanded roadways can degrade the pedestrian environment and increase space between land uses, which reduce the propensity of people to walk to destinations and makes transit services less viable. According to NACTO, if a project is determined to require an increase in roadway capacity, induced-demand should be considered a negative externality and other strategies should be considered to mitigate the projected demand.

Mode Targets

Many different U.S. cities and states have developed mode targets to achieve within a set time frame. The Massachusetts Department of Transportation has established a goal of tripling the number of trips taken by transit, bicycle, and walking. New Jersey municipalities should consider adopting mode goals and developing programs and strategies to achieve them.

Parking Minimums

The provision of free parking is one of the largest factors that influences travel demand. A growing body of research continues to demonstrate the effect that parking can have on vehicle miles traveled (VMT), both making it easier to drive a car and making it harder to use other modes by increasing the distances between land uses. The provision of parking is often a goal of municipalities that consider parking beneficial and require minimum parking requirements for most development. Removing these parking requirements can equalize the supply of parking with a more accurate representation of demand. More information on the effect of parking on travel demand and development cost can be found on page 70.

Further Guidance

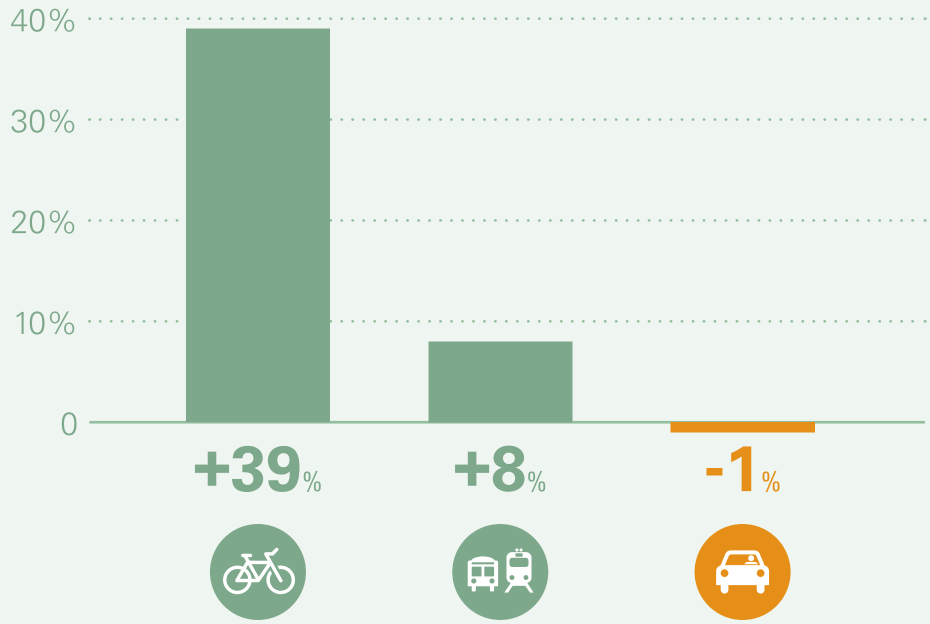
- *Urban Street Design Guide,* NACTO

Mode Share

Retrofitting streets for pedestrians, cyclists, and transit may sometimes require reducing or reallocating roadway vehicle capacity. While conventional perception is that reduced vehicular capacity leads to congestion, research suggests that the opposite is often true. This is related to the inverse of induced demand, known as "traffic evaporation," which means that when road capacity is reduced, vehicle volumes can actually respond by decreasing in similar proportion. Research suggests that displaced traffic either is absorbed by the surrounding street network, shifts to another mode, or the trip is altered. In essence, travel behavior reflects the conditions of the transportation system.

Investments made in making it easier to use transit, walk, or bicycle can influence changes in mode share. Recent data has shown dramatic increases in mode share for bicycling and public transportation.

Percentage Change in Mode Share (2005—2011)



Source: USDOT Bureau of Transportation Statistics and the League of American Bicyclists

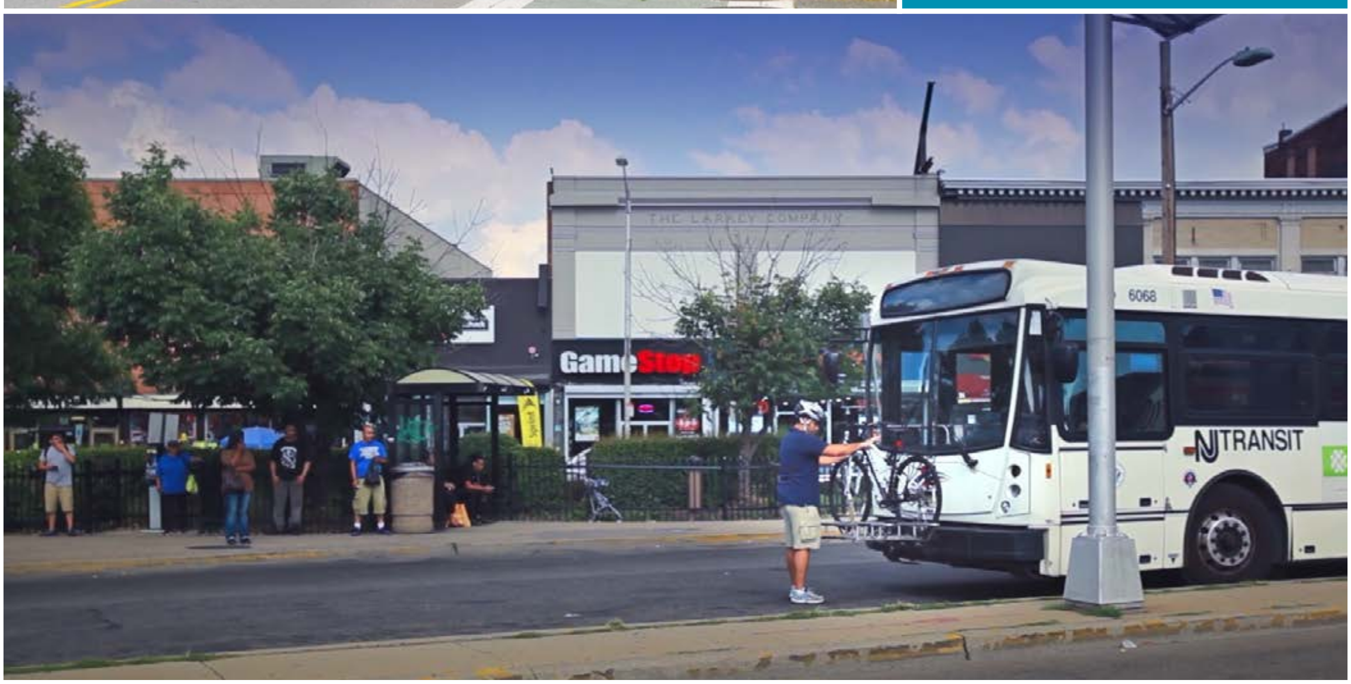
Photos (clockwise)

Crosswalk near the Morristown Green in Morristown, NJ

NJ Transit Passengers in Hamilton, NJ

NJ Passenger unloading bicycle in Passaic, NJ

Outside Morristown train station in Morristown, NJ



Is This a Good Investment?

Decisions we make regarding transportation investments have a direct influence on travel behavior, future transportation investment needs, and the overall cost of maintaining and operating our transportation system. When roads are expanded and supply is increased, often at no direct cost to the user, the demand for that road goes up. This principle, commonly referred to as "induced demand," significantly reduces the benefits of roadway expansions, particularly when it seeks to reduce congestion.

The graphic below demonstrates this concept. Traffic grows when roads are uncongested, but the growth rate declines as congestion develops, reaching a self-limiting equilibrium. If capacity increases, traffic grows until it reaches a new equilibrium.

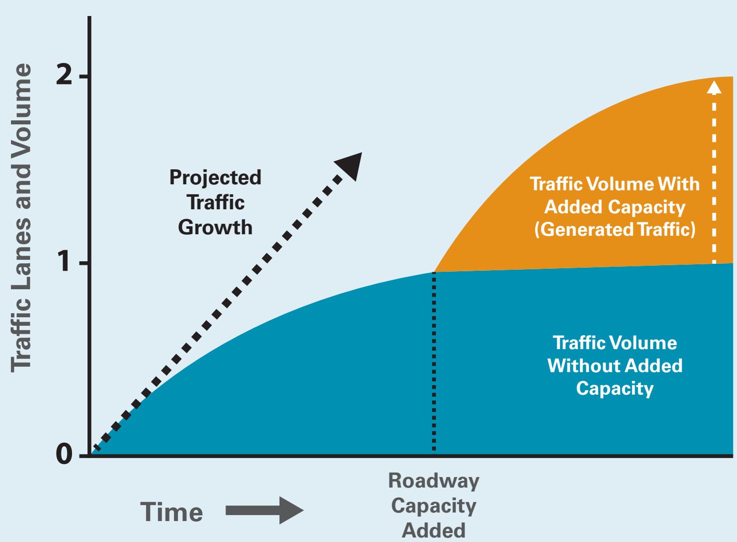
ARE ROADWAY CAPACITY IMPROVEMENTS A GOOD INVESTMENT?

The answer is that it depends on the situation. Planners, policymakers, and engineers, however, should always consider the impact that their transportation decisions will have on travel behavior, and therefore the long-term efficacy of their investment. Providing a good (such as road capacity) at no cost to the user will generate demand for that good. An investment in increased road capacity will often lead to marginal improvements in conditions over the long-term while carrying significant initial and long-term costs (as well as significant land use impacts).

WHAT'S THE SOLUTION?

Complete Streets! The Complete Streets approach prioritizes transportation choices. This means building a transportation system that not only accommodates and encourages multi-modal travel options, but also seeks to disperse motor-vehicle traffic through a well-connected roadway network with many travel options rather than funnel traffic toward higher-capacity roadways where driving is the only choice. This strategy is more cost effective and can better improve performance of the transportation system.

How Road Capacity Expansion Generates Traffic



Source: VTPI. "Smart Congestion Relief." 2013.

Transit

Efficient and cost-effective public transportation is essential for the continued growth and quality of life in a dense state like New Jersey. New Jersey has the highest population density of any state in the country and also has one of the most extensive public transportation networks, providing service in both urban and suburban areas. Despite this network, New Jersey has the third-highest average commute to work time in the United States at 30.4 minutes.[38] This is partly because of roadway congestion in New Jersey, which is some of the worst in the United States, particularly in urban areas.

New Jersey residents rely on public transportation far more than the typical U.S. resident. According to the U.S. Census Bureau, nearly 35 percent of workers in the New York/New Jersey/Long Island metropolitan area commute to work on public transportation, which is over twice as high as the next highest metropolitan area. The State of New Jersey overall has the second-highest percentage of residents (11 percent) who commute to work via public transportation.[39]

While many of New Jersey's transit riders take advantage of the state's extensive rail network, the majority of transit riders using NJ Transit ride the bus. For Fiscal Year 2014, NJ Transit reported over 530,000 average daily weekday boardings on its bus systems compared with over 295,000 on commuter rail and an additional 73,000 on light rail (this does not include privately operated bus trips). This means that in New Jersey, the bus network plays an integral role in the daily transportation needs of residents. Better accommodations for bus service on New Jersey's streets is an important goal of Complete Streets and also critical to the future mobility of New Jersey's residents. Compared with single-occupancy vehicles, buses consume far less public space per passenger and can help relieve congestion, improve air quality, and reduce greenhouse gas emissions.

Improving the frequency, speed, comfort, and reliability of transit is critical to supporting growth and encouraging mode shift away from private automobiles. These guidelines outline two basic types of transit facilities that can help achieve this goal: bus lanes, which are demarcated with color but no physical separation, and Bus Rapid Transit, which generally provides some level of physical separation along with other service enhancements to make bus transit more efficient, reliable, and attractive.

Every transit passenger is a pedestrian before and after their transit trip. Safe, comfortable, and convenient pedestrian connections are therefore critical to an effective transit service and encouraging higher ridership. The toolbox elements discussed in the Sidewalk section provide strategies to integrate transit stops into the pedestrian network and enhance pedestrian access to transit.

Travel Mode and Capacity

The capacity of a single 10-foot lane (or equivalent width) by mode at peak conditions with normal operations

Source: NACTO Transit Street Design Guide

=1,000/HR

PRIVATE MOTOR VEHICLES
600–1,600/HR

MIXED TRAFFIC WITH FREQUENT BUSES
1,000–2,800/HR

TWO-WAY PROTECTED BIKEWAY
7,500/HR

TRANSIT LANES[1]
4,000–8,000/HR

SIDEWALK
9,000/HR

ON-STREET TRANSITWAY[2], BUS OR RAIL
10,000–25,000/HR

1. **TRANSIT LANES:** Transit lanes are a portion of the street designated by signs and markings for the preferential or exclusive use of transit vehicles, sometimes permitting limited use by other vehicles. Transit lanes, unlike on-street transitways, are not physically separated from other traffic.

2. **TRANSITWAYS:** Transitways are running ways dedicated to the exclusive use of transit vehicles and protected from incursion by physical separation. Transitways are typically used for Bus Rapid Transit (BRT) or Light Rail Transit (LRT) systems.

Bus Lanes

Marked bus lanes provide a dedicated space for buses in the street, distinguished by colored pavement, different pavement material (such as concrete), bus-only pavement markings, and/or other signage. Curbside bus lanes, also called Business Access and Transit (BAT) lanes, are generally open to private vehicles at intersections or driveways as turning lanes.

In constrained urban environments, a contra-flow bus lane can be used to provide bus service counter to the flow of general traffic on one-way streets. Contra-flow lanes are generally used on short segments of connector streets to provide a continuous transit network. Because other users might be unaccustomed to looking both ways on a one-way street, contra-flow lanes should be well marked and separated from opposing traffic lanes.

Design Guidance

- Bus lanes should be at least 11 feet wide when there is no buffer beside the lane. Buffers can include striped shoulder, gore strips, bicycle-lane buffers, or other clear zones. When a buffer is present, bus lanes can be designed at a narrower width.
- Curbside parking adjacent to the bus lane should be avoided where possible.
- For contra-flow lanes, separation can be achieved with double yellow lines as well as flexible bollards, if necessary.

Further Guidance

- *Urban Street Design Guide,* NACTO
- *Transit Street Design Guide,* NACTO

Bus Rapid Transit

Bus rapid transit (BRT) is a high-capacity, lower-cost alternative to fixed-route rail that can dramatically improve transit mobility and transform communities from auto-centric to multimodal friendly. While there is a wide range of BRT systems that have been implemented in this country, including some that operate primarily in mixed-traffic, the higher-end BRT system generally includes dedicated lanes as well as other infrastructure designed to improve system quality and reduce delay.

A BRT system aims to provide the capacity and quality of service of a light rail or subway system at a lower cost and higher degree of flexibility. The features, characteristics, and quality of BRT systems typically make them more attractive to potential riders than conventional bus services, which can help encourage a mode shift toward transit. Because of its flexibility, BRT can support multi-nodal corridors, as opposed to traditional hub-focused rail systems.

While there are currently no higher-end BRT systems in New Jersey, many projects have been undertaken to provide enhanced and higher quality bus service using some of the elements of a BRT system. Moving forward, BRT can be implemented to improve mobility in New Jersey in both urban settings and suburban corridors. When undertaking BRT projects, efforts should be made to provide as many of the design features described below as possible, particularly those that improve the reliability of service to the highest degree (including dedicated lanes and bus priority at intersections).

Elements of Bus Rapid Transit

BRT systems typically include some or all of the following features:


Photo credit: wikipedia.com

Dedicated Lanes

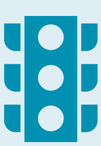
Bus-only lanes improve system reliability by accommodating faster travel and ensuring that buses are not delayed by traffic congestion. Bus right-of-way can be demarcated using a variety of methods, including a change of grade, curbing, bollards, or lane markings. Dedicated lanes are a critical component of a high-end BRT system, facilitating faster and more reliable service and making the bus a more attractive and usable travel option.

Transit Signal Priority at Intersections

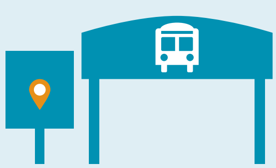
Bus priority can improve service and reduce delay at intersections controlled by traffic signals by extending the green phase or reducing the red phase in the required direction. Bus priority can be implemented by installing a detection system for the traffic signal and a transmitter on the transit vehicle. Bus priority strategies include green extension, where the green interval is extended up to a preset value if the transit vehicle is approaching; early green, where the conflicting phase is shortened when a bus arrives at an intersection; early red, where the green phase is shortened when a bus is on approach to cycle through the red phase earlier; phase rotation, where the order of phases at the intersection can be shuffled so that transit vehicles arrive during the phase they need; and actuated transit phases, which are phases that are called if a transit vehicle is present and allows transit vehicles to make movements that are generally not allowed for mixed traffic.

BRT Funding

For a BRT project to qualify for federal (FTA) funding, it must have:



Transit Signal Priority



Defined **stations with shelters** and **passenger information**

Branding

Short headways
(10 minute peak or 15 minute all day)

Frequent Service

BRT service should have a minimum 15-minute service frequency throughout a weekday or a combination of 10-minute peak service and 20-minute off-peak service frequencies. High service frequencies add greatly to the convenience of the system and eliminate the need for riders to consult schedules.

Intersection Treatment

In addition to bus priority, installing queue-jump lanes that allow a bus to avoid the queue and access an intersection can have major benefits.

Off-Board Fare Collection

Off-board fare collection allows passengers to pay their fare at the station, or stop, instead of on the bus. This allows riders to board any door, reducing the delay caused by passengers funneling through the front door and paying on board. Off-board fare collection is particularly useful at busy stations or stops.

Platform-Level Boarding

Passenger platforms at stations or stops should be approximately level with the bus floor to provide for easy access and boarding. Making boarding fully accessible for wheelchairs, disabled passengers, and baby strollers reduces delay and provides a higher quality of service for all passengers. Platform-level boarding can be accomplished through raised platforms (to approximately 12 to 14 inches) combined with low-floor buses.

High-Capacity Vehicles
Higher-capacity vehicles, such as articulated (60-foot) buses, may be used to provide additional capacity on more popular routes.

Branding or System Identity
Creating an identifiable and attractive system identity is critically important to the attractiveness of the BRT system for passengers and to increase ridership. Branding should apply to the buses, the stops/stations, and to passenger information materials. A distinct BRT identity helps passengers distinguish and identify the BRT system from other BRT lines in the system and from conventional bus services.


Photo credit: flickr user Embarqe Brasil

Higher Quality Stations
Providing improved bus stops and stations is essential to creating a successful BRT system. Many BRT systems include enhanced stops that feature attractive shelters, ticket vending machines, raised platforms, well designed and visible signage, and enhanced informational displays, including real-time bus schedule information.

Further Guidance
- Transit *Bus Rapid Transit Service Design Guidelines,* VTA
- *Bus Rapid Transit Planning Guide,* Institute for Transportation and Development Policy
- *Transit Street Design Guide,* NACTO

Quality of Transit Service

Reliable, frequent, and comfortable transit service is critical to the utility and success of transit systems. Transit modes in New Jersey include commuter rail, light rail, subway, and buses. These modes serve different purposes and meet the needs of many different users. Some transit services, such as commuter rail or subways (including NJ TRANSIT and PATH service), run exclusively along dedicated right-of-way. Light rail service (including the Hudson-Bergen Light Rail and River Line) runs primarily on dedicated right-of-way but interacts with other modes at at-grade intersections and shares the roadway with vehicular traffic where dedicated right-of-way is not available. Buses in New Jersey run primarily in mixed traffic, and as a result, the quality of service is generally dependent on traffic and other street conditions.

Strategies

Designing streets for transit access can improve the quality of service and encourage more people to use the service. Quality transit includes many components, as described below.

Reliable and On-time Service

Reliable and on-time service is a key component to a successful transit system. This is more easily achieved on dedicated right-of-way. Greater frequency of transit service helps improve reliability and the number of options available for transit riders. In denser urban areas of New Jersey, high-frequency transit service is typical and often has a variety of connected transit routes. For less dense suburban or rural areas, service is often less frequent. Bus service is critical in these locations for filling gaps in rail transit service, but long headways and unpredictable schedules can limit the usability and attractiveness of the system. More reliable service is an integral element to quality transit service.

Well-designed and Accessible Stations and Stops

Stations and stops should be comfortable and accessible for all users. In New Jersey, bus stops are often located in very hard to reach locations (such as a jug-handle) and/or do not have shelters, benches, or signs. By making stations and stops accessible and comfortable for passengers, transit service becomes a more attractive option for potential users and a more dignified option for those who already rely on the system. Quality station or stop design should include the following (depending on context):

Posted Schedules and Routes

The availability of posted schedules and route maps is an essential component of transit service. Schedules should be kept up to date and include any special advisories.

Seating

In locations that include a bus shelter, seating can improve the experience of waiting for a bus. Seating generally includes one or more benches.

Lighting

Lighting enhances the visibility of a transit stop and can improve the sense of safety and security at a stop.

Signage

Signage is an essential element of quality transit. Signs indicate that there is a stop, as well as the routes servicing that stop. Signage should be bright, well lit, and kept clean to maintain a high level of service.

Facilitated Access from All Modes, Particularly Pedestrians and Bicyclists

This includes providing bicycle parking at stops and stations and facilitating the ability of passengers to carry bicyclists on buses or trains. Passengers often use bicycles to get to a transit stop, and once they arrive at their destination stop, their bicycle might be critical for the last leg of their journey.

Quality Wayfinding to Stations and for Navigating the System

Stations and stops must be easy to locate. Once at a station or stop, passengers should be able to easily navigate the transit systems. Facilitating this requires quality and easy-to-understand wayfinding to stations and stops, and easy-to-understand maps and schedules at the station or stop. The availability of real-time information indicating the location of vehicles is an important innovation that dramatically improves the quality of transit service—particularly for buses, which often run outside of their schedule. This information is available on many systems via smartphone and online applications. This information can, and should, be included at more heavily used stops as well.

Further Guidance

- *Transit Streets Design Guide,* NACTO

Photos (clockwise)

NJ Transit's River Line light rail (shown in Palmyra, NJ) serves many towns between Trenton, NJ and Camden, NJ

Bus stop on George Street in New Brunswick, NJ features clear signage and a comfortable and accessible bus shelter

NJ Transit commuter rail platform in Morristown features bicycle parking and a downtown location

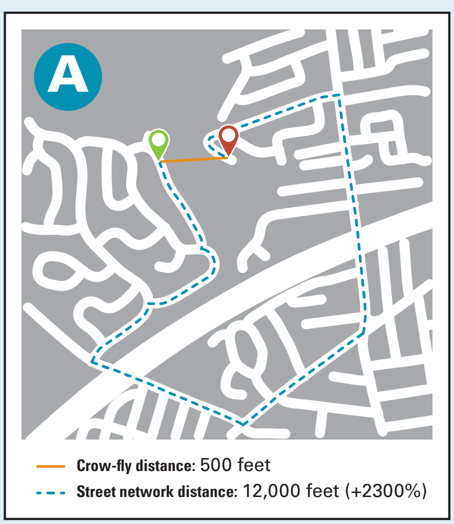
Walkability, Connectivity, and Land Use

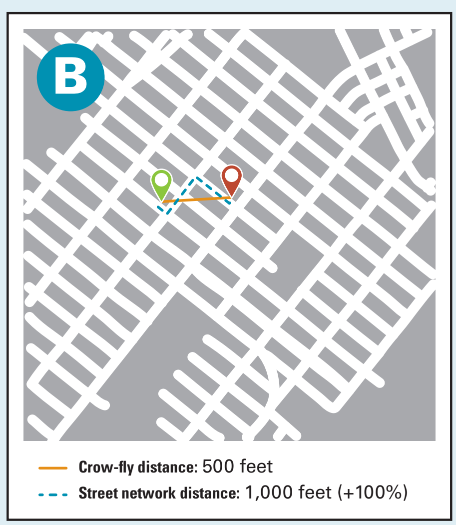
One of the most important factors that influences mobility is the mix and layout of the land uses of an area. The relationship between transportation and land use is symbiotic. Diffuse land use patterns necessitate investments in transportation that provide access to these areas. Similarly, an auto-centric transportation system necessitates automobile use and therefore increased roadway capacity and parking availability, which can further diffuse land uses.

Because of the closeness of this relationship, land use decisions are a critical component that determines transportation needs and costs. In this way, what are often private decisions (e.g., how to develop a lot, where to develop) become public concerns (e.g., roadway widening, new traffic signals, expanded utilities). It is in the public's interest for land use and transportation decisions to be planned together.

Development patterns impact the needs of a transportation system, user behavior, and the viability of different modes. The development pattern shown in **Example A** is characteristic of typical suburban development patterns seen in New Jersey following World War II. In this example, retail is located in a separate section of town from residential areas. Furthermore, the residential area features a winding street pattern that discourages through traffic. The result is that a trip from one residence to a store is 2,300 percent longer on the street than the physical distance. Additionally, there is only one possible path to the store—funneling all traffic onto one road, placing increased burdens on this roadway. The long distances discourage non-motorized transportation, and the lack of central nodes makes transit difficult to operate.

Example B shows a more traditional grid street pattern found in many older communities in New Jersey. In this example, residential areas are either next to or mixed within commercial areas. A trip from one residence to a store can take many different paths, and the distance between these locations is far shorter than in Example A, encouraging the use of non-motorized modes such as walking or bicycling. Additionally, because this development pattern features centralized nodes, transit service is more viable and more easily administered. These examples demonstrate how development decisions affect the mobility and mode options (and choices) of a community.





Access during Construction

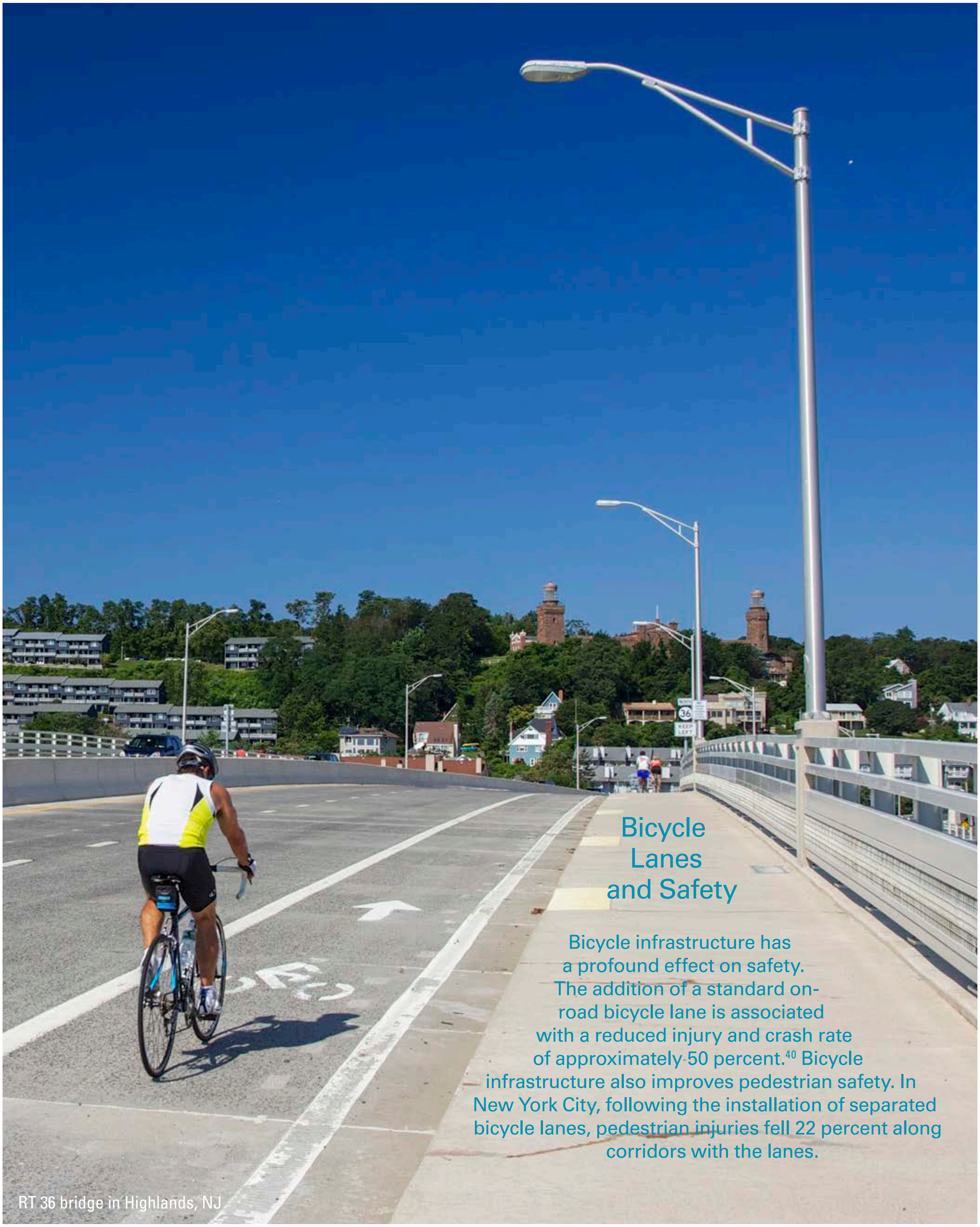
When construction occurs within or adjacent to the public right-of-way, public accessibility must be provided for people of all ages and abilities. While construction can disrupt mobility for all pedestrians, changes to the sidewalk travel flows and infrastructure can be particularly troublesome or hazardous for those with limited mobility. A closed sidewalk can cause hardship for pedestrians and someone in a wheelchair by forcing a long detour. This can be even more problematic for the visually impaired if there is not proper advanced warning signage and guidance. Such individuals might be used to navigating along a particular route and a disruption to this route can be dangerous. The following accommodations should be considered when laying out construction sites:

- Advanced warning and guidance signs
- Adequate illumination and reflectors
- Use of temporary walkways
- Channeling and barricading to separate pedestrians from traffic
- Adequate barricading to prevent visually impaired pedestrians from entering work zones
- Wheelchair accessible alternate pedestrian circulation routes with appropriate signage

Local construction ordinances should be updated to define accessibility requirements.

Further Guidance

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf.cfm



RT 36 bridge in Highlands, NJ

Bicycle Lanes and Safety

Bicycle infrastructure has a profound effect on safety. The addition of a standard on-road bicycle lane is associated with a reduced injury and crash rate of approximately 50 percent.[40] Bicycle infrastructure also improves pedestrian safety. In New York City, following the installation of separated bicycle lanes, pedestrian injuries fell 22 percent along corridors with the lanes.

Bicycle Facilities

The provision of bicycle facilities is critical to accommodating cycling as an essential form of transportation and encouraging increased cycling rates. However, bicycle facilities must be properly designed and implemented in order to ensure that they are safe, comfortable, and useful to the largest segment of the population. The guiding principles to achieve effective implementation is to follow the "Five Cs:"

Further Guidance

- *Urban Bikeways Design Guide,* NACTO
- *Guide to the Development of Bicycle Facilities,* AASHTO
- *Separated Bicycle Lane Design Guide,* FHWA
- *Small Town and Rural Multimodal Networks,* FHWA

Continuous

Many bicycle lanes disappear at intersections and other stressful locations. To be successful, bicycle lanes must be continuous through these locations.

Connected

Gaps in a bicycle network can discourage potential riders. Bicycle routes should be interconnected to create a robust network that connects where people live and where they want to go.

Convenient

Bicycle networks must conveniently and directly connect cyclists to key destinations in order to encourage higher rates of cycling.

Complete

A successful network takes into account what happens when a bicycle ride ends. This means considering how complete a street is, including the presence of sidewalks, bicycle parking, and access to transit.

Comfortable

A bicycle network should be comfortable and inviting for riders of all ages and abilities, providing the sense that cycling is a safe and convenient activity.

Bicycle Lanes

Bicycle lanes provide an exclusive space for bicyclists through the use of pavement markings and signage. Bicycle lanes are intended for one-way travel and are typically located on both sides of a two-way street and on one side of a one-way street. Bicycle lanes enable bicyclists to ride at their preferred speed, free from interference from motorists. Bicycle lanes help facilitate predictable behavior between bicyclists and motorists. Bicyclists may leave the bicycle lane to pass other bicyclists, make left turns, or avoid obstacles and conflicts. Motorists may pass through the bicycle lane to access parking or make other turning movements, but they may not stand or park in the lane.

The preferred location for bicycle lanes on a one-way street is on the left side of the roadway. Left-side bicycle lanes can result in fewer conflicts between bicyclists and motor vehicles, particularly on streets with heavy right-turn volumes or frequent bus stops. Left-side bicycle lanes can also increase the visibility of bicyclists to motorists at intersections. On one-way streets with parking on the right side, a left-side bicycle lane will result in fewer conflicts with parked cars. Additionally, due to higher frequency of single-occupant vehicles, on one-way streets with parking on both sides, bicyclists riding on the left will have fewer conflicts with car doors opening on the passenger side.

Design Standards

- The minimum bicycle lane width with no on-street parking is 5 feet adjacent to a curb, 4 feet with no curb.
- The desirable bicycle lane width adjacent to parking is 7 feet. The minimum width permitted is 5 feet.
- When placed next to a parking lane, the desirable reach from the curb face to the edge of the bicycle lane is 14.5 feet. Wherever possible, parking width should be minimized in favor of increased bicycle lane width.

Applications and Use

- Bicycle lanes are recommended on streets with a posted speed limit of 25 to 35 mph. Where additional space is available, consider providing a buffered bicycle lane.
- On constrained corridors with high parking turnover, consider including pavement markings to guide bicyclists out of the door zone of parked vehicles.
- Bicycle lane striping should use the following standards: a 6- to 8-inch solid white line next to the travel lane, and a 4-inch solid white line next to the parking lane.
- Bicycle lane placement should be intuitive and visible for drivers *and* bicyclists.
- Left-side bicycle lanes have the same design requirements as right-side bicycle lanes.
- Left-side bicycle lanes are recommended on most one-way streets.
- On one-way streets where there is a dramatically higher frequency of left turns to right turns, a right-side bicycle lane may be the appropriate treatment.
- Left-side placement may not be appropriate on streets that transition from one-way to two-way.


14.5'
preferred
5' min

Buffered Bicycle Lanes

Buffered bicycle lanes are conventional bicycle lanes that are paired with a marked buffer space to horizontally separate the bicycle lane from the adjacent motor vehicle travel lane. While buffers are typically used between bicycle lanes and travel lanes to increase bicyclist comfort, they can also be used between bicycle lanes and parking lanes where there is high parking turnover to discourage cyclists from riding too close to parked vehicles, decreasing the risk of conflicts with drivers opening their car door.

Buffered bicycle lanes on a one-way street should follow the same guidelines as one-way conventional bicycle lanes. Buffered bicycle lanes on a one-way street should be placed on the left side of the roadway when possible and follow the same guidelines for right-side buffered bicycle lanes.

Design Standards

- The preferred (and minimum) width of a buffered bicycle lane is 5 feet.
- The preferred width of a buffer is 3 feet (minimum 1.5 feet).

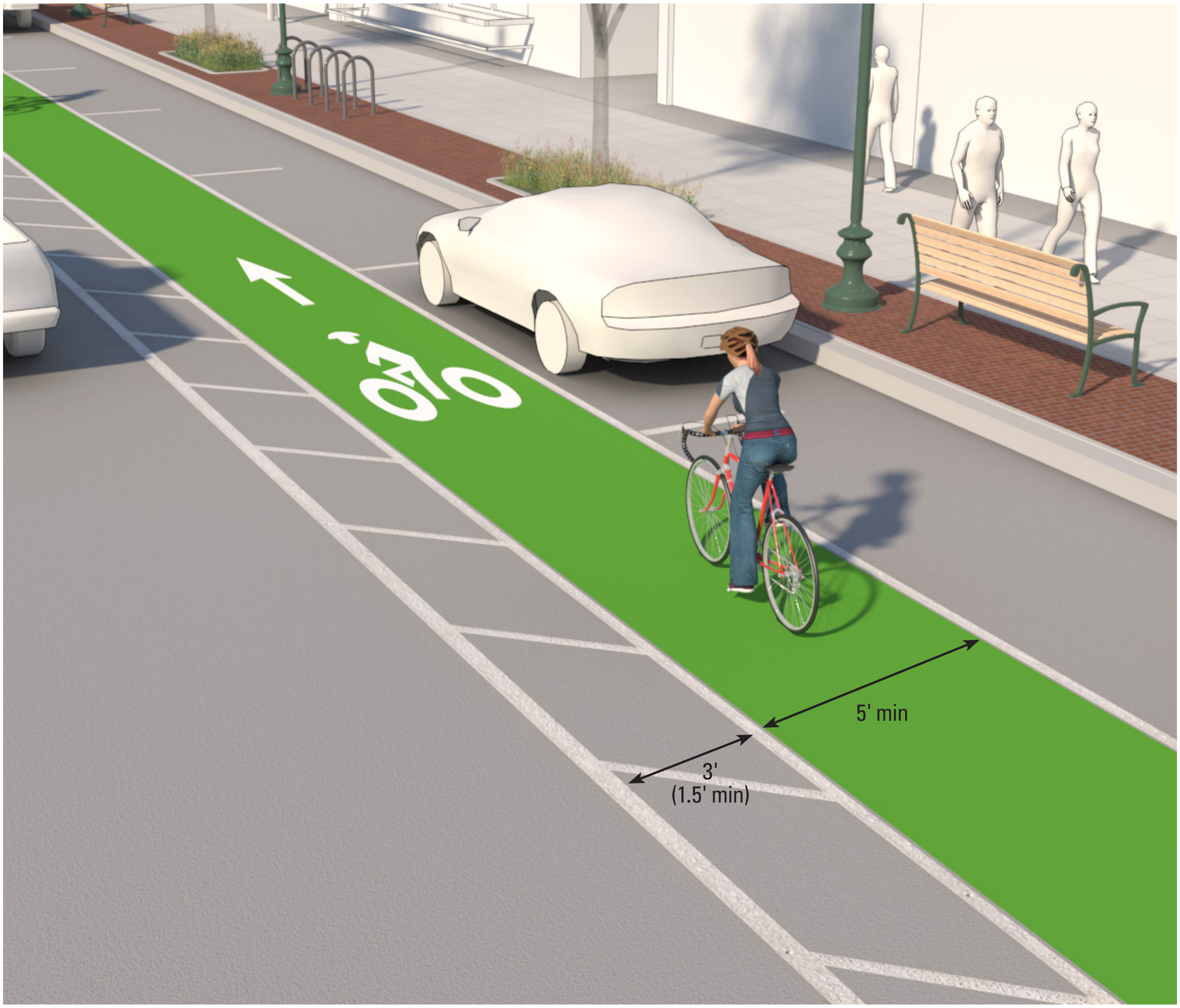
Applications and Use

- Buffered bicycle lanes are appropriate on streets with a posted speed limit between 25 and 35 mph.
- Where only one buffer can be installed on a constrained corridor with on-street parking, the buffer should typically be placed between the bicycle lane and the travel lane.
- Buffer striping should use the following standards: a 6- to 8-inch solid white line next to the travel lane, and a 4-inch solid white line next to the parking lane.
- Buffer striping should have interior diagonal cross hatching or chevron markings if 3 feet in width or wider.
- On wide one-way streets with a buffered bicycle lane, consider adding a buffer to the opposite side parking lane to further narrow the motor vehicle lanes and encourage lower travel speeds.
- Where existing cartway width allows, buffered bicycle lanes should be considered anywhere a conventional bicycle lane is recommended, particularly on streets with high travel speeds and volumes or on-street parking. On streets with extra width and on-street parking, a second buffer should be considered between the bicycle lane and the parking lane.

Benefits

- Buffered bicycle lanes provide additional separation between bicyclists and motor vehicles.
- Buffers provide space for bicyclists to pass one another without encroaching into the adjacent motor vehicle travel lane.
- The buffer encourages bicyclists to ride outside of the door zone when the buffer is placed between the bicycle lane and the parking lane.
- Buffered bicycle lanes increase the perception of safety on the roadway and therefore encourage increased bicycle use.

According to a 2011 Portland State University study, cyclists indicated that they feel a lower risk of being "doored" in a buffered bicycle lane, nearly nine in ten cyclists **preferred a buffered lane over a conventional lane**, and seven in ten indicated that they would go out of their way to ride in a buffered lane rather than a conventional lane.


5' min
3'
(1.5' min)

Separated Bicycle Lanes

Separated bicycle lanes are bikeways that are at street level and use a variety of methods for physical separation from passing traffic. Unlike a conventional or buffered bicycle lane, a separated bicycle lane provides vertical separation to prevent vehicle encroachment, improve safety, and deter double-parking. The separation of the bicycle lane from motor vehicle traffic makes the facility more attractive for bicyclists of all ages and abilities. Separated bicycle lanes also have a reduced risk of "dooring" compared to conventional bicycle lanes.

A separated bicycle lane on a one-way street should follow the same guidance for a buffered bicycle lane on a one-way street. Separated bicycle lanes on a one-way street should be placed on the left side of the roadway when possible and follow the same guidelines for right-side separated bicycle lanes.

Design Standards

- The preferred width of a separated bicycle lane is 6 feet. The minimum width permitted is 5 feet.
- The preferred and minimum width of the buffer with on-street parking is 3 feet. The minimum width permitted without parking is 1.5 feet.
- The minimum width between any vertical separation and the curb is 7 feet.

Applications and Use

- Separated bicycle lanes should be used along streets with high motor vehicle volumes and/or speeds.
- Separated bicycle lanes should be designed to allow bicyclists to pass other bicyclists.
- Typical forms of separation include removable or permanent bollards, raised curbs or medians, or planters.
- Where on-street parking is present, the parking lanes should be located adjacent to the travel lane, creating a physical separation for the bicycle lane.
- Parking should be prohibited a minimum of 20 feet from an intersection to increase the visibility of bicyclists.
- Similar to guidance for conventional bicycle lanes and buffered bicycle lanes on one-way streets, separated bicycle lanes on one-way streets should typically be placed on the left side of the road because of the increased visibility of cyclists to drivers.
- Separated bicycle lanes are preferred treatments on streets with on-street parking, frequent parking turnover, high traffic volumes or speeds, and along streets with high bicycle volumes. Separated bicycle lanes might not be feasible on streets with frequent intersections or driveways. Where separated bicycle lanes are feasible, they are the preferred design option.

Benefits

- Separated bicycle lanes encourage increased cyclist use among users who do not like riding with traffic.

According to a 2015 study by Portland State University, protected (or separated) bicycle lanes increase the number of adults who say they would be "very comfortable" biking on the road from 9 percent to 29 percent. This compares to 12 percent of adults who say they would be "very comfortable" biking on a street with a painted bicycle lane but no physical separation.


7' min
6'
(5' min)
3' min

Two-way Separated Bicycle Lanes

Two-way separated bicycle lanes are physically separated bicycle lanes that allow bicycle movement in both directions on one side of the road. Two-way separated bicycle lanes share many of the same design characteristics as one-way separated bicycle lanes, but might require additional considerations at driveway and side-street crossings. Two-way separated bicycle lanes reduce the detour length for bicyclists by providing contra-flow movement and permitting more convenient and direct routes. Research indicates that two-way separated bicycle lanes are more attractive to bicyclists of all ages and abilities.

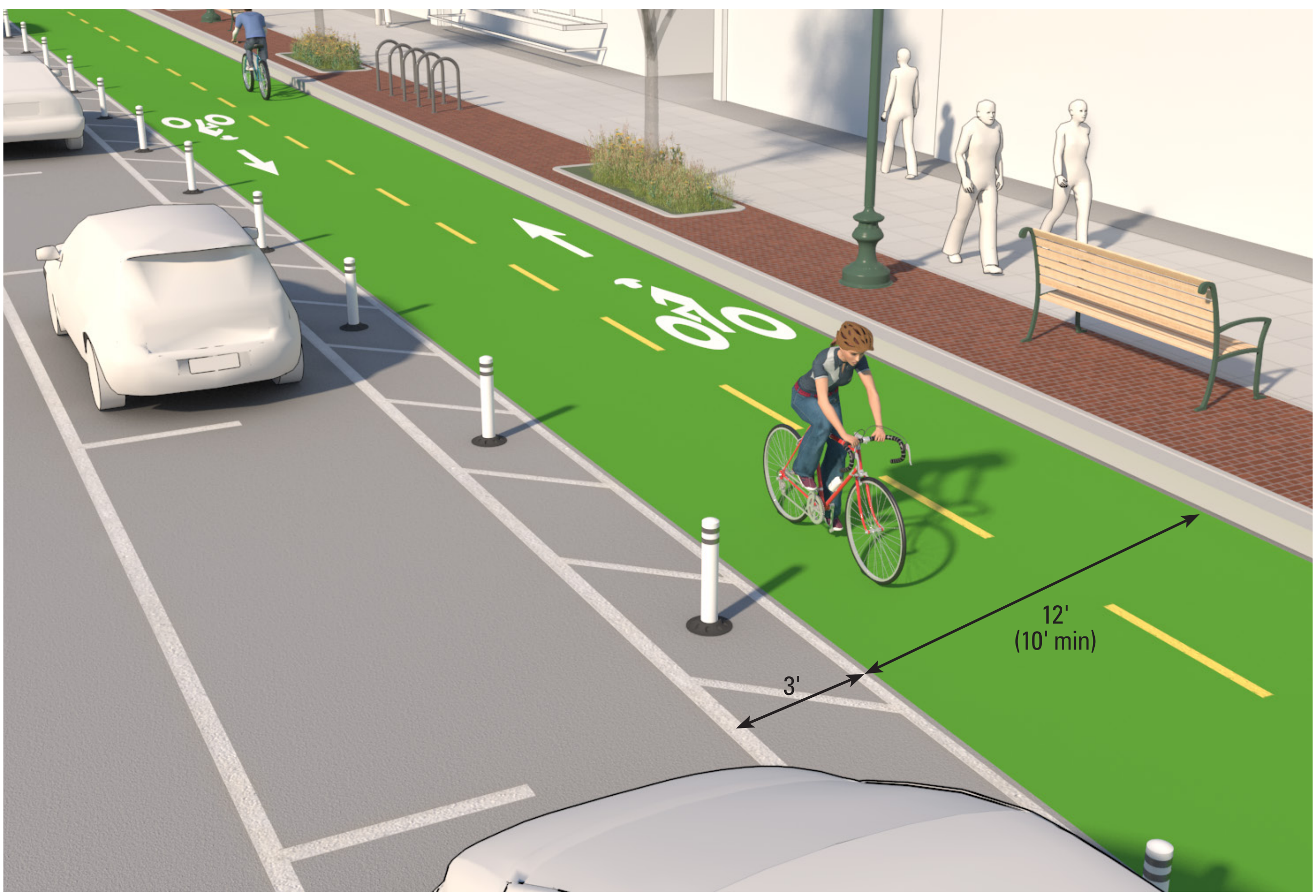
Design Standards

- The preferred width of two-way separated bicycle lanes is 12 feet. The minimum width permitted is 10 feet.
- The preferred and minimum width of the buffer with parking is 3 feet. The minimum width permitted without parking is 1.5 feet.

Applications and Use

Two-way separated bicycle lanes are typically located on:

- Streets with few driveway or cross-street conflicts
- Streets where there is not enough room for one-way separated bicycle lanes on both sides of the street
- One-way streets where contra-flow bicycle travel is desired
- Streets with extra cartway width
- Streets where high traffic speeds and/or volumes could create high levels of stress for bicyclists

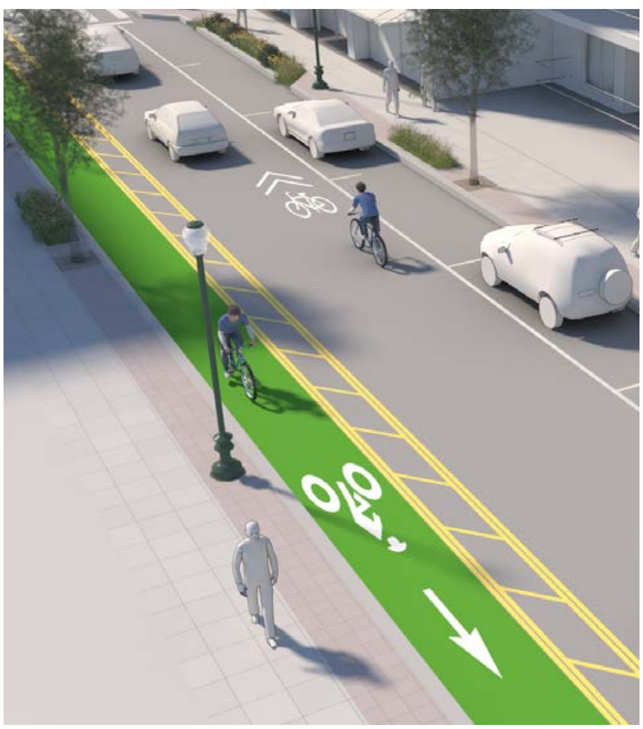


Contra-flow Bicycle Lanes

Contra-flow bicycle lanes are bicycle lanes that are designed to allow bicyclists to ride in the opposite direction of motor vehicle traffic. In many locations throughout New Jersey, particularly dense urban settings, the configuration of a roadway network (including the layout of one- or two-way streets) can make bicycling to specific destinations and points within the network difficult. A contra-flow bicycle lane can help solve this problem by converting a one-way street into a two-way street for cyclists: one direction for motor vehicles and bicycles and the other for bicycles only. Contra-flow lanes should be separated with yellow center lane striping.

Design Standards

Dimensions of a contra-flow lane should follow the guidance of bicycle lanes (or buffered bicycle lanes where possible).



Applications and Use

- Bicycle lane word, symbol, and arrow markings (MUTCD Figure 9C-3) should be used to define the bicycle lane direction and designate space for cyclists.
- "One-Way" sign (MUTCD R6-1, R6-2) with "Except Bikes" plaque should be posted along the facility and at intersecting streets and driveways.
- "Do Not Enter" sign (MUTCD R5-1) with "Except Bikes" plaque should be posted along the facility to only permit use by bicycles.
- A solid double-yellow lane line marking should be used to demarcate the lane from opposing traffic.
- If sufficient space exists, a buffered bicycle lane design should be used.
- Contra-flow lanes are for use on one-way streets that provide more convenient connections for bicyclists where other routes are less desirable.
- Contra-flow lanes are less desirable on streets with frequent and/or high-volume driveways on the side with the proposed lane.
- Contra-flow bicycle lanes are typically used on one-way streets where:
  - There is already a high number of cyclists riding the wrong way
  - The contra-flow lane provides direct access to a major destination
  - The contra-flow lane provides a network connection that reduces the trip length and improves the convenience of cycling
  - The contra-flow lane provides an alternative to high speed or high volume roadways

Benefits

- Provide connectivity and access to bicyclists traveling in both directions
- Reduce dangerous wrong-way riding and the frequency of bicyclists riding on the sidewalk
- Reduce bicyclist trip distance while accommodating bicyclists on safer and less heavily traveled streets

Shared Lanes

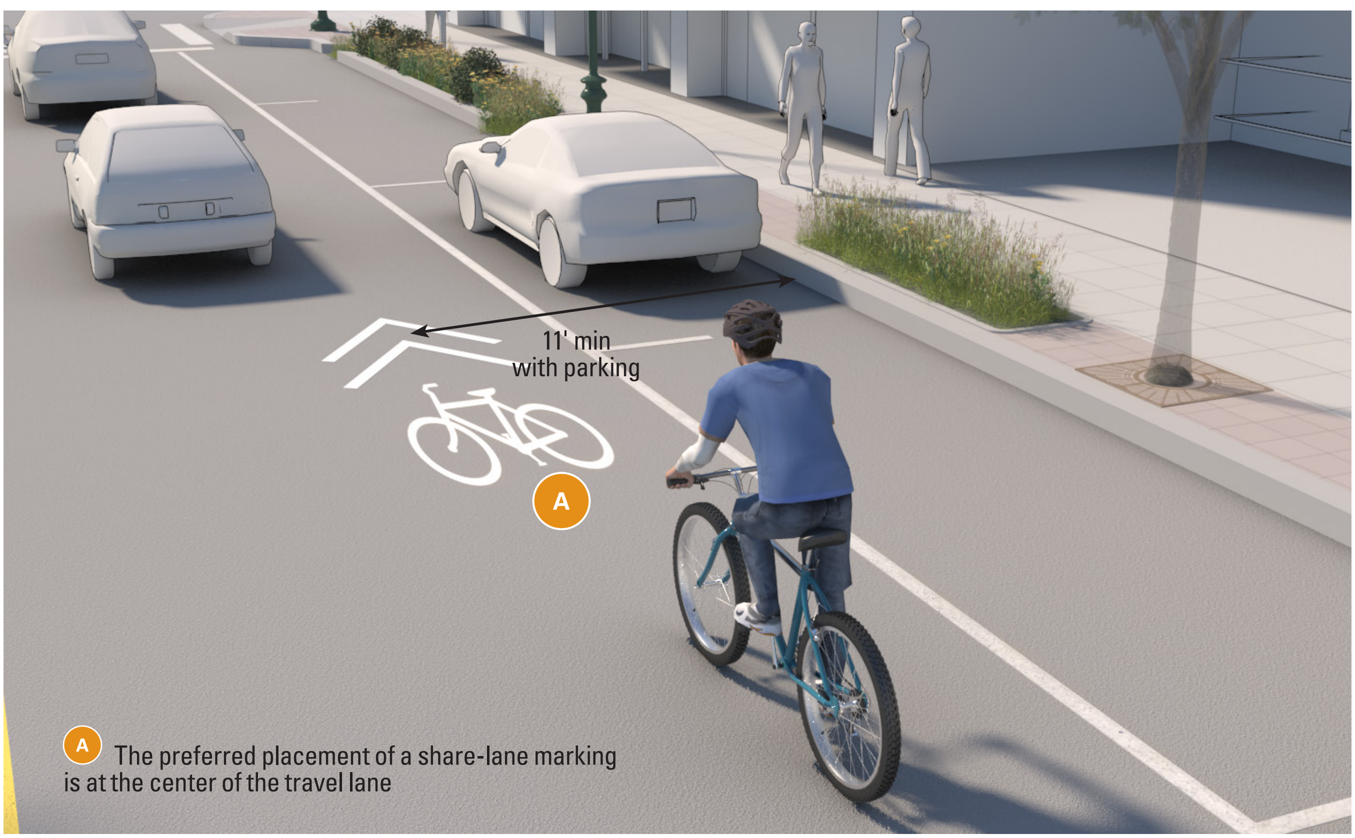
On roadways where it is not feasible or appropriate to provide dedicated bicycle facilities, shared-lane markings (also known as "sharrows") may be used to indicate a shared environment for bicycles and automobiles. Shared-lane markings should be used to connect and provide a designated route to dedicated bicycle facilities. A shared-lane marking is not a facility type but can be used to assert the legitimacy of bicyclists on the roadway and offer directional and wayfinding guidance. Shared-lane markings help direct bicyclists to ride in the most appropriate location on the roadway and provide motorists with visual cues to anticipate the presence of bicyclists.

Design Standards

- When adjacent to parking, shared-lane markings should be placed a minimum of 11 feet from the curb (4 feet without parking).
- The preferred placement of a shared-lane marking is at the center of the travel lane.

Applications and Use

- Shared-lane markings should only be used on streets with a posted speed of 25 mph or less and where traffic volumes are low enough that it is desirable for bicyclists to ride in traffic.
- Shared-lane markings should be used in conjunction with traffic-calming measures to encourage and reinforce appropriate vehicular speeds for shared-lane conditions.
- Shared-lane markings may be used at intersections where the roadway is too constrained for a continuous dedicated facility.
- Shared-lane markings are more appropriate on single-lane rather than multi-lane roadways.



A The preferred placement of a share-lane marking is at the center of the travel lane

Bicycle Boulevard

Bicycle boulevards are linear corridors of interconnected, traffic-calmed streets where bicyclists are afforded an enhanced level of safety and comfort. Many local streets that have existing low motorist travel speeds and volumes create the basic components of a safe and comfortable bicycling environment. These streets can be enhanced by a variety of design treatments that discourage high vehicle speeds and volumes to create a bicycle boulevard. Many of these treatments benefit not only bicyclists, but all users of the street by creating a safe and quiet environment.

Bicycle boulevard treatments include signs, pavement markings, and other traffic-calming measures to discourage through trips by motor vehicles while accommodating local access. Some bicycle boulevards also include links for bicyclists that are not open to vehicular through traffic.

Applications and Use

According to NACTO's *Urban Bikeway Design Guide*, streets developed as bicycle boulevards should have 85th percentile speeds at 25 mph or less (20 mph preferred). A variety of tools are available to help manage vehicle travel speeds and create a comfortable environment for bicyclists and pedestrians.

Toolkit

The following treatment types can be used (where applicable) to create a bicycle boulevard:

- Reduced speed limits
- Signage and markings
- Speed management
- Volume management

Reduced Speed Limits

Bicycle boulevards should have a maximum posted speed limit of 25 mph. Speed limits below 25 mph should be considered. Speed limit adjustments and signage alone may do little to reduce vehicle travel speeds and should be considered in conjunction with physical infrastructure improvements as a method for reducing vehicle travel speeds.

Signage and Markings

Signs and pavement markings are important elements of a bicycle boulevard. While signs and markings alone do not create a safe and effective environment, they indicate and reinforce the concept that a roadway/corridor is intended as a shared, slow street. The NACTO *Urban Bikeway Design Guide* provides additional guidance on sign and marking types and applications.

Speed Management

Speed management treatments aim to reduce motor vehicle speeds closer to those of bicyclists. Reducing vehicle speeds is a critical feature of the bicycle boulevard. Lower speeds improve the bicycling environment by reducing instances of vehicles overtaking bicyclists, enhancing the drivers' ability to see and react to bicyclists, and reducing the severity of crashes if they occur. Speed management treatments can be divided into two types: horizontal and vertical deflection. These treatments can be implemented individually or in combination to increase their effectiveness. Traffic-calming measures are also discussed in more detail on page 61.

Speed Management Techniques:

- Decrease motor vehicle speeds
- Decrease crash likelihood
- Decrease chances of injury resulting from crash
- Improve bicyclist comfort
- Benefit pedestrians and residents by reducing vehicle speeds
- Establish and reinforce bicycle priority on bicycle boulevard
- Provide an opportunity for landscaping and other community features such as benches, communal space, and artistic painted intersections, benefiting all roadway users and residents

Horizontal Deflection

Horizontal speed control devices are used to slow motorists by either visually narrowing the roadway or deflecting motorists through an artificial curve. Where possible, sufficient space should be provided for bicyclists to pass around the outside of the elements.

The following are examples of horizontal deflection:

- Curb extensions
- Chicanes
- Center islands
- Neighborhood traffic circles

Vertical Deflection

Vertical speed control measures are composed of wide, slight pavement elevations that self-enforce a slower speed for motorists. Narrow and abrupt speed bumps that are often used in private driveways and parking lots are not recommended for public streets and are hazardous to bicyclists.

The following are examples of vertical deflection:

- Speed humps
- Speed tables
- Speed cushions
- Raised crosswalk

Volume Management

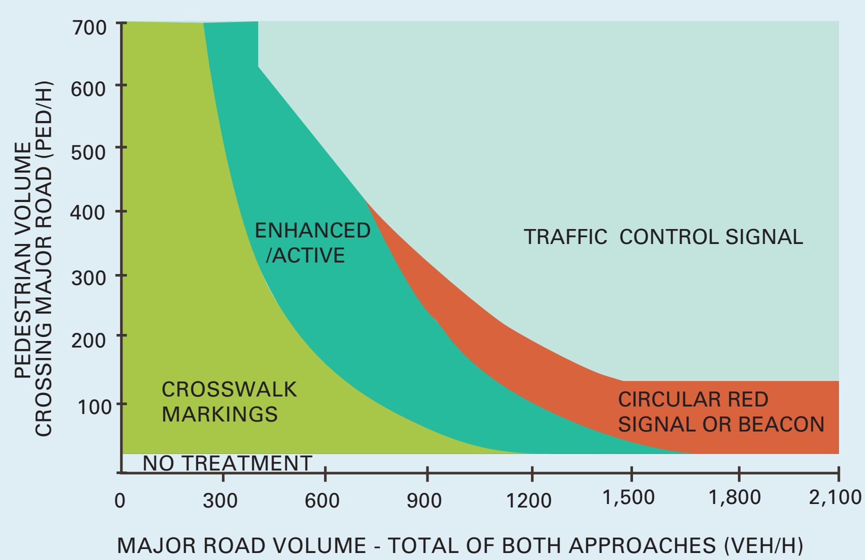
Volume management techniques reduce or discourage through traffic on designated bicycle boulevards by physically reconfiguring select intersections. Bicycle boulevards should be designed for motor vehicle volumes under 1,500 vehicles per day.

Volume management techniques include:

- **Forced Turn at Intersection**—Restriction on through movements for motor vehicles using signage. This can allow passage by buses and emergency vehicles but can lead to reduced compliance.
- **Channelized Right-In/Right-Out Island**—Forces motor vehicles to turn right while bicyclists can continue straight through.
- **Median Islands/Diverters**—Used to close one direction of traffic at an intersection while allowing full bicycle passage.

FHWA GUIDANCE ON BICYCLE BOULEVARDS

FHWA's guide, *Small Town and Rural Multimodal Networks,* provides robust guidance on the design and implementation of bicycle boulevards. The chart below, taken from the guide, is a helpful tool for deciding appropriate crossing treatments for a bicycle boulevard in a given context. The guide provides additional guidance for other contexts as well and should be used as a reference in a addition to professional judgment.



Example Guidelines for Pedestrian Crossing Treatments adapted from NCHRP 562 (Fig. A-5). Calculations assume 34 ft (10.4 m) Pavement, 35 mi/h 5 km/h), 3.5 ft/s (1.1 m/s) Walking Speed.

Credit: FHWA *Small Town and Rural Multimodal Networks*

Photos (clockwise)

Photosimulation of potential “shared-street” concept in Princeton, NJ creates more comfortable and usable space for all street users and encourages slower motor vehicle speeds

Traffic diverter in Portland, OR helps reduce motor vehicle volumes while accommodating bicycle access

The Haven Avenue Bicycle Boulevard in Ocean City, NJ uses curb extensions to slow motor vehicle traffic and medians to reduce volumes on many residential side streets

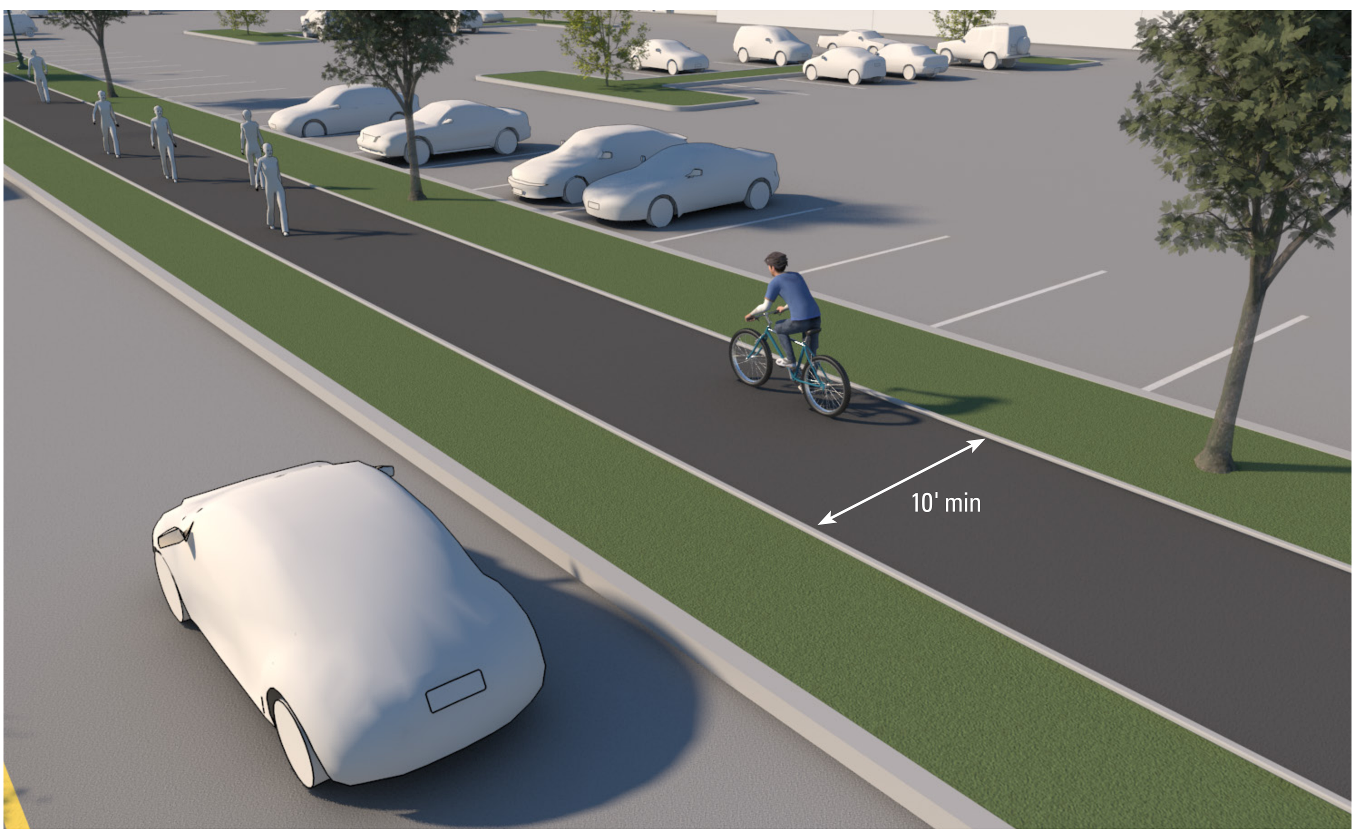
Shared-use Paths

Shared-use paths are bikeways that are distinctly separate from the roadway. Located outside of the cartway, they are separated physically from motorized traffic by either open space or a barrier. Shared-use paths are sometimes referred to as "trails." However, the term "trail" often refers to an unimproved recreational facility. Shared-use paths are designed to facilitate both utilitarian and recreational trips. Intended users may include bicyclists, pedestrians, roller skaters, skateboarders, and other non-motorized users.

Shared-use paths are typically designed for two-way travel. They can help provide low-stress bicycle accommodations in a variety of circumstances: a shortcut through residential neighborhoods, a commuting route from residential to commercial centers, a recreation route in a park or greenway, or as a side path along a roadway in lieu of (or in addition to) an on-road bicycle facility. Shared-use paths should be built as a system of off-road transportation routes that complements and enhances the on-road bicycle network.

Design Standards

- The minimum width for a shared-use path is 10 feet, although the recommended width differs based on the context, volume, and mix of users of a path. Typical shared-use paths range from 10 to 14 feet wide, with wider paths for higher-volume paths.
- A path may be reduced to an 8-foot width in certain circumstances:
  - For a short distance due to physical constraint
  - Where bicycle traffic is expected to be low
  - Where pedestrian use is not expected to be frequent
  - Where there are frequent passing opportunities
- Wider paths (11 to 14 feet) are advised where there are steep grades to provide additional passing area.



Applications and Use

- Using a sidewalk as a shared-use path is generally undesirable. Additionally, it is not appropriate to sign a sidewalk as a shared-use path if this prevents the use or development of preferable bicycle facilities. Sidewalks are not intended for use by bicycles. If there is an intention for bicyclists to ride along the same right-of-way used by pedestrians, the facility should be designed to accommodate bicycle use and follow the design guidelines for a shared-use path.
- Shared-use paths should generally receive priority at driveways and minor cross streets.
- At intersections and driveways, motorists might not expect bicyclists traveling at higher speeds. Signage and pavement markings should be used to indicate the potential presence of bicyclists and remind drivers to approach the intersection with caution.

Benefits

- Provides low-stress facility that accommodates multiple types of users
- Provides connections between important origins and destinations and increase bicycle network connectivity where roadway space or context might make implementation of an on-road bicycle facility infeasible
- Helps improve bicycle mode share for commuting and recreational trips

Accessibility

Because shared-use paths are designed for both bicyclist and pedestrian use, they fall under the accessibility requirements of the ADA and should be designed as fully accessible facilities. The United States Access Board provides guidelines for the design of accessible shared-use paths.

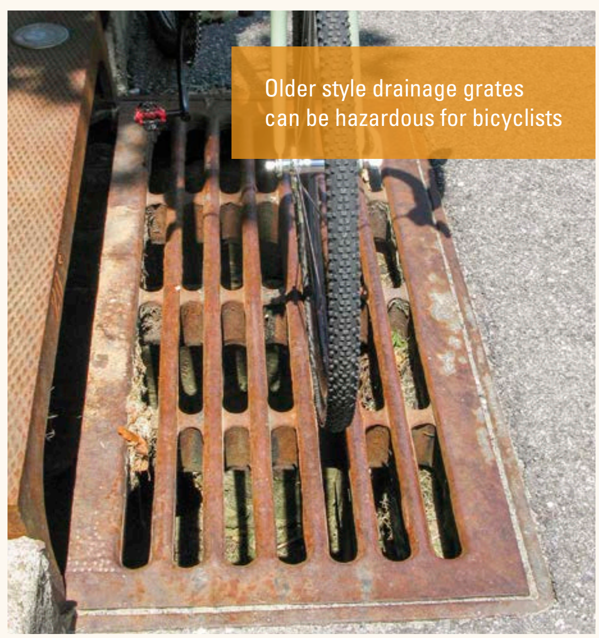
Further Guidance

- *Guide for the Development of Bicycle Facilities,* AASHTO

Gaps, Grates, and Other Openings

Wheelchair casters, bicycle wheels, and walking aids such as canes and crutches can get caught in grates and gaps. Grates should be placed within the furnishing zone away from the pedestrian travel area and away from the bottoms of curb ramps and crosswalks. Gaps and grate design should use the following guidance:

- Wheelchair casters, inline skating wheels, or bicycle wheels can get caught in openings and gaps wider than one-half inch. Therefore, gaps and grate openings should not allow the passage of a one-half-inch sphere
- The long dimension of the grate opening should be perpendicular or diagonal to the dominant direction of travel.



Older style drainage grates can be hazardous for bicyclists

Bicycle Level of Traffic Stress

Analysis tools and methodologies provide performance indicators to measure the quality of a transportation service or infrastructure. Recent research and development of newer metrics related to cycling recognize the need to provide a wider range of bicycle facilities types in order to accommodate the diversity of cyclists' needs, abilities, and experience levels.

The Bicycle Level of Traffic Stress (LTS) analysis is a tool used to quantify a cyclist's comfort level given the current conditions of the roadway. The LTS metric, developed by the Mineta Transportation Institute, is based on the Dutch concept of low-stress bicycle facilities, which has proven influential in the advancement of bicycle planning in the United States. Because different bicyclists have different tolerances for stress created by volume, speed, and proximity of automobile traffic, the LTS method identifies four levels of stress:

- **Level of Stress 1:** The level most users can tolerate (including children and seniors)
- **Level of Stress 2:** The level tolerated by most adults
- **Level of Stress 3:** The level tolerated by "enthusiastic" riders who might still prefer dedicated space
- **Level of Stress 4:** The level tolerated by the most experienced riders

In general, lower stress facilities have increased separation between cyclists and vehicular traffic and/or have lower speeds and lower traffic volumes. Higher stress environments generally involve cyclists riding in close proximity to traffic, multi-lane roadways, and higher speeds or traffic volumes.

Basis for Criteria

Extensive research into cycling behavior has made clear what many cyclists, and potential cyclists, might already know implicitly: most users do not feel comfortable sharing the road with motor vehicles when the prevailing speed of traffic is above 25 mph. High vehicle volumes add further complications to sharing the road, even at lower speeds. This discomfort manifests itself in a couple of ways. A street network built only to accommodate motor vehicles will discourage many bicyclists from riding, particularly if there are perceived barriers between the origin and the destination. Further, those who do choose to ride will typically be adults who feel more confident riding in mixed traffic, which often excludes the majority of the population.

Methodology

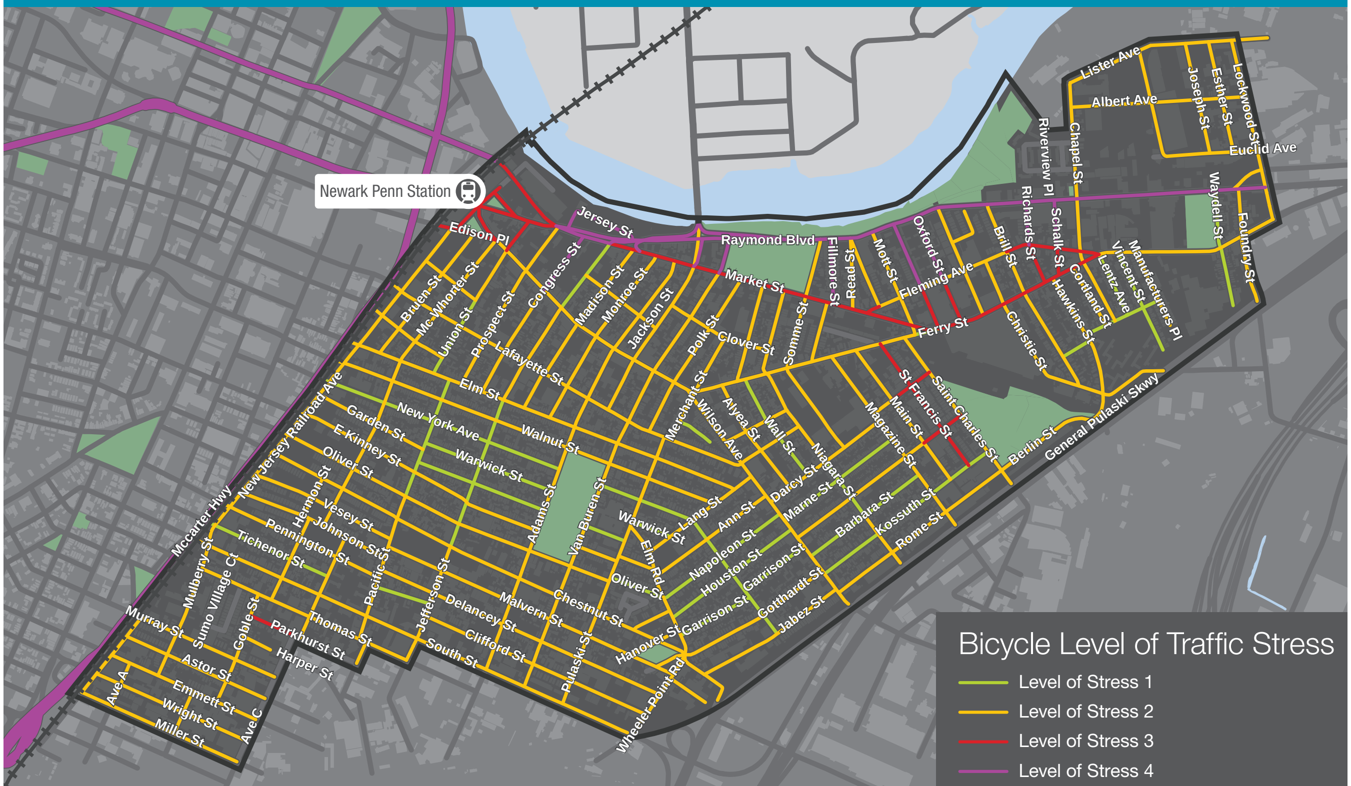
The LTS analysis is based on the Mineta Transportation Institute's research on low-stress bicycling and network connectivity. The LTS metric analyzes roadways in two ways: as segments between two points, and at intersections, where conditions often vary from the leading segment. For segments, roads are primarily rated based on their number of lanes and prevailing traffic speed. At intersections, stress level is determined based on the number and character of turning lanes, the presence or absence of traffic signals, and the level of stress of the roadway being crossed.

The intersection analysis is conducted because of the importance of connectivity in bicycle networks (and transportation networks in general). For many cyclists, a high stress intersection in a network can discourage them from riding or significantly limit the destinations and routes they feel comfortable biking to. When thought of in terms of automobiles, this principle becomes clearer. The vast majority of roadways accommodate automobile travel. If there were gaps in the roadway network where cars couldn't drive, the usefulness of the automobile would be severely limited. The same is true for bicycles.

Further Guidance

- *Low-Stress Bicycling and Network Connectivity,* Mineta Transportation Institute

Bicycle Level of Traffic Stress Map from the *Bike Ironbound: Bicycle Plan for the City of Newark*



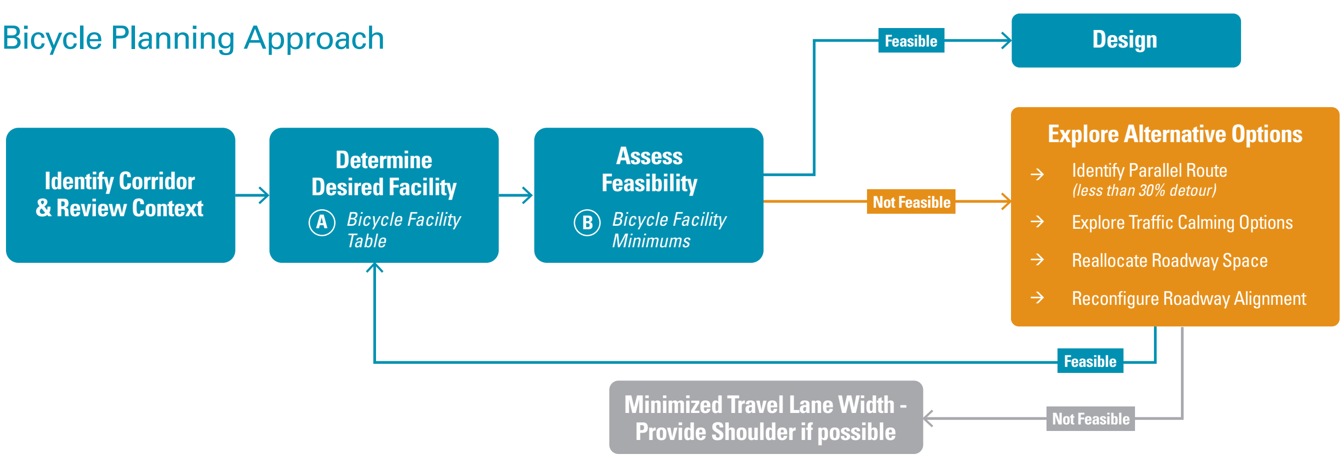
The Bicycle Level of Traffic Stress (LTS) Analysis was used as part of the *Bike Ironbound: Bicycle Plan for the City of Newark* to demonstrate barriers to comfortable and continuous bicycling in Newark's Ironbound neighborhood. The existing LTS is shown in the map above. The analysis was also run for the network assuming full implementation of the Plan's recommendations. This was useful to demonstrate the impact the recommendations would have on low-stress bicycle connectivity in the neighborhood.

Bikeway Selection Guidance

Selecting the appropriate bicycle facility is a process that requires an understanding of context, roadway characteristics, the types of cyclists expected to use the facility, and how the facility fits within the overall roadway and cycling network. The flow chart below outlines a basic bicycle planning approach for engineers and planners in New Jersey. The process requires the user to determine which bicycle facility is appropriate for the roadway using the Bicycle Facility Table.

The table below uses 85th percentile motor vehicle speeds (if not available, use posted speed) and average daily traffic to determine which bicycle facility is appropriate and comfortable for most adults (generally a bicycle level of traffic stress of 2 or better). Additional factors, such as truck volumes, should also be considered. Design options with lower speeds or greater separation are more attractive for most bicyclists. As with most design guidance, flexibility through professional judgment is essential in applying the guidelines.

Bicycle Planning Approach



A Bicycle Facility Table

ADT	85TH PERCENTILE SPEED[1]						
	≤ 20	25	30	35	40	45	≥50
≤ 2,500	A B C D E F	A[2] B C D E F	C D E F	C D E F	C D E F	D E F	F
2,500–5,000	B C D E F	B C D E F	C D E F	C D E F	D E F	D E F	F
5,000–10,000	B[3] C D E F	B[3] C D E F	C D E F	D E F	D E F	E F	F
10,000–15,000	D E F	D E F	D E F	D E F	E F	E F	F
≥15,000	D E F	D E F	D E F	E F	E F	F	F

A: Shared Street/Bicycle Boulevard **B:** Shared-lane Markings **C:** Bicycle Lane **D:** Buffered Bicycle Lane
E: Separated Bicycle Lane **F:** Shared-use Path

[1] If data not available, use posted speed
[2] Bicycle boulevards are preferred at speeds ≤25 mph
[3] Shared-lane markings are not a preferred treatment with truck percentages greater than 10%

B Bicycle Facility Minimums

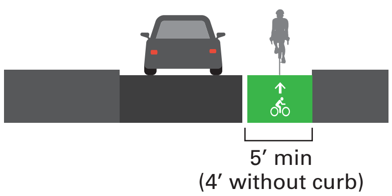
The following guidelines should be used to determine whether the selected facility can be implemented along a given corridor. More detailed guidance on these facilities is provided on pages 90-103 of this guide. The following considerations should be made in addition to the guidance provided below:

- General purpose travel lanes for motor vehicles in most contexts should be 10 to 11 feet wide.
- Shared-streets have no minimum width requirements.
- Shared-lane markings are not appropriate on multi-lane streets.
- Separated bicycle lanes can be striped at a different grade than street level and be considered "off-road."

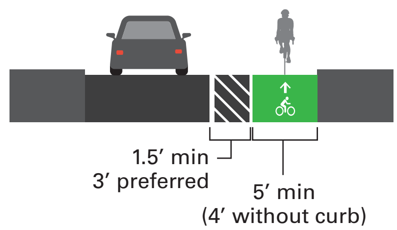
Further Guidance

- *Urban Bikeway Design Guide,* NACTO
- *Small Town and Rural Multimodal Networks,* FHWA

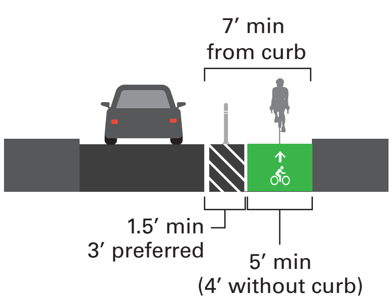
Bikeway Treatments and Minimum Requirements



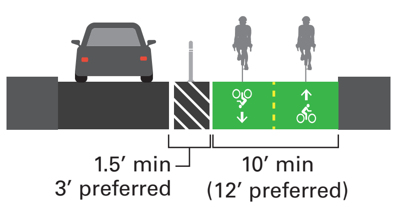
Standard Bicycle Lane



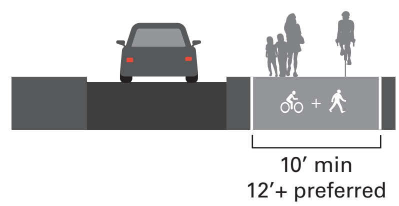
Buffered Bicycle Lane



One-way Separated Bicycle Lane



Two-way Separated Bicycle Lanes



Shared-use Path

Wayfinding

Pedestrian and bicycle wayfinding systems provide navigational aids that help pedestrians and bicyclists orient themselves within their surroundings and determine the best route to reach a destination. Wayfinding systems also help create a sense of place within a community or corridor, knitting it together through consistent treatments to help residents and visitors navigate between points of interest. Wayfinding signage should clearly identify the locations of key destinations, such as businesses, recreational areas, historical or cultural landmarks, bicycling routes, transit, and connections to nearby areas of interest.

Wayfinding systems can be designed and implemented formally by municipalities or business improvement districts. In many cases, walking and biking advocates have organized informal wayfinding systems to promote active transportation.

Signage should be flexible and fit its context and need. Types of wayfinding signage are shown in the graphic on the following page, including sidewalk signs with area maps, decision point signs at intersections showing directions and distances to nearby destinations, and bicycle route signs used to indicate where the cyclist is and directions/distances to other paths or destinations.

Wayfinding has many benefits for a community. By helping pedestrians and bicyclists overcome the hurdle of distance perception (where the time needed to walk or bike tends to be over-estimated), wayfinding can help encourage different transportation choices, including improving access to transit.

Many transit agencies have found that one of the simple, yet critical ways to increase transit ridership is to improve the communication of information to passengers. Real-time bus or rail information (on a smartphone, computer, or at a transit-stop) and improved route planning are among the ways that transit agencies have improved service and made transit a more attractive option. Similarly, a comprehensive wayfinding system for a bicycle network has many benefits that can help increase bicycle ridership, including the following:

- Familiarizes cyclists with the bicycle network
- Improves awareness of the bicycle network and the presence of bicyclists among motorists
- Identifies the preferred routes to key destinations
- Makes bicycling and the bicycle network more accessible and convenient for visitors and casual users
- Minimizes the tendency to overestimate the amount of time it takes to travel via bicycle by including information on mileage and/or travel time to destinations

A comprehensive and coordinated wayfinding system can contribute to a community's distinct identity while improving mobility for many different types of street users

Design Guidance

In order to be as effective as possible, a wayfinding system should be implemented in a consistent and deliberate manner. The following guidelines should be followed, when possible, when implementing or retrofitting a wayfinding system:

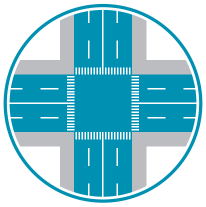
- Signage should maintain a clean, visible, and consistent design.
- Signs should be posted on both sides of the street or trail along major walking or bicycling routes.
- Maps should be oriented so that the direction the user is facing is at the top; indicate the orientation with the underlined phrase "You Are Here" where the pedestrian is within the map, and place an upward arrow under it.
- Distances should be defined by the time needed to reach them (e.g., "It's a 15-minute walk away" or circles encompassing destinations within a 5-, 10-, or 15-minute walk).
- A standard prioritization system should be used on maps to limit the number of landmarks identified.
- The facades of important landmarks should be illustrated on maps to help orient pedestrians.
- Indexes of major landmarks should be included.
- Public data should be made available to private organizations to develop smartphone applications ("apps") at no cost to governmental agencies. QR codes can be incorporated to improve information delivery and reduce visual clutter.

Further Guidance

- *Urban Bikeways Design Guide,* NACTO
- *Urban Street Design Guide,* NACTO

A well-designed intersection facilitates visibility and predictability for all users, reduces motor vehicle travel speeds, and makes complex movements feel safe and intuitive. An intersection should promote eye contact between all street users, allowing the street space to be effectively shared by pedestrians, drivers, and bicyclists.

Hoboken, NJ



INTERSECTIONS

Intersections are critical parts of the transportation network and streetscape. They are key decision points for all users as they navigate the street network and important activity nodes for community life as well as transportation. Intersections often account for the most serious and frequent conflicts between pedestrians, bicyclists, and drivers. Poorly designed intersections can dramatically reduce mobility and safety for all of these modes. However, a well-designed intersection can reduce crashes, improve mobility, enhance public spaces, and tap civic and economic potential.

A well-designed intersection facilitates visibility and predictability for all users, reduces motor vehicle travel speeds, and makes complex movements feel safe and intuitive. An intersection should promote eye contact between all street users, allowing the street space to be effectively shared by pedestrians, bicyclists, and drivers.

The strategies described in this section enable practitioners to build intersections that safely and effectively accommodate all users.

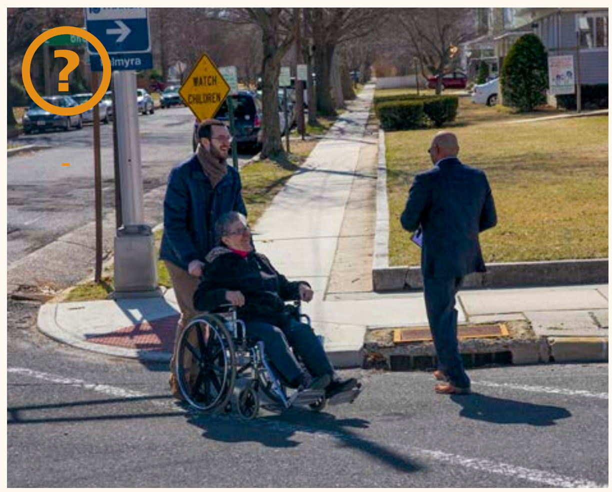
Accessible Intersections

Intersections can be very challenging or hazardous for those with disabilities or limited mobility. Improperly designed intersections have the potential of either putting people in harm's way as they try to cross the street or creating an impenetrable barrier that severely limits the mobility of many street users.

Small differences in design can have a large impact on the safety and usability of an intersection for users with various levels of mobility.

Many design decisions influence the accessibility of an intersection. Small differences in design can have a large impact on the safety and usability of an intersection for users with various levels of mobility. An improperly aligned curb ramp can lead a blind person into the middle of the street rather than the crosswalk. The lack of curb ramps or a moderate rise in the level between the ramp and street can prevent a wheelchair user from accessing the sidewalk or street. It is important to design intersections that at least meet the minimum standards for accessibility, but it is preferable to design intersections with the intention of maximizing the safety and accessibility of all roadway users.

The photos to the right show three intersections with varying degrees of accessibility. The intersection at the top, while not perfect, provides reasonable accessibility to all users with minimal sloped ramps that are oriented toward each crosswalk. The middle intersection provides an ADA-compliant curb ramp; however, there is only one ramp for the corner and it orients the user to neither crosswalk. The final intersection is not accessible for those with limited mobilities because there is no curb ramp provided.



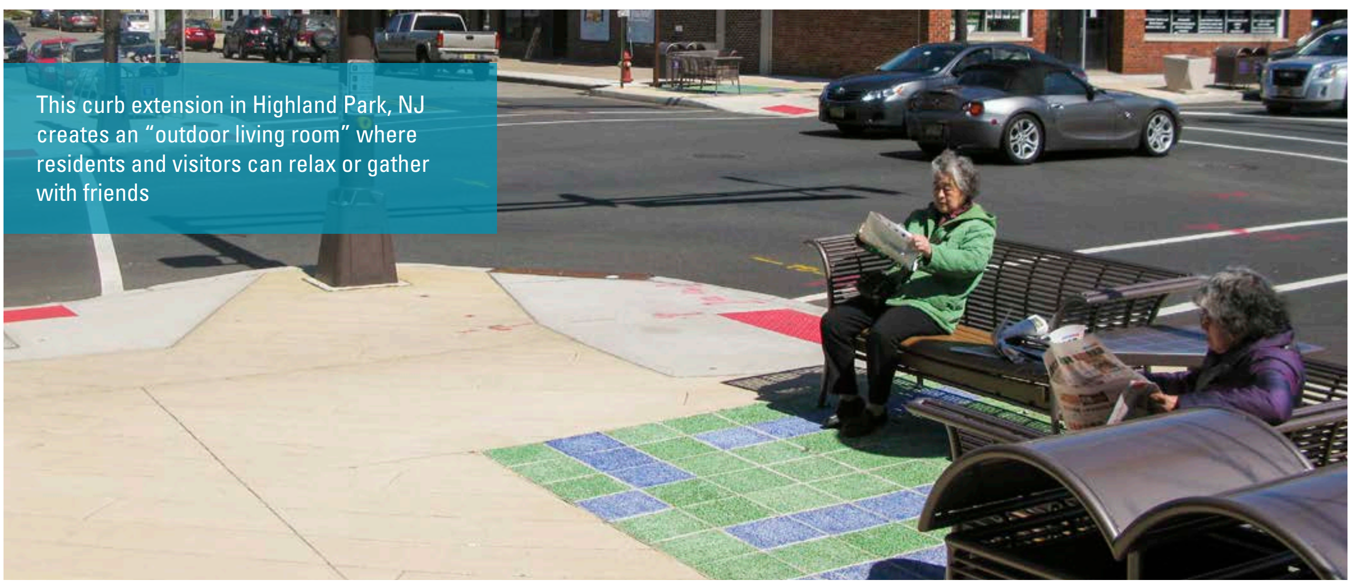
Placemaking at Intersections

As the junction between people traveling along two or more streets, intersections are nodes of activity. Not only do they serve an important transportation function, but they often play an important role in community life as crossroads of social activity, commerce, and public space. Particularly in downtowns and along main streets, they are places for people to gather, interact, and enjoy. Intersections are also important for wayfinding. They are typically key waypoints in the transportation network as travelers navigate to their destinations, often featuring notable landmarks or public buildings. These functions should be reflected in intersection design to create a more pedestrian-friendly environment reflective of the context.

Design Guidance

Intersection design should reflect the multiple functions that an intersection can serve and the context that it lies within. The following placemaking and wayfinding strategies can be integrated into the design to create a more pedestrian-friendly environment:

- Reclaim space at intersections into the pedestrian realm by creating additional public space for people to gather and interact using such tools as curb extensions or reducing curb radii, which are discussed in more detail later in this chapter
- Create a more welcoming environment with street furniture, public art, planters, kiosks, pedestrian-scale lighting, parklets, or small plazas
- Define the space using street trees, buildings, art, or other features that help enclose the area
- Enhance access to public buildings or local amenities, such as libraries, post offices, schools, and businesses
- Integrate access to transit stops and bike share stations
- Provide wayfinding signage using a consistent theme for the community that identifies nearby destinations



This curb extension in Highland Park, NJ creates an "outdoor living room" where residents and visitors can relax or gather with friends

Gateways

Major intersections often serve as gateways within a community, delineating a change in community context or street typology, or serving as a de facto entrance to a downtown, historic district, or public square. For example, an intersection might mark a transition from a higher speed, auto-oriented context to a quiet residential street or to a denser, lower-speed, downtown environment with greater pedestrian activity. By alerting users of the change in character and context of the roadway, gateway treatments are intended to trigger and enforce a change in user behavior, such as for drivers to reduce speed or be aware of a higher level of pedestrian and bicyclist activity.

This proposed gateway treatment for Raymond Boulevard in Newark, NJ is intended to transition drivers entering from nearby highways to a slower, community-oriented speed

Design Guidance

Gateway treatments incorporate visual cues to alert users of a change in street typology or context. Strategies may include a variety of traffic calming, placemaking, and wayfinding tools, such as the following:

- Vertical cues can make a roadway feel more confined, triggering a higher state of alertness among users and a greater awareness of their surroundings. Tools include:
  - Massing and height of buildings near corners, such as for the gateway to a main street business district; building entrances facing the corners help frame the intersection
  - Unique, decorative signage welcoming users to a neighborhood or district, either at the curbside or an overhead banner
  - Specialty light fixtures
  - Prominent street trees near the intersection
  - Public art installations, such as sculptures or murals
  - Radar speed signs to highlight a change in speed limit
  - Raised crosswalk or raised intersection
  - Wayfinding kiosks, signage, or map displays
- Horizontal cues include a physical narrowing of the roadway or features of visual interest, such as a change in color or texture. Tools include:
  - High-visibility crosswalk striping or a unique crosswalk striping design distinctive of the district or neighborhood
  - Textured pavement or a painted intersection using a mural design representative of the district or neighborhood
  - Curb extensions to narrow the intersection

The visual cues used at the gateway should be context sensitive and reflect the surrounding neighborhood, street typology, and vernacular design. Features introduced at the gateway do not need to be restricted to the gateway itself and may also be incorporated into the streetscape design of the neighborhood and street typology, or appropriately scaled and used at subsequent, smaller intersections.

In addition to roadway intersections, trail crossings present the opportunity to create a gateway that achieves multiple purposes: a gateway entrance, an enhanced trail crossing, and traffic calming.

Corners and Curb Radii

Corner treatments and curb radii have a significant impact on the safety, operation, and comfort of an intersection for all modes of travel. Selection of an appropriate curb radius should reflect the context and needs of the typical users of the street and be based on an appropriate design speed and design vehicle (see **p. 60** and **p. 71**). A large curb radius allows vehicles to make a turn more quickly and makes it easier for truck movements, but this comes at the expense of a longer crossing and less comfortable environment for pedestrians. Conversely, a small curb radius shortens the pedestrian crossing, improves pedestrian visibility, and slows vehicular turning traffic but could impinge access for large vehicles. Smaller curb radii also enable designers to incorporate more public space into the pedestrian realm. This provides more room for pedestrians to wait at crossings; streetscape features; positioning of lighting, traffic signal equipment, or signage; and flexibility in design and location of ADA-compliant curb ramps.

The two key elements of curb radius design are the actual curb radius and the effective curb radius. Actual curb radius refers to the physical curve of the curb, while effective curb radius refers to the path that vehicles follow when making a turn. The effective curb radius is affected by the presence of other street elements, such as on-street parking, bicycle lanes, adjacent travel lanes, medians, and other features, which may increase the curvature of the path that a vehicle takes around a corner.

Designing curb radii for the largest vehicle and adjusting design when necessary is common practice in many communities. Instead, engineers and planners should default to designing curb radii to create shorter crossings for pedestrians and lower and safer turning speeds for vehicles. If large vehicles must be accommodated, designs should be modified off of that default.

Mountable curb in Portland, OR creates tighter curb radius and slower turning speeds for most vehicles while allowing larger vehicles to mount the curb and negotiate the turn

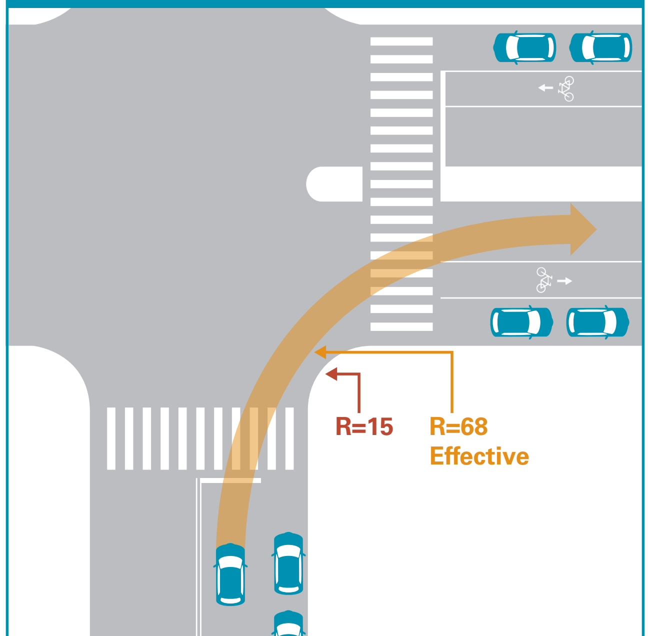
(Photo: Central Seattle Greenways)

Design Guidance

Design should seek to optimize the curb radii to best fit the context, allowing safe and practical operation by typical vehicles while also minimizing vehicular turning speed and maximizing pedestrian safety and comfort. Key concepts include the following:

- Minimize the actual curb radii in locations with higher densities, where there is more pedestrian activity, or where traffic calming is desired, such as downtown and residential environments
- Maintain an adequate effective curb radius to accommodate larger vehicles, as necessary, such as along bus routes or designated truck routes
- Select the smallest possible desired design vehicle, taking into account traffic volumes and how often larger vehicles are expected to access the street
- Include all roadway elements and geometry in the evaluation of the effective curb, such as the angle of the intersection, curb extensions, the number of receiving lanes, on-street parking, bicycle lanes, medians, the number of travel lanes, and lane width
- Implement a variety of mitigation measures to increase the effective curb radius, helping to balance the needs of pedestrians (desiring a small actual curb radius) with those of larger vehicles (desiring a larger effective curb radius), such as:
    - Integrate other features such as bicycle lanes or on-street parking into street design
    - Utilize an advanced stop bar adjacent to the receiving lanes
    - Prohibit parking at least 20 feet from an intersection to increases the effective turn radius for vehicles and to "daylight" the intersection to improve visibility for pedestrians, bicyclists, and drivers
    - Provide an apron on medians or mountable curbs to better accommodate large vehicles
    - Allow the use of adjacent travel lanes on multi-lane streets and use of the full street width on low volume, local roadways

Effective Turning Radius



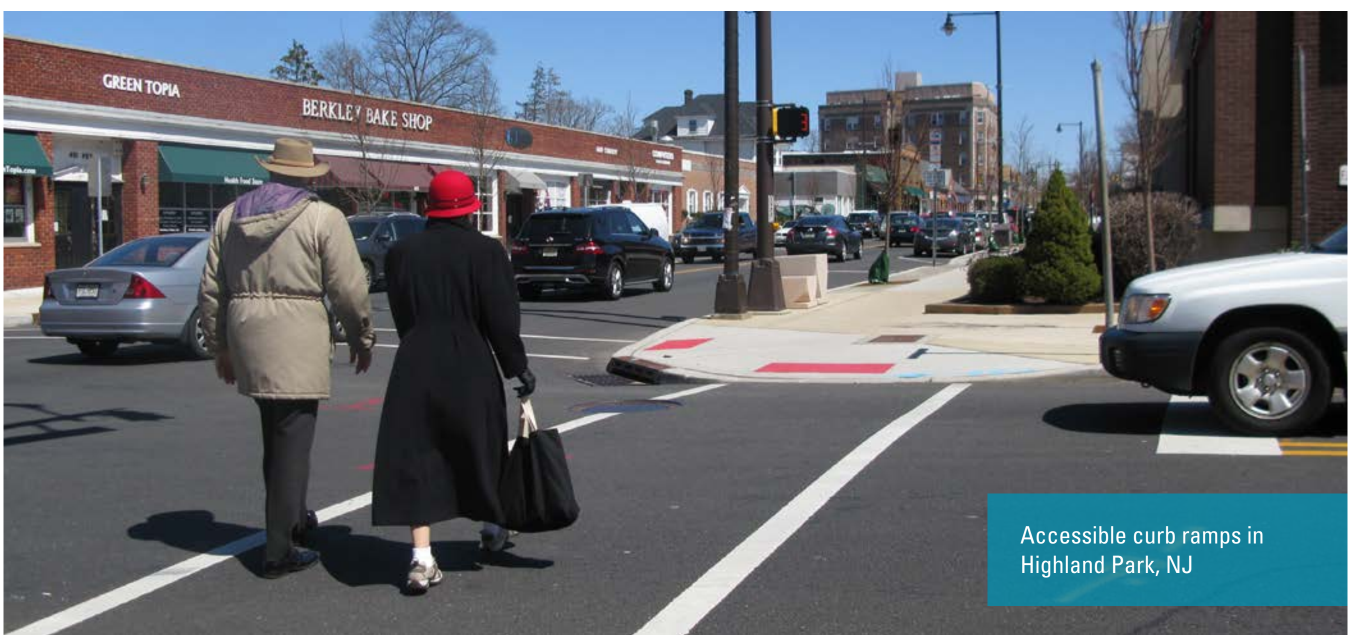
It is important for designers to account for the distinction between the corner radius and the effective turning radius. Curb radii are often designed based solely on the intersection geometry and overlook the effective radius, which is the result of the presence of on-street parking, bicycle lanes, the number of travel lanes, medians, and traffic control devices. As a result, curb radii are often larger than necessary and drivers routinely turn as wide as possible to maintain travel speeds.

Curb Ramps

ADA guidelines require appropriately designed curb ramps at all pedestrian crossings. Curb ramps are essential to provide easy access to crossings for pedestrians of all ages and abilities, benefiting not only those with mobility or visibility disabilities, but also children, seniors, or those with strollers, carts, bicycles, or delivery dollies. Curb ramps enable a smooth transition from the sidewalk level to street level at intersections and mid-block crossing locations.

Design Guidance

- Curb ramp placement should reflect the desired pedestrian path through an intersection.
- Directional curb ramps (i.e., typically two curb ramps per corner) are preferred over a single curb ramp located at the apex of the corner. The directional curb ramps provide direct access to their associated crossing along the pedestrian's direction of travel, whereas a single diagonal curb ramp attempts to accommodate pedestrians on different travel paths by opening toward the center of the intersection.
- Drainage design should prevent water and debris from accumulating at the bottom of a curb ramp.
- Drainage grates, utility access covers, and other appurtenances should not be placed on curb ramps, landings, or along the pedestrian crossing.
- Curb ramp width should generally be the same as that of the pedestrian zone on the sidewalk approach.
- Curb ramps must be designed to meet ADA requirements, including a:
  - Stable, firm, and slip-resistant surface
  - Detectable warning surface to alert the visually impaired of the transition from the sidewalk to the roadway that extends across the full width of the curb ramp and includes a series of raised, truncated domes in a high contrast color relative to the surrounding sidewalk
  - Maximum sidewalk cross slope of 2 percent
  - Maximum ramp slope of 8.33 percent
  - Maximum running slope of 5 percent along the crosswalk



Accessible curb ramps in Highland Park, NJ

Curb Ramps

According to Title II of the ADA, curb ramps are requirements for existing facilities as well as all new construction. For existing facilities, curb ramps must be included in transition plans. Curb ramps are critical to providing access between the sidewalk and the street for people who use wheelchairs or have limited mobility. Curb ramps are also essential for those with vision impairments who rely on the curb to identify the transition point between the sidewalk and the street. Curb ramps must be designed with special care to accommodate these two user groups.

An accessible connection between the sidewalk and the street can be provided through a variety of curb ramp designs. To maximize accessibility and safety for all pedestrians, curb ramp design should adhere to the following best practices:

- Provide a level maneuvering area or landing at the top of the curb ramp
- Clearly identify the boundary between the bottom of the curb ramp with a detectable warning surface
- Design ramp grades that are perpendicular to the curb
- Place the curb ramp within the marked crosswalk area
- Avoid changes of grade that exceed 11 percent over a 24-inch interval
- Design the ramp so that it does not require turning or maneuvering on the ramp surface
- Provide a curb ramp grade that can be easily distinguished from surrounding terrain; otherwise, use detectable warning surfaces
- Design the ramp with a grade of 7.1 +/- 1.2 percent. Do not exceed 8.33 percent (1:12)
- Design the ramp and gutter with a cross slope of 2.0 percent
- Provide adequate drainage to prevent the accumulation of water or debris on or at the bottom of the ramp; do not place gutter at bottom of ramp
- Make transitions from ramps to street flush and free of level changes
- Align the curb ramp with the crosswalk so there is a straight path of travel from the top of the ramp to the center of the roadway to the curb ramp on the other side
- Provide clearly defined and easily identified edges or transitions on both sides of the ramp to contrast with the sidewalk

Further Guidance

- https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/08chapter7.pdf
- http://www.ada.gov/pcatoolkit/app1curbramps.pdf
- https://www.access-board.gov/guidelines-and-standards/streets-sidewalks/public-rights-of-way/guidance-and-research/accessible-public-rights-of-way-planning-and-design-for-alterations/chapter-6%E2%80%94curb-ramp-examples

DETECTABLE WARNING SURFACES

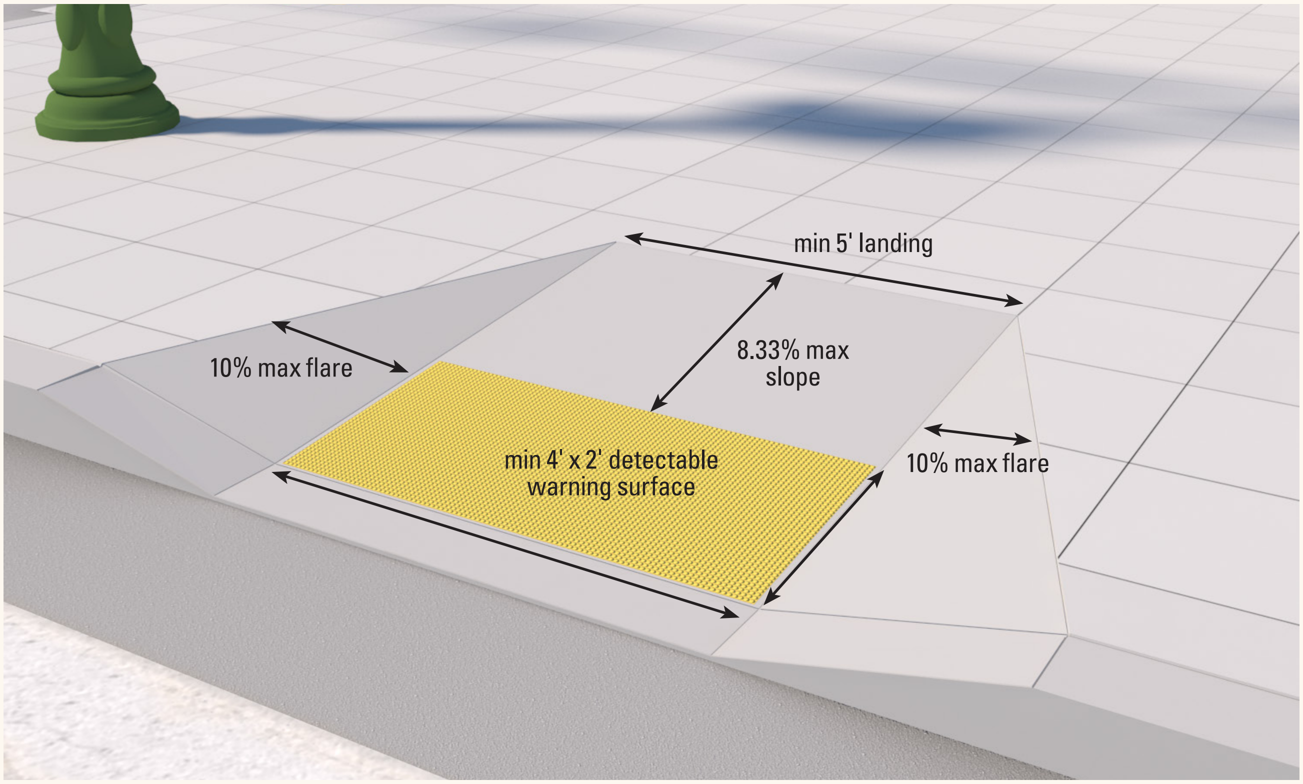
A detectable warning surface is defined in ADAAG Section 3.5 as, "a standardize surface feature built in or applied to walking surfaces or other elements to warn visually impaired people of hazards on a circulation path" (ADAAG, U.S. Access Board, 1991). Research shows that detectable warning surfaces designed according to ADAAG are highly detectable by people with visual impairments, and their guidelines should be followed. According to ADAAG, detectable warnings should consist of raised truncated domes with a:

- Bottom diameter of 0.9 inch
- Top diameter of 0.4 inch
- Height of 0.2 inch
- Center-to-center spacing of 2.35 inches
- Visual contrast

Further Guidance

More information on detectable warning surface design can be found in Chapter 6 of the FHWA guide *Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide* (pages 6-05 to 6-11).

https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/07chapter6.pdf



Curb Extensions

Curb extensions, also referred to as bulb-outs or bump-outs, can improve the quality and safety of the pedestrian environment at intersections. As denoted by its name, curb extensions extend the curb line and sidewalk into the roadway, expanding the pedestrian realm. Use of curb extensions is often referred to as "daylighting" an intersection due to the significant improvement in visibility at the intersection. Curb extensions have a variety of benefits, including improving visibility for pedestrians and drivers, reducing the pedestrian crossing distance, calming traffic, and shielding on-street parking at intersection approaches. They also expand the pedestrian realm, providing more opportunities for public space, such as street furniture, as well as more flexibility in placement of curb ramps, lighting, traffic signal control equipment, and signage. Curb extensions are also an opportunity to incorporate green stormwater treatments, such as rain gardens, as well as bicycle parking.

Curb Ramp Drainage

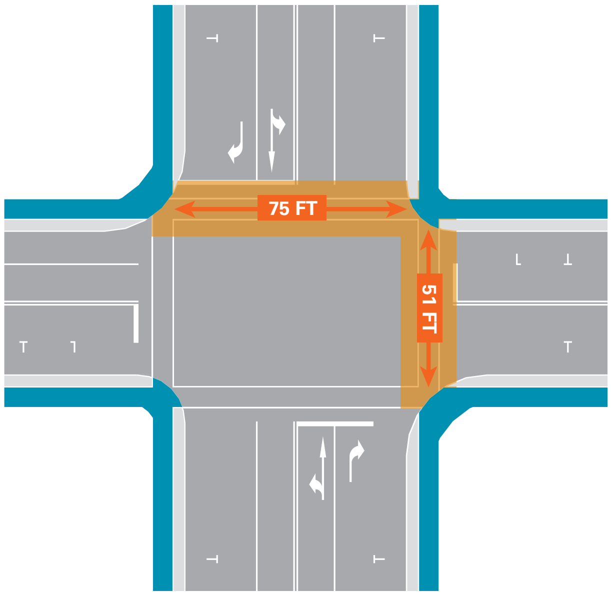
Poor drainage at the bottom of a curb ramp can be a nuisance for all pedestrians but is particularly problematic for those who cannot avoid the area. When the water dries up, debris often remains at the base of the ramp, further impeding access. In cold weather, water can turn to ice or slush creating a more hazardous situation.

Because many drainage systems focus on channeling water to the corner of the street, care should be taken when developing the grading plan to ensure that drainage of the sidewalk is directed across and down toward the bottom of a curb ramp and then away from the curb ramp. A grading plan should specify:

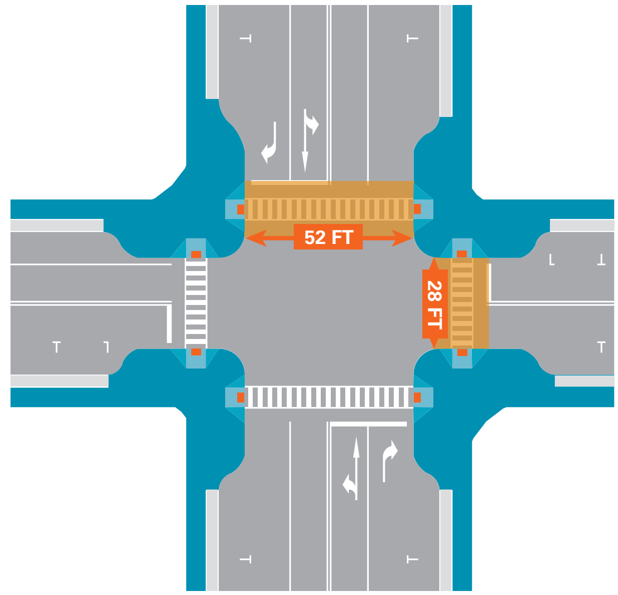
- Dimensioned distances, elevations, and inlet/catch basin locations
- Curb/gutter elevation (the ends, center, and quarter points are normally needed in each curve)
- Sidewalk, pavement, ramp, and gutter slopes

Drainage grates should be located adjacent to the uphill side of the curb ramp and not the bottom of the ramp. Gutter slopes should be designed specifically to guide water away from the bottom of the ramp. Maintenance programs should be established to periodically remove gutter debris.

Curb Extension—Before



Curb Extension—After



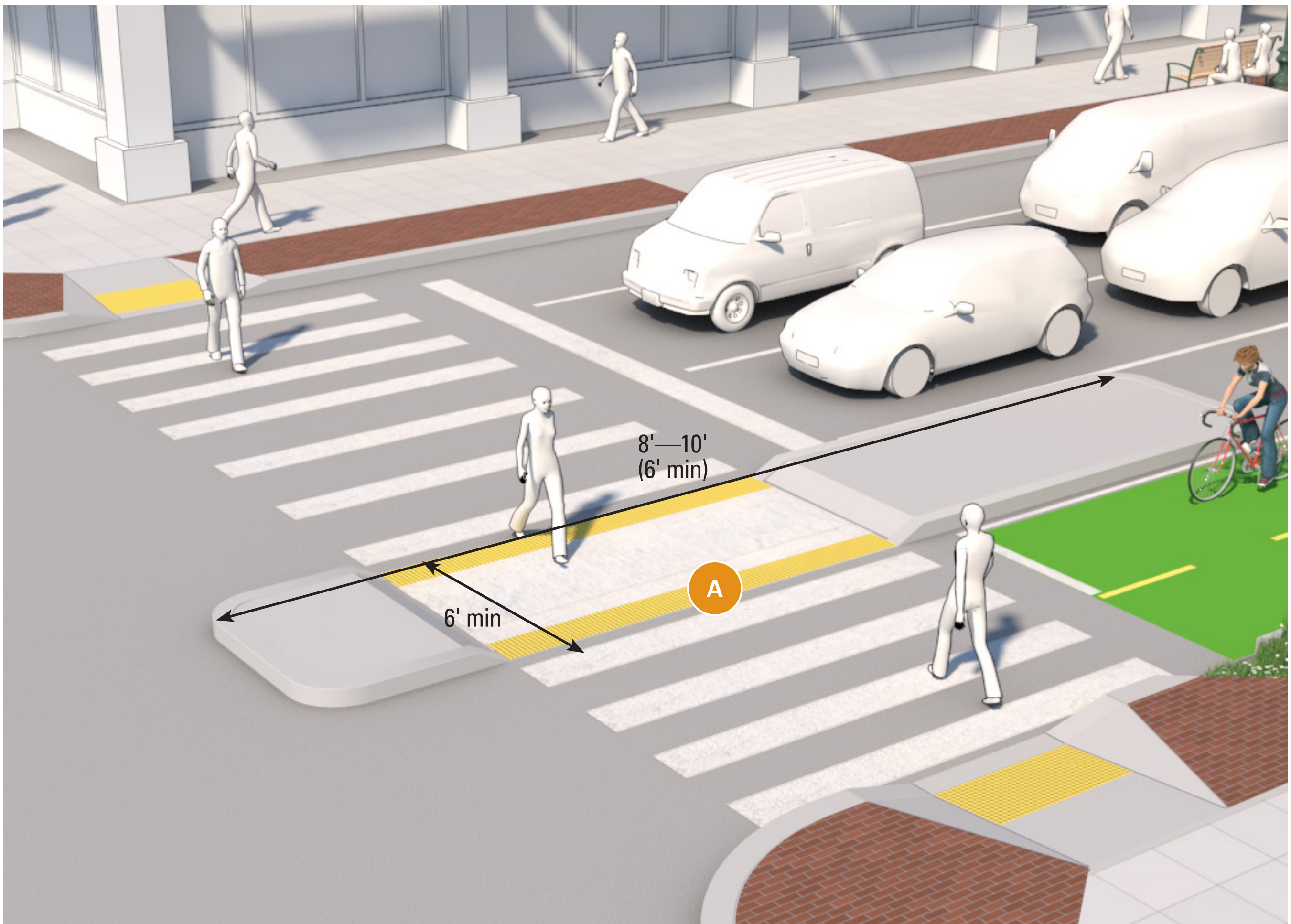
Curb extensions improve visibility for pedestrians and drivers, reduce the pedestrian crossing distance, calm traffic, and shield on-street parking at intersection approaches. In the above example, the addition of curb extensions shortens pedestrian crossing distances from 75 feet to 52 feet in one direction and 51 feet to 28 feet in the other direction without reducing the number of travel lanes.

Design Guidance

- Curb extensions are typically used at intersections or mid-block locations on streets with on-street parking.
- Curb extensions are well-suited for areas with significant pedestrian activity, wide intersections, intersections with high traffic volumes and/or speeds, or near schools or pedestrian routes to other major destinations.
- Curb extensions should not extend into the travel lane or bicycle lane.
- There is no prescribed width for curb extensions, but typically they extend the width of a parked vehicle, approximately 6 feet. The selected width is intended to achieve an effective curb radius that is compatible with the context and the street's desired design speed and design vehicle.
- The minimum length of a curb extension is the width of the crosswalk (minimum of 6 feet). The designer should consider extending the length to 20 feet—the minimum setback for on-street parking near an intersection (per the MUTCD).
- The designer should consider the impact of curb extensions on the effective curb radius and, particularly, potential impacts to larger turning vehicles. A narrower curb extension width may be used, as needed, to reduce the impact.

Crossing Islands

Crossing islands, or pedestrian refuge islands, are a means to calm traffic and improve pedestrian safety. They enable pedestrians to make a crossing in two stages—crossing one direction of vehicular travel lanes, pausing at the island, and then completing the crossing. This reduces the exposure time of pedestrians to vehicular traffic.



A Crossing islands must follow the principles of accessible design so they are not a barrier for pedestrians with limited mobility.

Medians

Medians separate traffic flows heading in opposite directions. Medians can be used to provide pedestrians refuge while crossing the road. At wide intersections, medians can help people with slower walking speeds cross the street safely. Medians can also serve as traffic-calming devices and green space.

Medians should be raised to separate pedestrian and motorists but must follow the principles of accessible design so they are not a barrier for pedestrians with limited mobility, people in wheelchairs, and people with strollers. Raised medians should be designed with a cut-through at street level or a ramp. Detectable warning surfaces should be placed at the edge of both ends of the median in order for the street to be recognized by the visually impaired. If the corner includes a pedestrian-actuated control device, one should also be located at the median.

If the median is ramped, the slope of the ramps must not exceed 8.33 percent. Additionally, a level area at least 36 inches wide and 48 inches long is required (60 inches by 60 inches is preferred). If a raised median has a cut-through level with the street, it should be at least 36 inches wide and 48 inches long (60-inch width preferred). The median width should be at least 72 inches for pedestrian safety.

Design Guidance

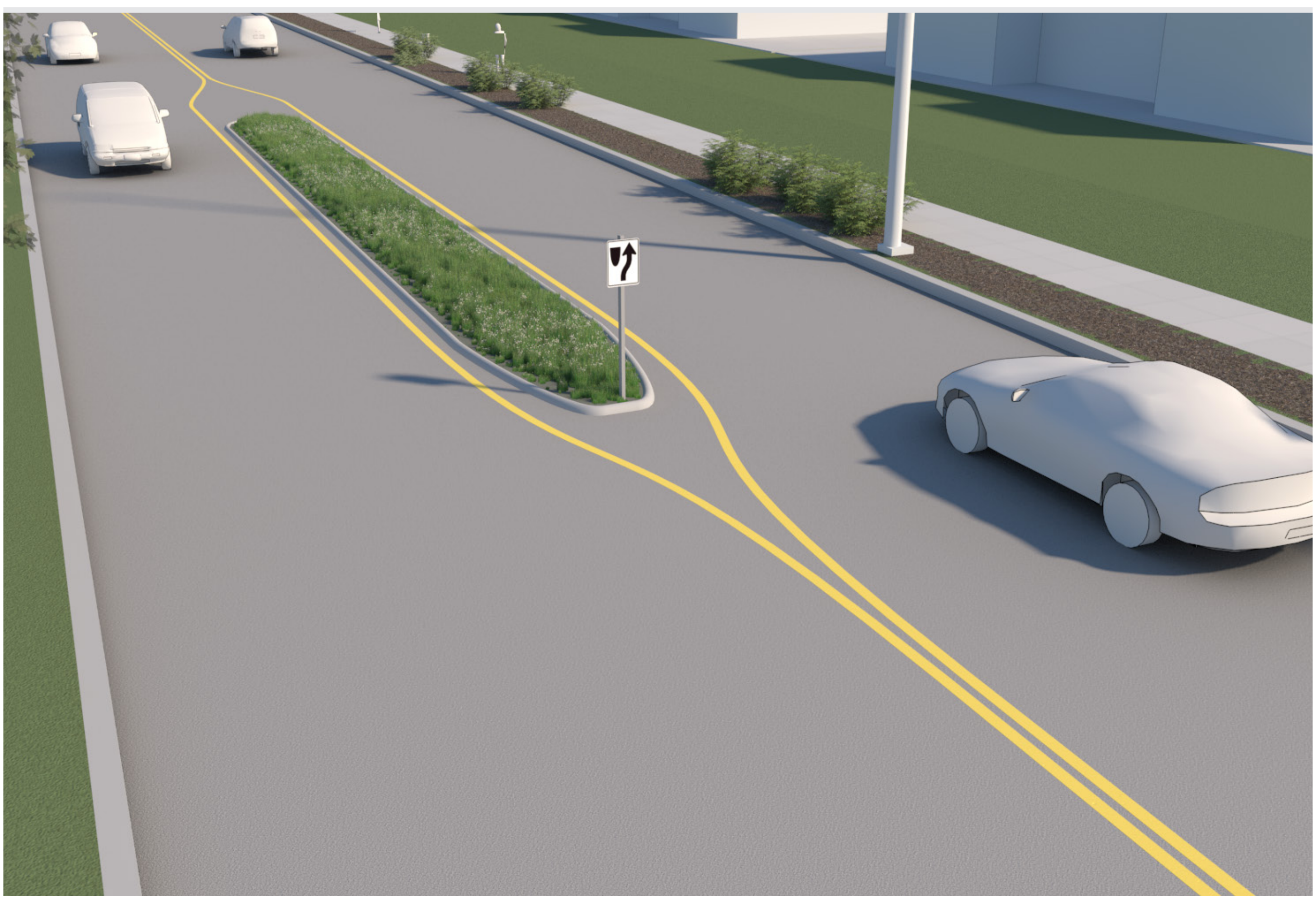
- Crossing islands are typically in locations where pedestrian crossings feel unsafe because of exposure to vehicular traffic. This often occurs on multi-lane roadways, where pedestrians must cross more than three lanes of traffic, and/or on roadways with high traffic volumes or speeds.
- Crossing islands may be used at intersections or mid-block pedestrian crossings.
- Where intersections require slip lanes to accommodate turning vehicles, either because of geometry or operational issues, the resulting “pork chop” islands should be designed as pedestrian crossing islands.
- Roadways with an existing median space provide an opportunity to retrofit the median as a crossing island.
- Crossing islands must meet ADA requirements for pedestrian access.
- Crossing islands should be a minimum of 6 feet wide, with a preferred width of 8 to 10 feet, and a minimum of 6 feet long.
- Crossing islands should have a “nose” that extends beyond the crossing to protect pedestrians from turning vehicular traffic.
- Impacts to the effective curb radius for turning vehicles and the street design vehicle should be considered.

Splitter Islands

Similar to crossing islands, splitter islands provide a means to calm traffic and more formally separate vehicle movements. They provide a raised median or barrier that reduces the effective curb radius and prevents turning vehicles from "cutting the corner" and encroaching into an oncoming travel lane as they complete a turn. Unlike crossing islands, splitter islands are not wide enough to accommodate a pedestrian refuge area.

Design Guidance

- Splitter islands are used only where the available cartway width is insufficient to provide a full crossing island with a pedestrian refuge.
- Splitter islands are used to separate vehicle lanes at roundabouts or where the intersection design requires a slip lane to accommodate turning vehicles.
- Impacts to the effective curb radius for turning vehicles and the street design vehicle should be considered.



Raised Crossings and Intersections

Raised crossings prioritize pedestrian movement through an intersection or mid-block crossing. They improve the visibility of pedestrians and force vehicular traffic to slow down as they pass through the crossing. They also increase the rate at which motorists comply with the "stop for pedestrians law." Raised crossings may be implemented for an individual crossing or expanded to cover an entire intersection to create a wide public space level with the sidewalk.

Design Guidance

- Raised crossings and intersections should be flush with the sidewalk.
- ADA-requirements must be followed for pedestrian access.
- Vertical deflection should be gradual, following similar design guidance as a speed hump.
- Raised crossings and intersections calm traffic and are typically applied on minor streets with access to major pedestrian destinations, such as routes to school.

Highlands, NJ

Roundabouts

The modern roundabout has been gaining in popularity in the past decade and offers an alternative to a traditional signal- or stop-controlled intersection design. The modern roundabout differs significantly from its predecessor, the traffic circle. Unlike a traffic circle, the modern roundabout is designed with a much smaller diameter and yield control on all entries, leading to a reduction in vehicular speed and significant safety and operational improvements.

Compared to a traditional four-way intersection, roundabouts reduce the total number of vehicle conflicts points by 75 percent and eliminate conflicts with crossing traffic, which are often associated with more severe crashes. As a result, roundabouts generally have a lower number of crashes and lower injury crash rate for motor vehicle occupants. However, consideration must be given to accommodations for bicyclists and pedestrians, as they are often involved in a relatively higher proportion of injury crashes compared to other intersection designs.

Roundabouts can also improve the operation of the roadway. Since vehicles do not need to come to a complete stop at a roundabout, vehicles typically experience less delay than other intersection designs, particularly at off-peak times. All approaches have equal priority in roundabout design, as all vehicles must yield to traffic when entering the roundabout. Therefore, it is also important to consider the comparative volumes on each approach and the potential undesired delay for the major movements.

In addition to safety and operational improvements, other benefits associated with roundabouts include:

Operation and maintenance costs: Roundabouts do not have as many on-going maintenance costs compared to signalized intersections. Roundabouts typically have a service life of 25 years, compared to 10 years for a signalized intersection.

Traffic calming: By requiring all approaches to yield, a roundabout or series of roundabouts can have a traffic-calming effect on a street network

Aesthetics: The central island of a roundabout provides opportunities to create signature entries or centerpieces of a community.

Environment: The reduction in vehicle delay and the number and duration of vehicle stops have a positive impact on fuel consumption, carbon dioxide emissions, and noise and air quality impacts.

Spatial Requirements: The spatial advantages and disadvantages of a roundabout vary by the alternative intersection design. While roundabouts generally require more land area than a typical four-way stop-controlled intersection, they can be more space-efficient than intersections with jug-handles, highway interchanges with large infield areas, or signalized intersections with several turn lanes on multiple approaches.

Roundabouts can be scaled to fit a wide range of contexts and street typologies. Mini-roundabouts and neighborhood traffic circles can be used on local residential streets to provide traffic calming and efficient vehicle flow; urban compact roundabouts can balance efficient vehicle flow with the needs of bicyclists and pedestrians; and multi-lane urban and rural roundabouts can provide safe and efficient operation on higher-volume streets.

Design Guidance

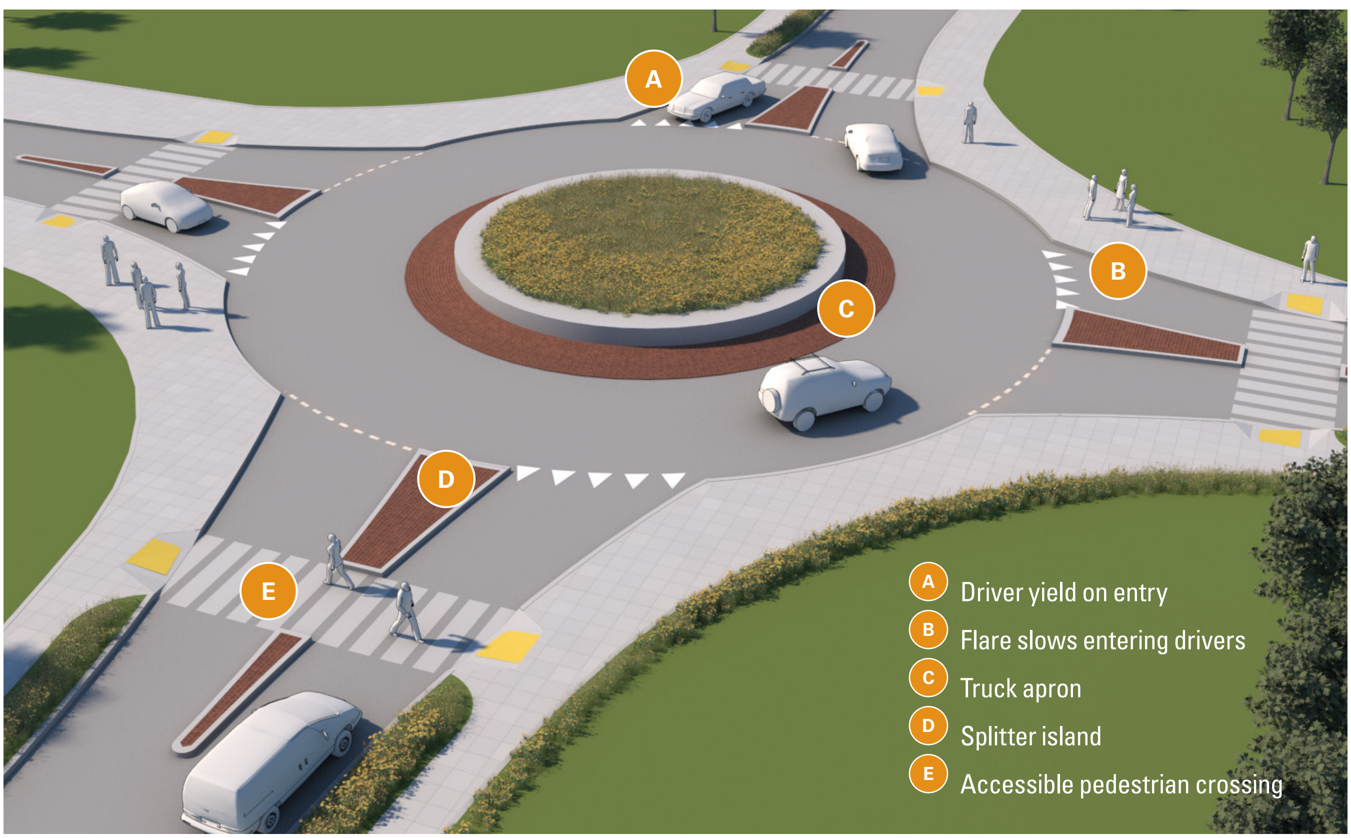
Roundabout design should create conditions that reduce vehicle speed and provide a consistent speed into, through, and out of the roundabout. Lower speeds reduce crash frequency and severity for all roadway users, allow safer and easier merging of traffic, provide more reaction time for drivers, and make the facility more accessible for novice users. The diameter chosen for the roundabout must balance safety with the capacity demand of the intersection. Maximum entry design speeds range from 15 mph for mini-roundabouts to 30 mph for a rural double-lane roundabout.

Design considerations include the following:

- Design entry points that require vehicles to deflect around the central island. Entry points that enable a path tangent to the central island support faster vehicle speeds.
- Provide pedestrian crossings at all approaches. Raised crossing islands with high-visibility striping at each approach create a more comfortable crossing for pedestrians, reduce vehicle speeds, and improve driver awareness of pedestrians as they enter/exit the roundabout. Pedestrian crossings should generally be located one car length from the roundabout entry/exit point, which both minimizes vehicular speed and improves pedestrian visibility at the crossing point.
- Minimize vehicle speed to allow more comfortable navigation of the roundabout by bicyclists. On larger roundabouts or multi-lane roundabouts, deflect bicycle routes to a shared-use path around the perimeter of the roundabout to allow bicyclists to navigate the roundabout as pedestrians. This provides separation from vehicular traffic, creates a more comfortable environment for most bicyclists, and enables them to use the pedestrian crossings.
- Provide truck aprons to accommodate freight traffic and emergency vehicles on roundabouts with a smaller diameter and/or on designated truck routes.
- If the roundabout is on a transit route, ensure that the design comfortably accommodates operation of the transit vehicle without the need to use the truck apron.

Further Guidance

- FHWA's *Roundabouts: An Informational Guide*



Channelized Right-Turn Lane

Channelized right-turn lanes, also referred to as slip lanes, facilitate right-turn movements for motorists. They may be necessary to enable right turns when the intersection geometry would otherwise make the turn infeasible, such as an acute angle. Channelized right-turn lanes can also be used to improve the operation of an intersection for motorists, particularly where there is a high volume of right-turn movements.

By widening the intersection and enabling higher turning speeds, channelized right-turn lanes generally create a less inviting environment for bicyclist and pedestrians. They are therefore best suited for contexts that need to prioritize truck movements and auto-centric corridors, and should be avoided in areas with higher levels of bicycle and pedestrian activity. The drawbacks of channelized right-turn islands, however, can be mitigated through proper design, including minimizing curb radii and integrating pedestrian refuge islands into the turn island.

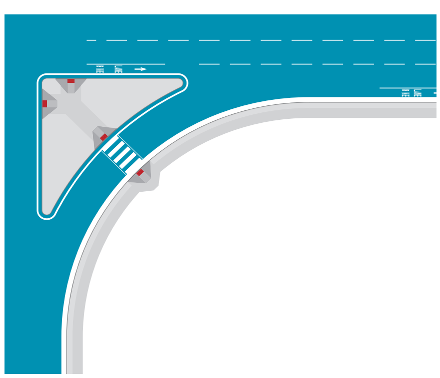
Design Guidance

- Channelized right-turn lanes are most appropriate where:
  - Geometric constraints make right turns difficult, such as an acute angle intersection
  - There is high demand for right-turn movements, particularly by large vehicles
- Channelized right-turn lanes should be avoided in areas with high levels of bicycle and pedestrian activity, such as downtowns, mixed-use areas, and residential neighborhoods
- Design features:
  - Minimize the angle at which the right-turn lane intersects the cross street (e.g., 110 degrees)
  - Minimize the curb radius (depending on the design vehicle) to slow vehicle speeds and improve visibility
  - Minimize the width of the turn lane using edge and gore striping to narrow the perceived roadway width while still accommodating larger vehicles, if necessary
  - Locate the crosswalk one car length back from the curb line
  - Orient the crosswalk perpendicular to the flow of traffic
  - Design the turn island as a pedestrian crossing island
  - Do not provide an acceleration lane coming out of the turn which encourages motorists to take the turn quickly and not stop or yield at the intersection

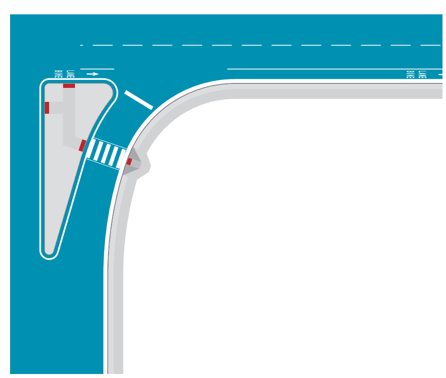
Channelized Right Turns

Where channelized right turns are necessary, they should be designed to slow driver turning speed and improve visibility of pedestrians, bicyclists, and on-coming motor vehicle traffic for the turning driver.

Before



After

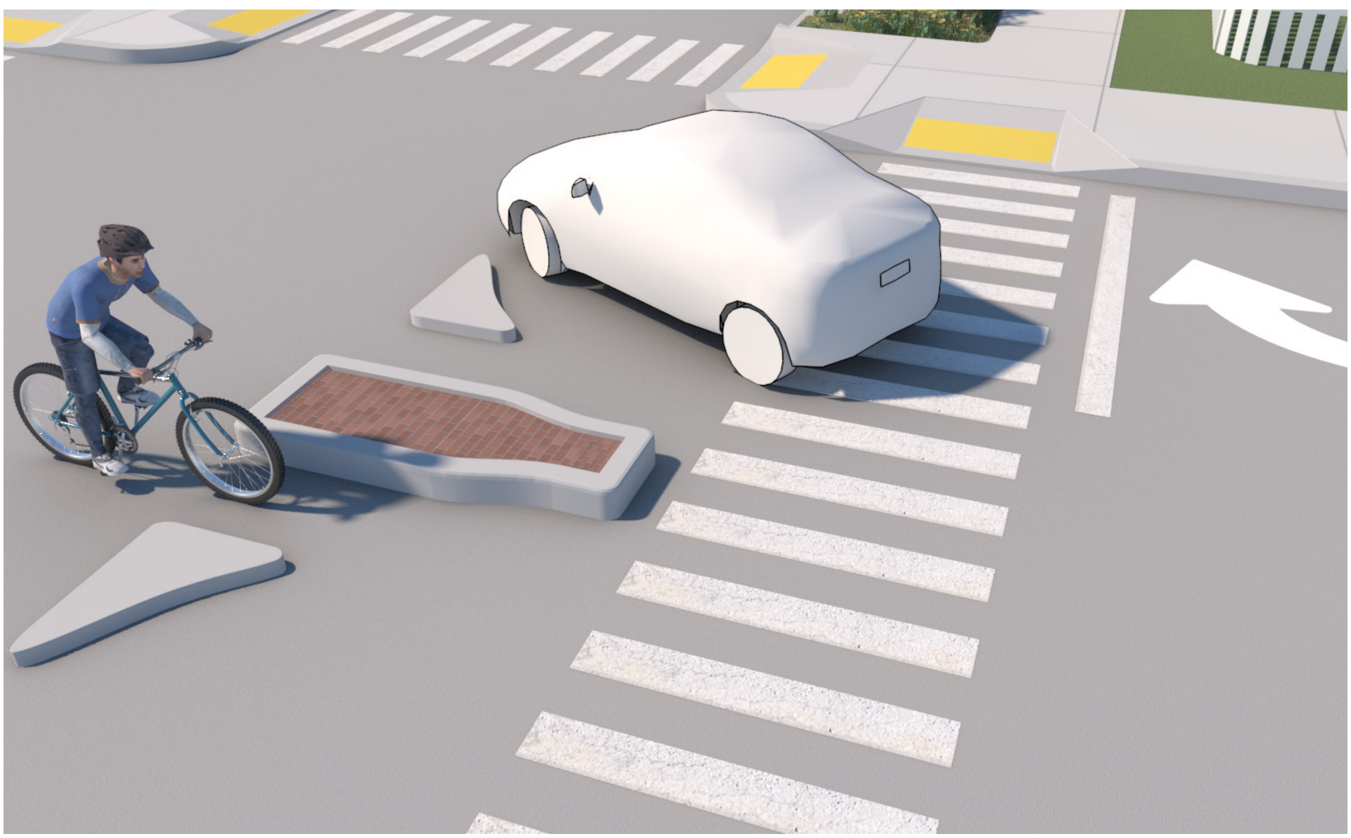


Diverters

Diverters are a tool for traffic volume management. They are used to restrict the movement of vehicles onto a given street and deter its use as a "cut through" by regional traffic. Diverters reduce traffic volumes and speeds, creating a friendlier environment for bicyclists and pedestrians. Diverters can take a variety of forms, such as curb extensions, medians, or islands.

Design Guidance

- Diverters may prohibit through traffic or a particular turning movement.
- Implementation of a diverter should be part of a larger strategy for traffic calming and traffic routing.
- Diverters should restrict vehicular movement while still accommodating pedestrian and bicycle access.
- Typical applications are along local roadways, either to discourage through traffic on a residential street or to support a bicycle boulevard.
- Consideration should be given to emergency vehicles; designs that allow access by emergency vehicles are preferred.

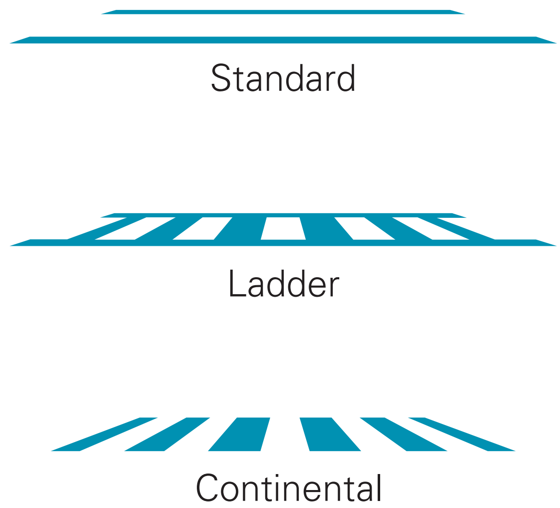


Crosswalk Design

Marked crossings are a critical component of a Complete Street. Crosswalks delineate a clear path for pedestrians, connecting sidewalk segments to create a complete pedestrian network and a more walkable environment. Effective crosswalk striping improves pedestrian safety, enhances visibility of the crossing to motorists, improves motorist awareness and creates an expectation of potential pedestrian activity, and indicates to pedestrians a preferred crossing location.

Striping design can significantly impact the visibility of a crosswalk. Transverse striping, typically a pair of parallel lines oriented perpendicular to the driver, has a very limited visual profile to motorists. Conversely, longitudinal striping (often referred to as "continental" striping) is oriented parallel to motor vehicle travel, which significantly improves the visibility of the crossing to motorists. On low volume and low speed roadways, crosswalk striping alone is often sufficient. However, on higher volume and higher speed roadways, additional pedestrian treatments are recommended to enhance the crossing and supplement crosswalk striping.

Types of Crosswalk Designs



Standard crosswalk striping, shown at top, often has very poor visibility to motorists, particularly on higher-speed roadways or where the striping has faded. Ladder or Continental striping is preferable in most situations because it significantly improves the visibility of the crossing to motorists and maintains this visibility better as it ages.

Design Guidance

- Crosswalks should typically be marked at all crossings of a signalized intersection. Crosswalk placement should also consider other aspects of the intersection design, such as signal phasing and sight lines.
- At uncontrolled crossings and mid-block locations, a crosswalk alone should not be used on streets with:
  - Vehicle speeds greater than 40 mph
  - Four or more lanes without a raised median or pedestrian refugee island and an average daily traffic (ADT) of 12,000 or greater
  - Four or more lanes with a raised median or pedestrian refugee island and an ADT of 15,000 or greater

  On these roadways, additional supplemental design tools should be used to enhance the visibility of the crossing, improve pedestrian safety, and/or slow vehicular traffic.
- On streets with low volumes (ADT less than 3,000), low speeds (less than 20 mph), and few lanes (1 or 2 lanes), crosswalks may not always be necessary at uncontrolled intersections. They should, however, be provided at major pedestrian destinations, such as schools, parks, transit stops, and major public buildings.
- Crosswalks should be marked to create the shortest pedestrian crossing distance, but also consider pedestrians desire lines. This is particularly an issue at skewed intersections.
- Crosswalk design should reflect the street context. High-visibility striping should be used to enhance pedestrian crossings and is preferable on crossings with significant pedestrian activity, crossings that provide access to major destinations (e.g., walking routes to schools and transit stops), and at mid-block locations.
- Transverse crosswalks must be a minimum of 6 feet wide (measured as the gap between the parallel lines). Crosswalks should be at least as wide as the paths they are connecting. This enables pedestrians moving in opposite directions to comfortably pass each other.
- Stop bars should be placed a minimum of 4 feet from the edge of a crosswalk. A larger buffer is preferred to create a more welcoming pedestrian environment.

Further Guidance

- NCHRP Report 600 *Human Factors Guidelines for Road Systems*

Signage

MUTCD guidance should be followed for signs. Signs should not be placed within the pedestrian zone. For font recommendations, the MUTCD references the Standard Alphabets for Highway Signs and Pavement Markings, which permits a series of six letter types on signs. ADAAG Section 4.30 also provides guidelines for signage. ADAAG specifications are targeted at indoor facilities and might not be applicable to all outdoor spaces. According to ADAAG, "letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke width-to-height ratio between 1:5 and 1:10" (ADAAG, U.S. Access Board, 1991). MUTCD requirements for size and stroke meet, and may even exceed, ADAAG specifications. ADAAG Section 4.30 also provides guidelines for character height, raised and brailled characters and pictorial symbol signs, finish and contrast, mounting location and height, and symbols of accessibility.

Signalized Intersections

The allocation of time at a signalized intersection is equally important as the allocation of space. In combination, time and space determine the quality of a street and transportation network, how it operates, and how it meets the mobility, safety, and public space needs of its users and the community. Signal timing should reflect the context and needs of the street. Just as the distribution of space within an intersection geometry and cross-section can make a street feel more or less welcoming to a given mode, the way in which time is distributed by a traffic signal has a similar impact: an inadequate pedestrian crossing time or lack of pedestrian signals can create a barrier to walking and discourage walking; transit priority signaling can improve the performance of a transit service and encourage higher ridership; and excessive delay at an intersection for any mode can create a bottleneck and cause users to violate the signal or take unsafe risks.

The following discussion highlights some key principles, tools, and design considerations for signalized intersections.

Pedestrian Signal Heads

Per MUTCD requirements, signalized intersections should include pedestrian signal heads with countdown timers. These accommodations provide clarity to pedestrians and increase safety by clearly indicating when it is appropriate to cross the intersection and how long they have to do so.

Pedestrian Clearance Time

The pedestrian clearance time is the amount of time a pedestrian has to cross the intersection and should provide adequate time for a pedestrian leaving the curb at the end of the "walk" interval to reach the opposite curb before the traffic signal changes to green for on-coming traffic. The minimum crossing time for the signal timing is a function of the width of the crossing and the pedestrian walk speed. For most locations, a **walk speed of 3.5 feet per second** is used (per MUTCD). However, in locations commonly used by pedestrians who walk more slowly or those in wheelchairs, a slower walk speed should be used.

Princeton, NJ

Pedestrian Push Buttons

The use of actuated pedestrian detection, typically through the use of push buttons, is discouraged. In downtowns and business districts, the pedestrian phase should be provided for all crossings during each cycle.

In the case that pedestrian actuation is deemed appropriate, typically where pedestrian volumes are low on suburban and rural streets, the following strategies can be considered to reduce pedestrian delay while limiting impacts to vehicle traffic:

- Provide the pedestrian phase during each cycle when pedestrian volumes are expected to be high, such as commuting times
- Eliminate the need for actuation by reducing the crossing length (and therefore time) through the use of curb extensions
- Reduce the cycle length

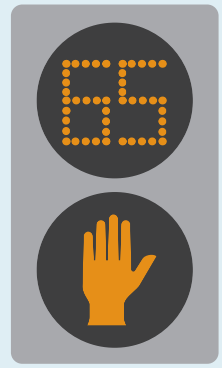
For semi-actuated signals, typically used where a high-volume street meets a lower-volume street, the pedestrian interval should always be provided with the higher-volume green phase. For the minor crossing, effort should be made to reduce wait times.

Cycle Length

Shorter cycle lengths reduce pedestrian wait times, which encourage walking and discourage unsafe pedestrian crossing behavior.

A single long wait time for pedestrians can be frustrating, and multiple long waits can discourage walking altogether. Additionally, pedestrians are more likely to not comply with a pedestrian signal when faced with very long wait times at a signal.

NACTO recommends cycle lengths that are 60 to 90 seconds.



Signal Timing

In areas with closely spaced signals, timing of adjacent traffic signals should be designed to balance the needs of all users of the road. This may mean not designing signal progression for typical vehicle-based metrics, such as maximum vehicle throughput or minimum vehicle delay.

Signal progression for vehicles can be used as a tool to limit vehicle speeds, which can in turn decrease both the risk and severity of collisions with pedestrians. Proper coordination can encourage drivers to travel at or below posted speeds by providing a progression of green lights that encourages drivers to travel at those speeds. NACTO recommends cycle lengths that are **60 to 90 seconds**.

Where there is a high density of signals, such as with a downtown grid, effort should be made to ensure that the coordination does not cause pedestrians to experience delays at consecutive crossings along the same street. Both block length and typical walking speed in an area would need to be considered to effectively implement this strategy.

Coordinated Signals

Traffic signal coordination, where traffic signal progression manages and synchronizes traffic flow across a corridor or network, has a variety of purposes. Traditionally used to increase vehicular throughput during the peak hour, it can also be used to slow vehicular traffic speeds in urban or downtown contexts, creating a friendlier environment for bicyclists and pedestrians. Optimizing the network for slower speeds, for example, can ensure the typical cyclist gets a consistent green signal at each intersection. Signals can also be coordinated to prioritize transit service on a corridor, leading to more reliable and faster transit service.

Adaptive Signal Control Technology (ASCT):

Unlike conventional signal equipment, ASCT processes real-time data and adjusts signal timing to accommodate changing traffic patterns and mitigate congestion. The technology responds to fluxes in daily traffic flow and events, such as crashes, construction, or special events, creating smoother traffic flow and improved travel time reliability. Compared to traditional signal equipment, average ASCT improves travel time by more than 10 percent, and in areas with particularly outdated signal timing, improvements can exceed 50 percent.

High Volumes

High volumes of pedestrians and turning vehicles can present both safety and congestion issues. Three strategies can be implemented to improve safety and operations when high volumes of pedestrians or turning vehicles exist:

Leading Pedestrian Interval

This treatment is best for intersections with high vehicular turning volumes. This interval provides a few seconds of pedestrian crossing time before vehicle traffic is provided a green light. This lead time allows for increased visibility of pedestrians, reducing the risk of collisions. NACTO recommends **3 to 7 seconds** for the leading interval before the corresponding vehicle interval begins.

Signalized Turns

This treatment is best applied for turning movements with high volumes where pedestrian volumes are high enough to severely limit turning capacity for vehicles. A short protected turning phase can be provided for right-turning vehicles from one-way or two-way streets, or for left-turning vehicles on a one-way street each cycle or when a long queue is detected. This protected turning phase should be just before the end of the green phase (not at the start) in order to prioritize pedestrian movement.

Pedestrian Scramble

This is sometimes referred to as an exclusive pedestrian phase. This treatment is best implemented at intersections with high pedestrian volumes that make turning prohibitive. During each signal cycle, a phase exclusive to pedestrians is provided, allowing pedestrians to cross between any corner in the intersection. The timing of this pedestrian phase should reflect the crossing distance from diagonal corners; this longer time required does not allow this treatment to be used on wide intersections. In a typical implementation, no pedestrian movements are permitted during the vehicular phases, therefore long cycle lengths are discouraged to increase pedestrian compliance.

Accessible Pedestrian Signals (APS)

Pedestrian signals are used to control pedestrian traffic and indicate pedestrian right-of-way to turning vehicles. Signal indications consist of the illuminated symbols of a walking person (symbolizing walk) and an upraised hand (indicating don't walk). Many signals use a flashing upraised hand to indicate a clearance interval for pedestrians who are already crossing to complete their crossing and that no pedestrians should enter the intersection. A preferred treatment is to use a countdown timer simultaneously with the flashing upraised hand to indicate how much time is left on the pedestrian phase.

CROSSING TIMES

The necessary times needed for a pedestrian to cross an intersection varies based on walking pace, visual impairments, disability, age, and mobility limitations. The MUTCD standard identifies a "normal" walking speed as 3.5 feet per second. However, according to FHWA, a majority of pedestrians walk at speeds slower than this. This group includes those with limited mobility and older adults. As the population of New Jersey ages, this group will grow larger.

It is required that crossing times be based on a walking speed of no more than 3.5 feet per second at all crossings. A slower walking speed should be considered near senior centers, rehabilitation centers, or other locations where a higher proportion of potential users may have a slower walking speed.

If crossing times cannot be reduced, crossing distance should be decreased (through either a curb extension or a median refuge) to benefit pedestrians who need more time or at particularly long or complex crossings.

DEVICE PLACEMENT

Where a pedestrian signal is actuated by a push button, the device should meet certain criteria for accessibility:

- Locate the device as close as possible to the curb ramp without interfering with the clear space
- Install the device so that it can be operated from a level segment of the sidewalk rather than on the curb ramp itself
- Provide a level (less than 2 percent slope) clear space at least 36 inches by 48 inches, or 60 inches by 60 inches if pedestrians will be required to turn or maneuver in order to use the device
- Mount the device no higher than 42 inches above the sidewalk so that children, people who use a wheelchair, or shorter individuals can easily operate it
- Place the device no closer than 30 inches to the curb and no more than 5 feet from the crosswalk
- Locate the control face of the button so that it is parallel to the direction of the marked crosswalk
- Design the device activation button so that it can be easily operated by people with limited hand function—larger buttons are preferred
- Design the activation button to require a minimum amount of force, no greater than 15.5 Newton (N) for people with limited hand and arm strength
- Avoid button designs that activate through conductivity

PROVIDING INFORMATION IN MULTIPLE FORMATS

People with vision impairments are at a disadvantage at an intersection if they are unaware of the presence of a pedestrian-actuated signal device. Signal information needs to be accessible and usable by all pedestrians, including those with vision impairments. Pedestrian-actuated signal device information can be provided in audible, vibrotactile, and visual formats.

Audible

The audible component of the pedestrian signal includes a tone or verbal information throughout the "Don't Walk" phase and a tone or verbal information during the "Walk" phase. Often, the longer a button is pressed, the louder the information is given. This can assist a pedestrian who is blind in a louder environment.

Vibrotactile

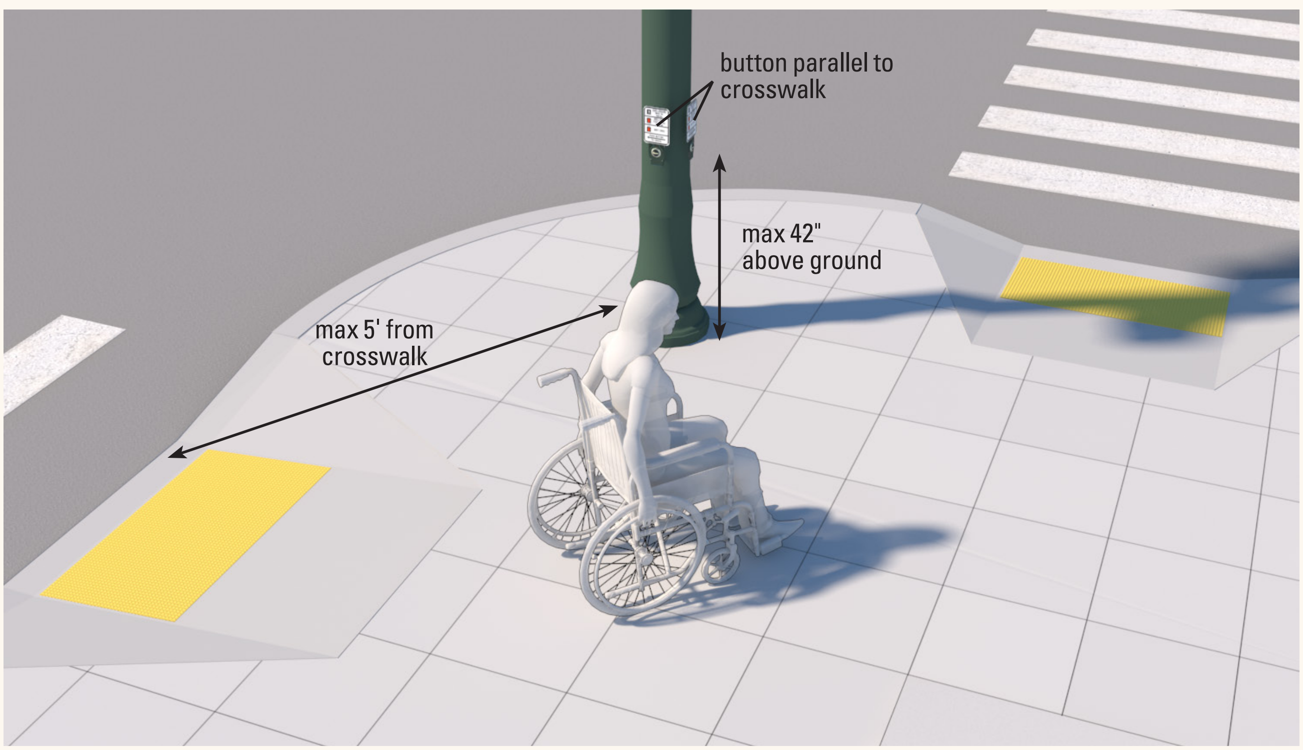
The tactile component of the pedestrian signal can be provided by a raised arrow on the pedestrian actuated signal device. This indicates which street is controlled by the push button. A vibrotactile component vibrates synchronously with the slow or fast repeating tone or tick.

Visual

The visual component of the pedestrian-actuated signal is provided on the actuation device and through the illuminated visual signal.

Further Guidance

MUTCD standards for signals
http://mutcd.fhwa.dot.gov/htm/2009/part4/part4e.htm



Bicycle Facilities

Intersections can be a confusing and stressful environment for bicyclists. In New Jersey, the majority of bicycle crashes (56 percent) occur at intersections. An inherent mixing of traffic occurs at intersections, creating conflicts between vehicular and bicycle traffic. This can be exacerbated when bicycle lanes appear to temporarily end at intersections and intersection approaches, or the roadway widens to provide turning lanes for vehicles.

Intersection design can create a more comfortable environment for bicyclists and reduce conflicts with motorists and pedestrians. Design for bicycles should focus on several key principles:

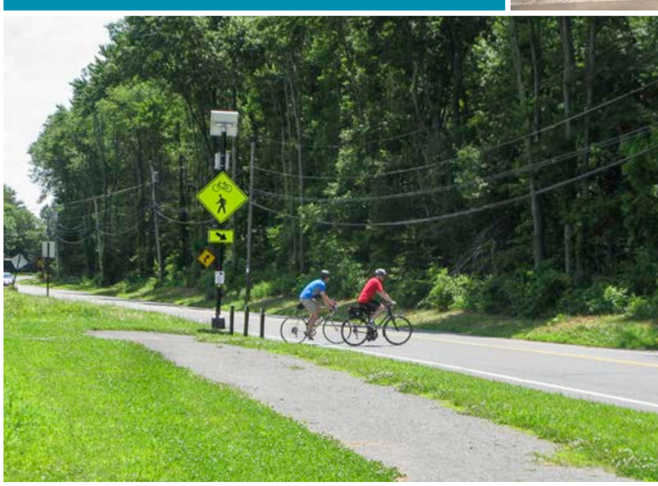
- Reduce conflict points between bicyclists, motorists, and pedestrians
- Improve the visibility of bicyclists to motorists
- Denote a clear right-of-way and path through the intersection for bicyclists

Photos (clockwise)

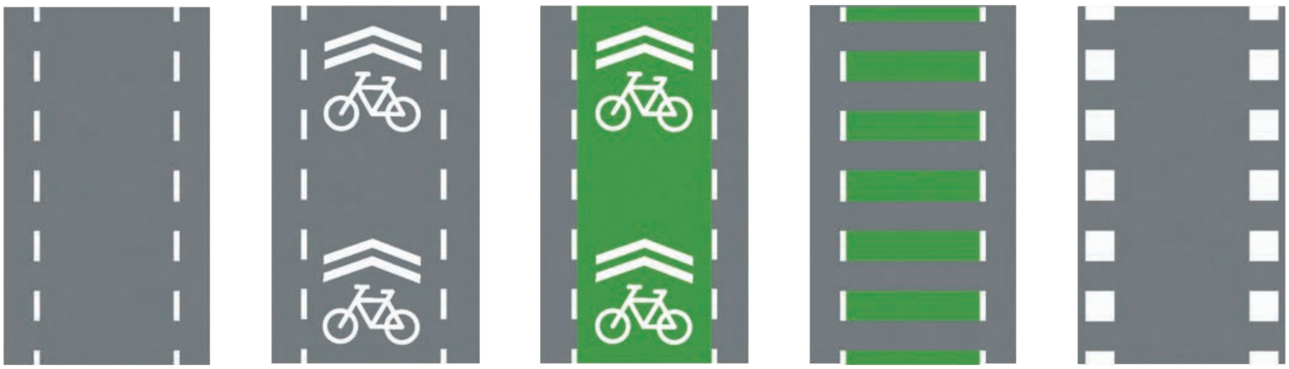
Rectangular Rapid Flashing Beacon (RRFB) and high-visibility continental crosswalk striping help create a safe and visible crossing for people on the D&R Canal Trail crossing Alexander Street in Princeton, NJ

Bicycle lane intersection markings along Dr. Martin Luther King Jr. Boulevard in Newark, NJ improve the visibility of bicyclists in the intersection

An RRFB improves the visibility of Lawrence-Hopewell Trail users as they cross Federal City Road in Hopewell Township, NJ



Bicycle Lane Intersection Markings



Dotted Line Extensions | Pavement Markings | Colored Bicycle Lane | Dashed Colored Bicycle Lane | Elephant's Feet Markings

Bicycle Lanes and Intersection Markings

Bicycle markings should be extended through intersections and major driveways to enhance the continuity of the bicycle facility, guide bicyclists through the intersection, and mitigate bicyclist stress.

This treatment has several benefits:

- Increases the visibility of bicyclists
- Reduces bicyclist stress by clearly delineating roadway space for bicyclists and guiding them through the intersection in a direct path
- Reinforces that through bicyclists have priority over turning vehicles or vehicles entering the roadway
- Helps bicyclists position themselves within the intersection
- Improves driver awareness of bicycle activity and movement through a high conflict area
- Makes bicyclist movement at intersections more predictable to motorists

Design Guidance

There are several common treatment types for intersection markings. The standard treatment is a white dotted line extension of the bicycle lane, which maintains the continuity of the bicycle lane through the intersection. The MUTCD contains guidance on this treatment in Section 3B.08.

This treatment may be enhanced to improve the visibility of the bicycle facility through various combinations of pavement markings, colored pavement, or higher visibility striping. Several treatment options are illustrated above. The use of colored pavement helps improve the visibility of the bicycle facility and increases awareness of potential conflict areas between bicyclists and motorists.

Further Guidance

- *Urban Bikeway Design Guide,* NACTO

Bike Boxes

A bike box provides a designated area for bicyclists at the front of a travel lane at signalized intersections. It allows bicyclists to move to the front of the queue during a red light, increasing their visibility to motorists. Bike boxes also reduce signal delay for bicyclists, help prioritize bicycle movement, mitigate the potential for "right-hook" crashes at the start of the green signal, facilitate left-turn positioning for bicyclists when the box extends across the entire intersection approach, and create an additional buffer from motor vehicles for pedestrians.

Bike boxes have several applications, including:

- At signalized intersections with significant bicycle and/or motor vehicle traffic, and where there are conflicts between turning movements
- To mitigate conflicts between through-bicycle movements and vehicle right turns
- To better accommodate left-turning bicycle traffic, particularly where there is a high volume of bicycle turning traffic, a designated bicycle route turns left, or a bicycle lane shifts from the right side of the street to the left side

Design Guidance

- Bike boxes should be 10 to 16 feet in length.
- The motor vehicle stop bar for the intersection is placed at the end of the bike box farthest from the intersection. It may be placed up to 7 feet in advance of the bike box to reduce motor vehicle encroachment. Optionally, a post-mounted "Stop Here on Red" sign (MUTCD R10-6A) and/or "Wait Here" pavement marking can be used to reinforce the stop bar and deter encroachment into the bike box.
- "No Turn on Red" signage (MUTCD R10-11) should be installed to prohibit vehicles from entering the bike box.
- A bike symbol pavement marking should be centered in the bike box. Aligning it outside of the wheel path increases the longevity of the marking.
- Colored pavement may be used to increase the visibility of the facility and encourage compliance by motorists.
- A "Yield to Bikes" sign may be used to reinforce that bikes have the right-of-way passing through the intersection and turning vehicles must yield.

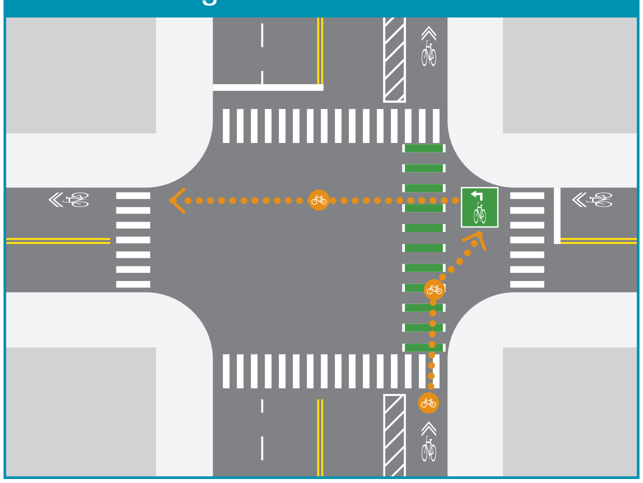
Further Guidance

- *Urban Bikeway Design Guide,* NACTO

Two-Stage Bike Turn Box

A two-stage bike turn box provides a more comfortable and safe way for bicyclists to cross multi-lane streets with high vehicle speeds or volumes. Similar to a jug-handle for motor vehicles, bicyclists complete a left turn by dividing it into two movements. Bicyclists first proceed through the intersection with traffic to a bike box on the far side of the intersection, where they position themselves in front of the traffic queue on the cross street. When the traffic signal turns green for the cross street, they cycle across the intersection with traffic, completing the left turn.

Two-Stage Bike Turn Box Process



Design Guidance

- A two-stage bike turn box is typically used with conventional or separated bicycle lanes to facilitate left-turn movements, particularly on multi-lane streets.
- The queue box should be placed in a protected area. Different configurations may be used based on the geometry of the intersection, design of the bicycle lane, the presence of on-street parking, etc.
- "No Turn on Red" signage (MUTCD R10-11) should be installed to prohibit vehicles from entering the turn box.
- The turn box should be marked with a bicycle symbol and turn arrow.
- Colored pavement may be used to increase the visibility of the facility and encourage compliance by motorists.
- The box should be positioned laterally in the cross street to improve the visibility of bicyclists.

Further Guidance

- *Urban Bikeway Design Guide,* NACTO

Additional Bicycle Accommodation Tools

Bicycle Signals

Bicycle signal heads and bicycle-specific timing strategies may be required with the provision of bicycle lanes or separated bicycle lanes. Bicycle signals can simplify bicycle movements at complex intersections, clarify navigation of the intersection for bicyclists, separate motor vehicle and bicycle movements to reduce conflicts, and prioritize bicycle movements. Bicycle signals are also necessary on two-way separated bicycle lanes, where the contra-flow movement typically requires its own signal phase and signal head to resolve conflicts with other movements.

Protected Intersections

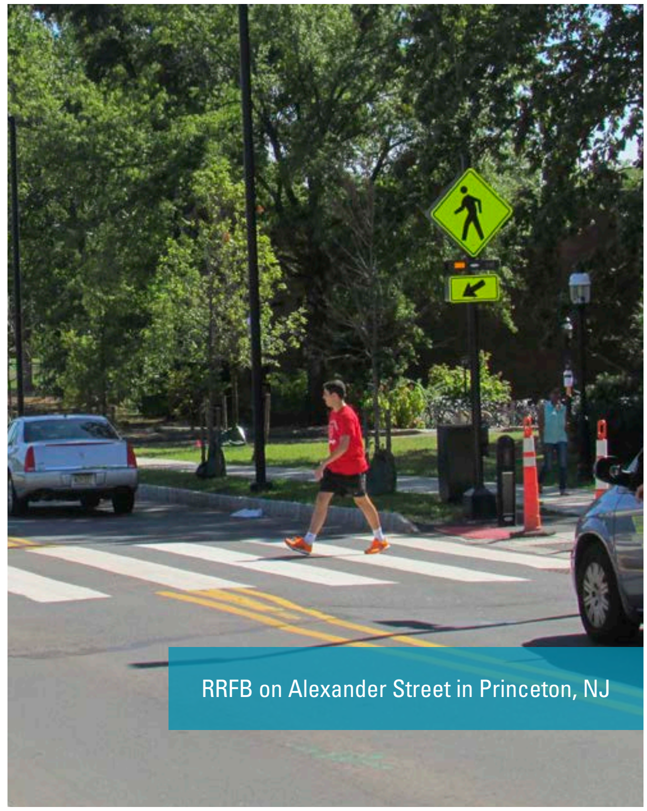
A "protected intersection," also referred to as a "Dutch junction," is the current state-of-the-art design for intersections to more safely accommodate pedestrians, bicyclists, and motorists. A standard practice in The Netherlands, the design has now been implemented in the United States in Davis, CA, and Salt Lake City, UT, with other locations currently under design. The protected intersection helps maintain separation between motorists and bicycles at the intersection, creating a lower stress environment for all modes. It is often used when all intersection approaches have a bicycle lane or separated bicycle lane. Built around similar principles as a curb extension, the design incorporates curbed islands at each corner. These islands force motorists to make turns more slowly, maintain separation between motorists and bicyclists, and reduce bicyclist exposure time to vehicles. They also slightly offset bicycle traffic from the intersection and move the conflict point between through cyclists and turning motorists so that the two modes cross paths where motorists have better visibility of the cyclists and motorists are at their lowest speed as they come through the turn. Protected intersections also facilitate two-stage left-turn movements for cyclists.

Rectangular Rapid Flashing Beacons

Rectangular Rapid Flashing Beacons (RRFBs) can be used to enhance a pedestrian crossing. The combination of signage and irregular flash pattern of the amber LED lights increases the visibility of a crossing, and studies show that they improve driver compliance with stopping for pedestrians at a marked crosswalk. A study in St. Petersburg, FL, found an increase in driver yielding behavior from 18 percent for a marked crossing with no beacon, to 81 percent with the installation of two beacons, and 88 percent with the installation of four beacons.

Design Guidance

- RRFBs should be used in conjunction with a marked crosswalk and curb ramps. They may be combined with other pedestrian crossing enhancements, such as curb extensions.
- RRFBs can be used on single-lane or multi-lane roadways. They are often used at unsignalized locations with significant pedestrian activity, such as mid-block crossings near major destinations or trail crossings, or where high traffic volumes, speeds, and/or driver behavior make pedestrian crossings challenging.
- Designers should consider the surrounding context. Existing sign clutter or visual noise, particularly in an urban area, may decrease the visual impact of the RRFB.
- RRFBs can be installed with active or passive actuation.
- On divided roadways, RRFBs can be included in the median or center island to further increase visibility and driver yielding behavior.
- RRFBs are typically freestanding and powered by a solar panel unit. They are therefore easily implementable at trail crossings or other locations without easy access to a traditional power source.



RRFB on Alexander Street in Princeton, NJ

Further Guidance

- MUTCD, FHWA

Pedestrian Hybrid Beacons

A pedestrian hybrid beacon, also known as a high intensity actuated crosswalk (HAWK), is a pedestrian-actuated traffic control device for mid-block pedestrian crossing locations. They enable pedestrians to cross high-speed and high-volume roadways while traffic is stopped. As the name implies, it is essentially a hybrid between a RRFB and a full traffic signal. It provides planners and engineers with an intermediary option for locations that do not meet requirements for a traffic signal warrant, but where traffic conditions exceed the limitations of an RRFB.

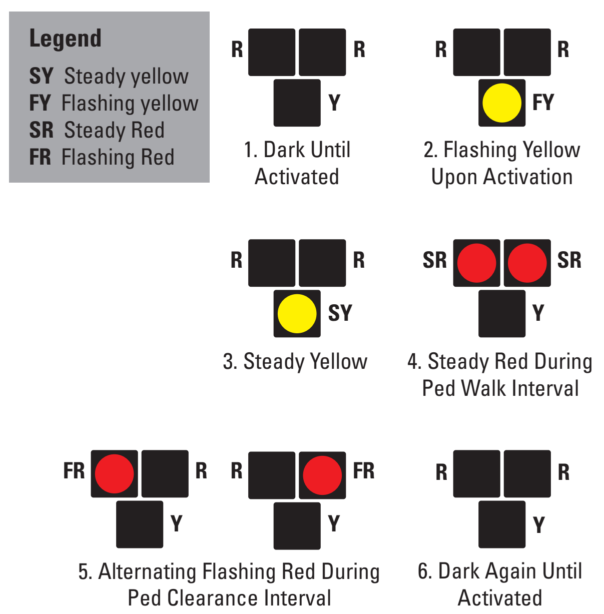
A pedestrian hybrid beacon consists of an overhead mast arm with two red lights and one yellow light, as well as pedestrian signal heads. When actuated by a pedestrian, the beacon goes through a sequence of flashing and steady yellow light intervals, followed by a steady red light to stop vehicular traffic, at which point a "walk" signal is indicated to pedestrians. At the conclusion of the "walk" phase, the pedestrian signal switches to a flashing orange hand, and the hybrid beacon switches to alternating flashing red lights. The beacon goes dark at the conclusion of the cycle, and traffic resumes as normal.

HAWK signal along NJ 27 improves access to the Metropark Train Station in Iselin, NJ

Design Guidance

- Pedestrian hybrid beacons should be used in conjunction with a marked crosswalk and curb ramps. They may be combined with other pedestrian crossing enhancements, such as curb extensions.
- Pedestrian hybrid beacons are typically installed at mid-block locations and roadways with heavy traffic volumes, wide cross-sections, or high traffic speeds that create difficult pedestrian crossings. They are a useful tool where gaps in traffic are insufficient to allow pedestrian crossings or where there is excessive pedestrian delay.
- Pedestrian hybrid beacons are often installed near schools, transit stops, or near major pedestrian destinations.

Display Sequence for HAWK Signal



Further Guidance

- MUTCD, FHWA

Metrics

Multimodal LOS

Level of service (LOS) is a metric used to quantify the quality of a transportation service. It is an indicator of the traveling public's general satisfaction with the performance of the service under typical demand and operation conditions. LOS is presented on a scale from "A" to "F," representing from best to worst condition, respectively.

Traditionally, LOS has typically focused on conditions for automobiles, which is a function of average travel speed and number of stops per mile. To improve the auto LOS, improvements such as signal timing adjustments, additional exclusive left-turn lanes, or creating additional capacity may be proposed. However, focusing on this one indicator does not account for potential adverse effects on other users of the intersection, such as longer crossings or additional crossing delay for pedestrians.

Multimodal LOS (MMLOS) provides a broader snapshot of the quality of the transportation system, allowing a Complete Streets approach to transportation analysis. MMLOS generates separate LOS indicators for four modes of travel: automobile drivers, bus passengers, pedestrians, and bicyclists. This enables transportation planners, analysts, and engineers to assess how various design changes impact each mode differently, weigh the potential trade-offs in performance for each mode, and seek a balance appropriate to the context of the study area and user needs.

MMLOS is included in the 2010 update to the *Highway Capacity Manual*. The metric was developed for urban streets, which the methodology defines as a street with a traffic signal control device at least once every 2 miles. It is typically applied in more urban environments where there is more multimodal need and activity, and not in rural settings or on residential streets.

Further Guidance

- *2010 Highway Capacity Manual*, Transportation Research Board

ENDNOTES

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04

Street Typologies

The character and usage patterns of New Jersey's streets has evolved over centuries, influenced by changing technology, shifting land use patterns, and population growth. Streets that were built as rural farm routes between and through downtowns are often now highways or arterials, carrying thousands of cars every day. Urban streets, which once carried carriages, then streetcars, were transformed by the rise of the automobile, often to the detriment of other modes of transportation and local residents.

The Complete Streets approach prioritizes context as a critical factor in street design. Because of this, it is important to recognize the unique history and function of New Jersey's streets, both in land use and transportation contexts, and understand how decisions made today will influence the future function and economic viability of a street, community, and ultimately the State.

The following street typologies represent a cross section of typical road types in New Jersey. They reflect not only the transportation needs of the street, which are often captured in a traditional functional classification hierarchy, but also the community context. The purpose of generating these typologies is to apply best practices in Complete Streets design to streets with different contexts and needs. The needs of any particular street, whether suburban residential or urban commercial, change depending on density and other contextual factors. These differences are addressed in this chapter through different applications of design considerations and minimum standards.

The street typologies presented in this chapter are not exhaustive, but the Complete Streets application principles behind them can be applied to other street typologies. Street typologies are not necessarily continuous along the entire length of a street; a single street may change typology as the surrounding land uses or functions of the roadway changes.

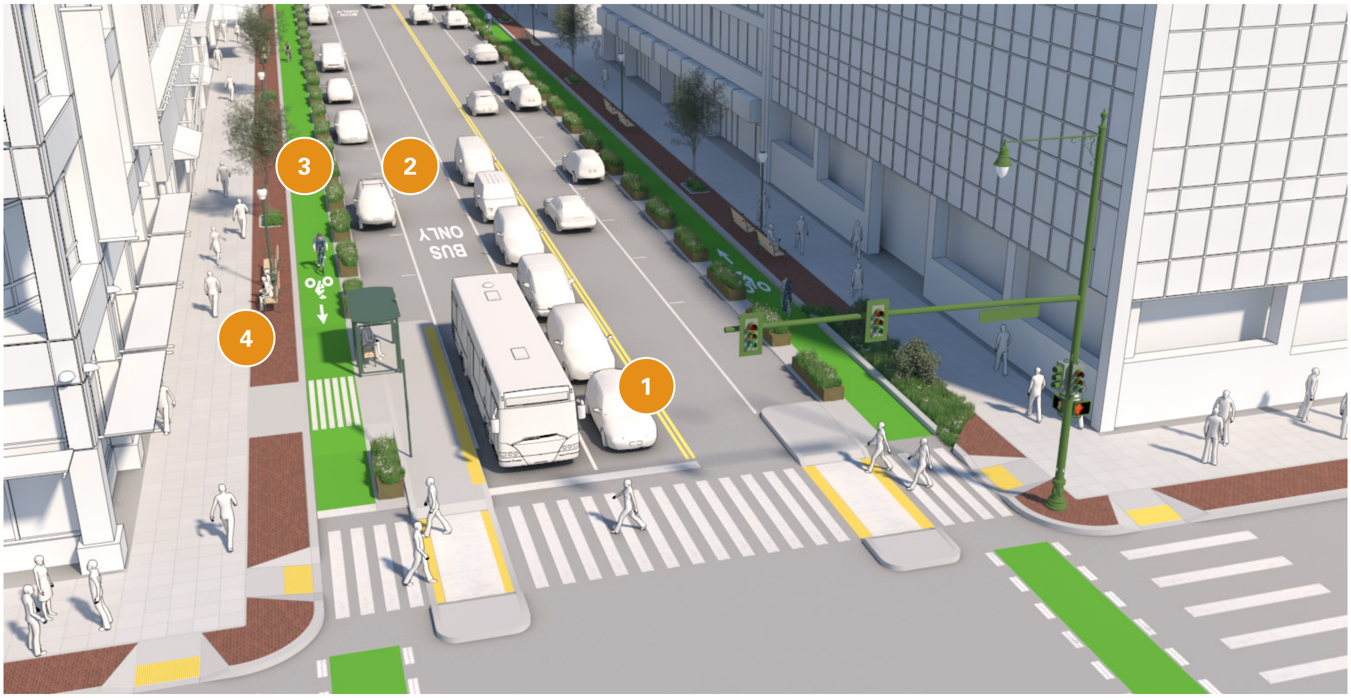
Downtown Urban Core

Downtown urban streets are often challenging for cities to reconfigure and retrofit. They typically have multi-modal needs and surrounding buildings, and the built environment creates a constrained environment. Design solutions often have to balance high motor vehicle volumes, commercial goods movement, heavy turn volumes, and other high-intensity uses with the needs of other street users. These streets often provide insufficient accommodations for bicyclists and pedestrians, and can be challenging and uninviting places to cycle or walk. Constrained streets can often be retrofitted using lane diets and conventional bicycle lanes or road diets to add higher quality bicycle, pedestrian, and transit facilities and improved vehicular safety.

Existing Conditions

The above illustration depicts a wide four-lane urban thoroughfare. This street only features accommodations for automobiles. This configuration can lead to weaving motor vehicles, double-parked cars, and obstruction of buses, which can make for an unsafe environment for motorists, pedestrians, and cyclists.

Undifferentiated street space and wide travel lanes can result in higher travel speeds and an uninviting environment for bicyclists, who often feel uncomfortable riding between fast-moving traffic and parked cars. Double-parked vehicles can cause bicyclists to weave into traffic unpredictably, creating an unsafe environment for all users.



Recommendations

1 A road diet allows the reorganization of the street space to provide accommodations for non-motorized users and transit vehicles.

2 Along high frequency transit routes, a dedicated bus lane can improve transit service and reliability and the overall attractiveness of the service. In conventional four-lane to three-lane road diets, the third lane is often used as a turning lane for motor vehicles.

3 A separated bicycle lane significantly reduces conflicts between bicyclists and motorists and creates an inviting and comfortable facility for bicyclists of all ages and abilities. Special attention must be given to separated bicycle lanes at intersections. Conflict areas should be highlighted using intersection crossing markings. Bicycle signals may be needed to allow bicycle traffic to operate safely along the corridor.

4 Better delineation of the sidewalk space allows for the provision of pedestrian amenities such as street furniture and pedestrian-scale lighting. Stormwater management techniques can provide additional greenery and reduce stormwater runoff.

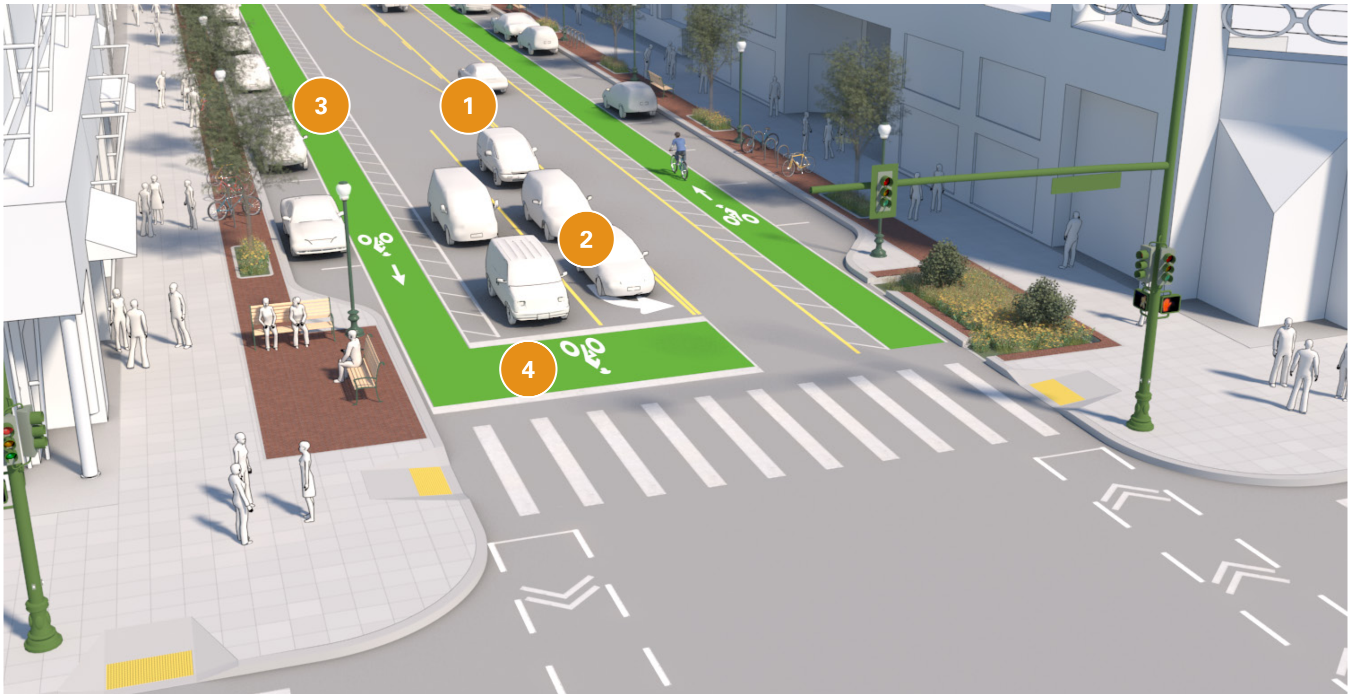
In constrained environments where the provision of a separated bicycle lane is impractical, a buffered bicycle lane is an appropriate treatment. A buffered bicycle lane provides cyclists dedicated space; however, in high-volume urban environments these facilities can often be blocked by double-parked vehicles or freight delivery vehicles. Policy and enforcement are critical to ensure that bicycle lanes remain clear and safe for cyclists.

Main Street

Main streets are the center of neighborhood life, with high volumes of pedestrians, transit vehicles/ passengers, bicyclists, and motorists vying for limited space. New Jersey's main streets, in both suburban and rural contexts, feature many similar characteristics. While the needs and challenges of a main street differ based on context and scale, most main streets need to balance the needs of local and through travel while maximizing livability and economic vitality. In New Jersey, many main streets are located on roadways that provide regional connectivity, which presents challenges in balancing local community needs with regional transportation concerns. Main street design should limit traffic speeds, encourage safe and comfortable pedestrian activity, facilitate commerce, and support inviting public spaces.

Existing Conditions

The existing conditions shown in the illustration above are typical of many main streets in New Jersey. The illustration depicts a main street with four motor vehicle travel lanes. Four-lane configurations have been shown to increase incidents of rear-end and sideswipe vehicle crashes. Many main streets that carry regional commuter traffic have been designed for peak-period travel and remain significantly below capacity at other times of the day.



Recommendations

1 Road diets are not appropriate on all four-lane cross sections. Generally, streets carrying up to 25,000 vehicles per day can function effectively with three lanes while providing extra space for non-motorized users. Road diets can improve traffic flow and reduce conflicts with turning vehicles and dangerous weaving movements. More information on Road Diets can be found on Page 66.

2 Turn lanes help eliminate weaving conflicts that are common on a four-lane road. Alternative treatments can incorporate pedestrian safety islands or a median with turn bays at key locations.

3 Buffered bicycle lanes provide dedicated space for cyclists with more distance from motor vehicles than a conventional bicycle lane. On streets with frequent deliveries or double parking, special accommodations and extra enforcement should be provided to ensure that the bicycle lane is not blocked.

4 Bike boxes help cyclists make left or right turns by placing them in front of traffic at a red light. On streets with higher volumes of traffic, cyclists may prefer to make a two-stage turn.

A raised, separated bicycle lane provides a low-stress facility that is comfortable for users of all ages and abilities. It allows for one-way or two-way travel, provides increased separation from motor vehicles than an on-street lane, and has lower maintenance costs due to limited motor vehicle wear.

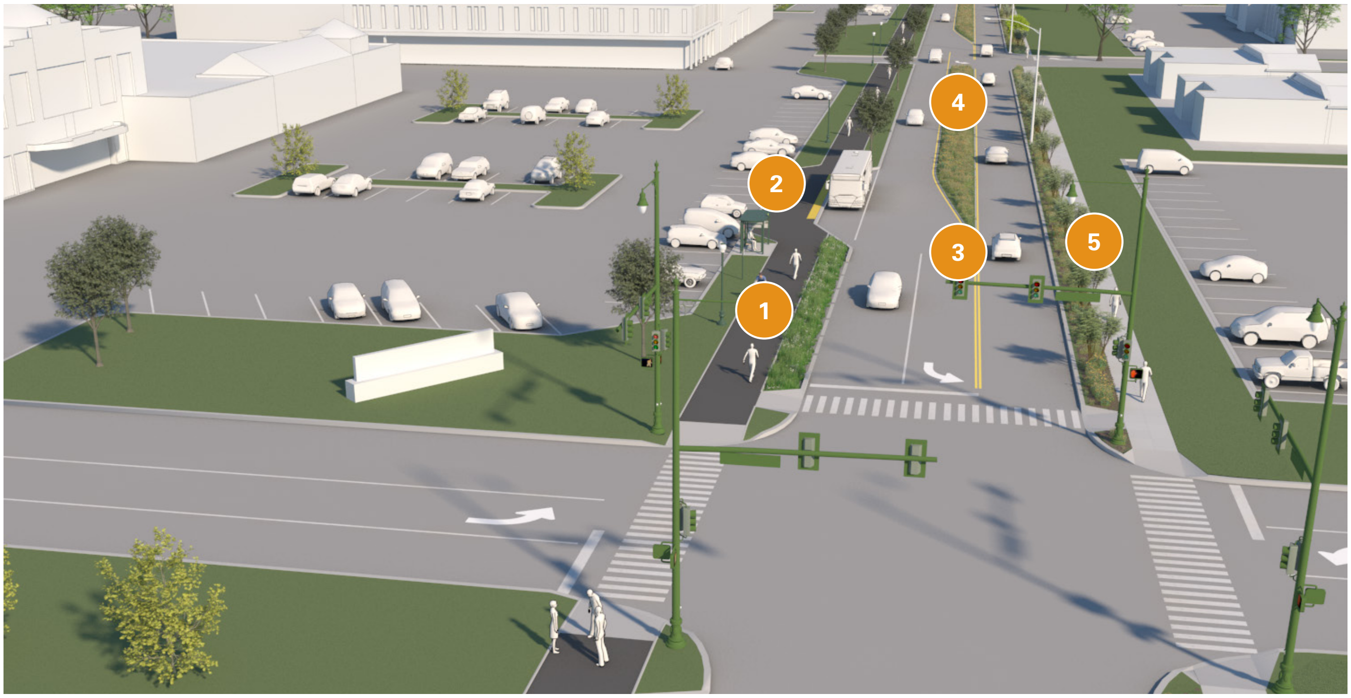
Commercial Strip Corridor

Commercial strip corridors are typical of suburban development patterns after World War II. These corridors, often along arterial roadways in suburban or exurban locations, were generally designed almost exclusively to accommodate automobile access. Pedestrian and bicycle mobility is often restricted along these corridors by disperse development patterns, high traffic speeds and volumes, and a lack of accommodations for non-motorized modes. While transit service, primarily bus, is often available along many of these corridors in New Jersey, the lack of adequate pedestrian facilities reduces the accessibility and usability of these services in many locations.

The lack of mobility and accessibility for pedestrian, bicycle, and transit modes has disproportionate negative impacts on low-income and minority populations who often work at or need access to commercial properties along these corridors. The lack of accommodations for non-motorized users reduces the economic mobility and opportunity for large parts of the population in New Jersey. Commercial strip corridors can also be some of the most dangerous for pedestrians and bicyclists, often ranking among the most frequent locations for severe or fatal bicycle and/or pedestrian crashes in New Jersey. These design solutions tend to focus less on street features that would be found in a downtown environment (e.g., street trees, public seating areas) and more on improving access and mobility for non-motorized road users.

Existing Conditions

The existing conditions shown in the illustration above are typical of many commercial strip corridors in New Jersey. The illustration depicts two travel lanes and one bi-directional turning lane. Wide travel lanes encourage higher speeds for motorists. The lack of sidewalks or accommodations for bicyclists forces many users to ride or walk in the roadway or to create informal worn paths in the planted area. Frequent driveways create many conflicts between motorists and non-motorized users. Many commercial areas in New Jersey feature more lanes for motor vehicles, wide shoulders, no shoulder, or other configurations that differ from the above illustration.



Recommendations

1 A multi-use path can be installed in the wide planted area to provide accommodations for bicyclists and pedestrians. Paths should feature lighting and be well marked at intersections and driveways.

2 A bus pull-out, while not ideal in an urban setting, is appropriate along an arterial corridor to reduce weaving from motorists. Bus stops should always be accessible for all users.

3 Narrowing travel lanes can help reduce travel speeds while maintaining vehicle capacity.

4 Defined turning lanes are preferable to bi-directional turning lanes (where possible). A curbed median can also provide a pedestrian refuge.

5 If insufficient space exists for a multi-use path, the addition of continuous sidewalk in a strip commercial corridor can dramatically improve pedestrian safety and mobility. Sidewalks/ paths should be provided on both sides of the roadway if possible.

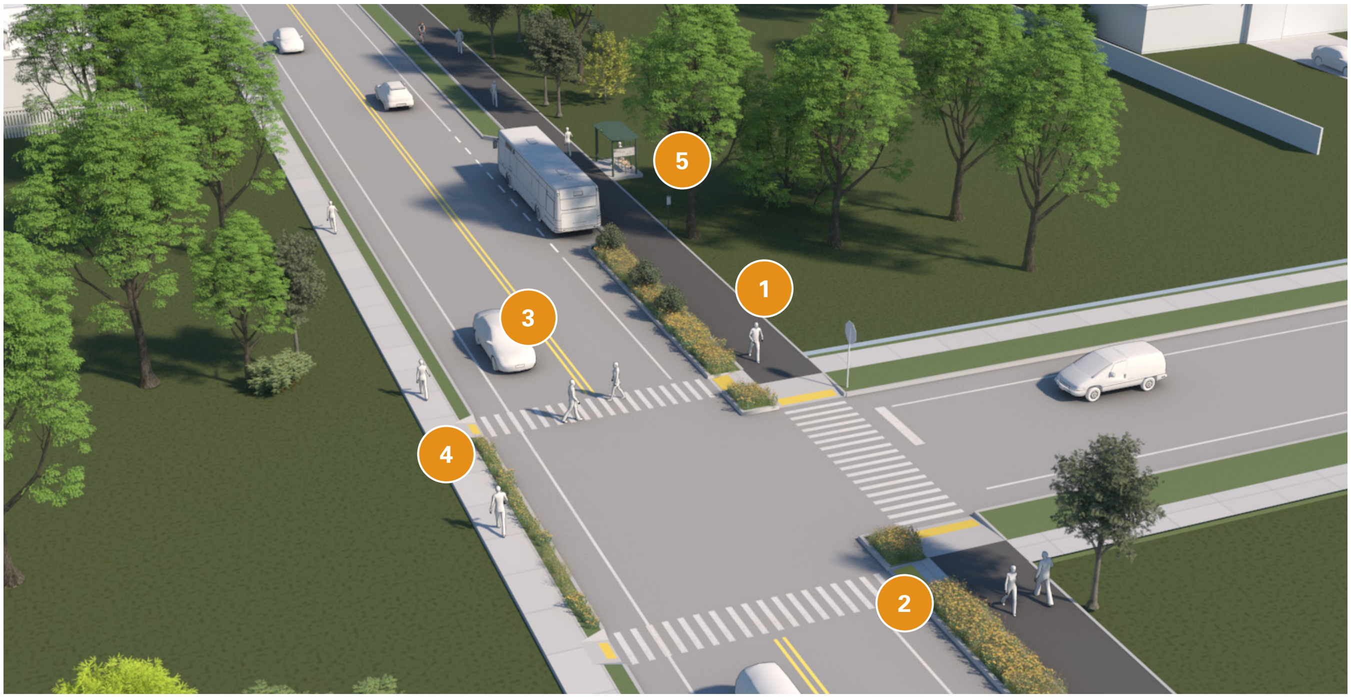
A buffered bicycle lane is an appropriate treatment for commercial strip corridors that feature travel speeds under 40 mph. With higher speeds and volumes (particularly on multi-lane roadways) a striped bicycle lane does not provide a low-stress facility that is comfortable for all users.

Low Density State/County Highway

New Jersey features many historic highways that have provided connections between municipalities since before the automobile. These roads still play a critical role in the state's transportation system, connecting communities, jobs centers, commercial areas, and residential development. Land uses along these roadways are often disparate while the roadways themselves generally carry higher speed traffic (>40 mph). The roadways often need to balance the needs of high volumes of regional automobile traffic with the needs of residents and other roadway users (including recreational and commuting cyclists).

Existing Conditions

The above illustration depicts a two-way highway in a low-density area. The roadway features two travel lanes with shoulders and vegetated areas on each side. While the shoulders may be used by bicycles, they are not marked as such and may often be obstructed by debris or other impediments. While many similar roadways in New Jersey have a more constrained cartway, there is often space within the public right-of-way that is not used. In this configuration, a bus stop is signed but there is no connecting sidewalk, which leaves this stop inaccessible to those with limited mobility.



Recommendations

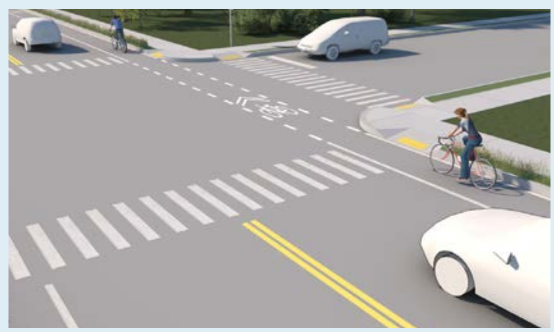
1 A multi-use path can be installed in the wide planted area to provide accommodations for bicyclists and pedestrians. The path should feature lighting and be well marked at intersections and driveways.

2 Shoulders marked as bicycle lanes should be kept free of debris and other impediments. The Public Works department should be aware of maintenance needs of all bicycle facilities. The marking of a shoulder as a bicycle lane does not preclude the occasional need to use the shoulder for emergencies or broken-down vehicles.

3 Narrower travel lanes discourage speeding and provide more space for shoulder/bicycle lane.

4 A continuous sidewalk provides a pedestrian facility at key locations along the corridor between various land uses.

5 The installation of a bus shelter with seating, in conjunction with the inclusion of a continuous sidewalk, creates an accessible and comfortable bus stop for all users. Bus shelters are particularly important along lower frequency routes where passengers might wait for significant amounts of time.



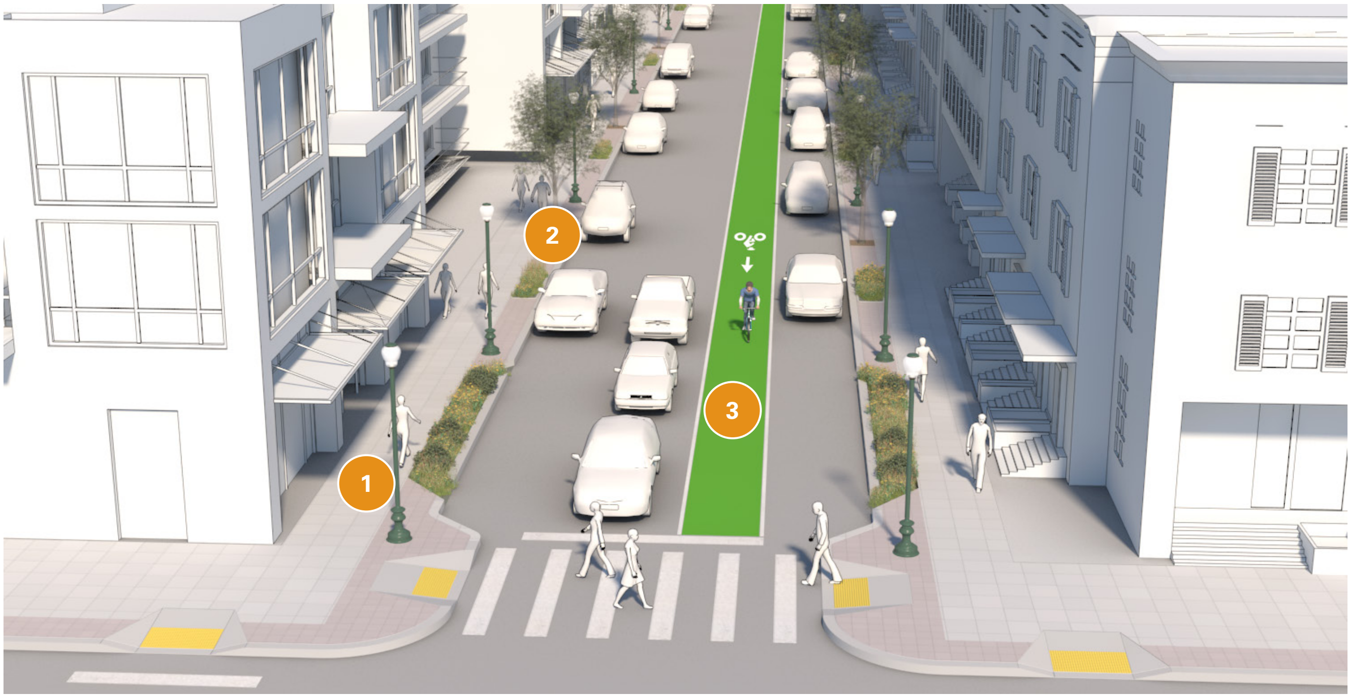
Bicycle lane markings should continue through intersections along low-density highways, even if the shoulder is not marked as a bicycle lane or the bicycle lane features infrequent markings. Intersections are the largest point of conflict between motorists and bicyclists. Intersection markings increase the awareness of the bicycle facility or the potential for bicycle activity that a motorist might not otherwise look for.

Urban Residential

Local streets in urban residential neighborhoods are often underutilized as spaces for play and leisure. Urban neighborhoods support a high demand for multimodal access, and the streets should provide safe and inviting places for people to walk and bike. Design features can include stormwater management techniques, curb extensions, vertical speed control elements, and bicycle facilities. Many of these streets in New Jersey feature narrower cartway widths and high demands for on-street parking.

Existing Conditions

The above illustration depicts a typical one-way urban residential street in New Jersey. This street features narrow sidewalks that have been uprooted by tree roots. A 16-foot-wide single travel lane leads to frequent double parking.



Recommendations

1 A wider sidewalk and narrower furnishing zone provides more room for pedestrians and increases accessibility for those with mobility limitations.

2 The addition of a tree pit with a metal grate covering provides more room for tree roots to grow, which minimizes sidewalk disruption. The metal grate creates a wider effective walking area and reduces tripping hazards for pedestrians.

3 The addition of a bicycle lane in this context provides dedicated space for bicyclists on a lower-stress street while reducing propensity for motor vehicle speeding and double parking. Increased enforcement might accompany this addition to deter double parking in the bicycle lane. Where space allows, the addition of a separated bicycle lane would remove the ability to double park and provide a more comfortable bicycle facility.

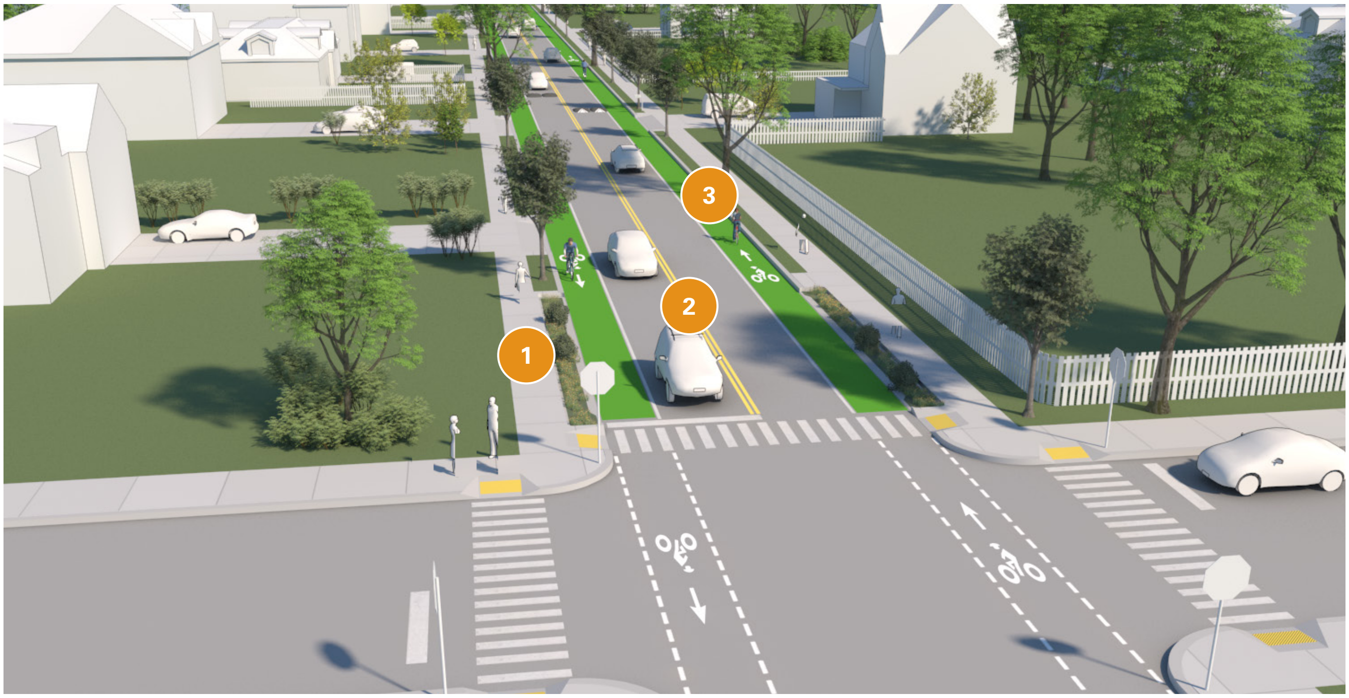
If space does not allow for the creation of a dedicated bicycle facility, shared-lane markings are generally appropriate on lower-volume, lower-speed residential streets to create critical connectivity within a bicycle network.

Suburban/Rural Residential (High-Volumes)

Suburban or rural residential streets often have very similar needs with differences based on the context and scale. Suburban/rural residential streets with higher traffic volumes generally feature a center line and often serve as connector roadways within the larger street network, in addition to providing local residential access. Many of these types of streets in New Jersey facilitate higher motor vehicle travel speeds. Design should generally favor separation of uses rather than shared spaces and focus on increasing safety and mobility for residents through a mixture of traffic calming and pedestrian and bicycle accommodations.

Existing Conditions

The illustration above depicts a typical suburban/rural residential street with higher traffic volumes. The street features two 12-foot travel lanes and parking allowed on one side. With off-street parking available at each residence, the on-street parking is rarely used. Sidewalks are narrow, which causes issues for pedestrians with limited mobility and can force pedestrians passing each other into the planting strip.



Recommendations

1 A wider sidewalk and narrower planting zone provides more room for pedestrians and increases accessibility for those with mobility limitations.

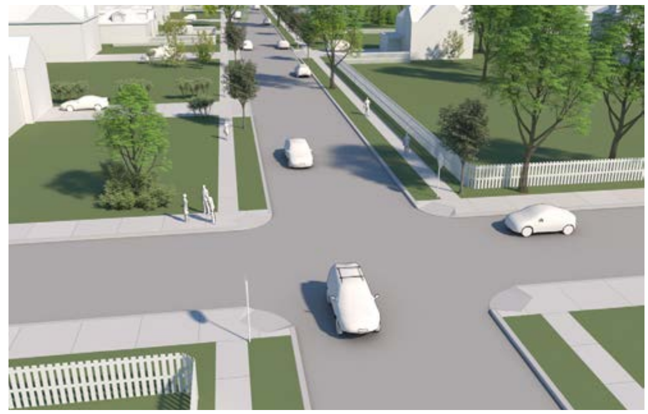
2 Narrower travel lanes (10 feet) and the removal of the rarely used on-street parking allows for the striping of two standard 6-foot bicycle lanes.

3 Speed cushions provide traffic calming benefits (in addition to narrower lanes) while allowing easier passage for emergency vehicles.

While separation is generally favored between bicyclists and motorists on a higher-volume roadway, if space does not allow for the striping of a minimum 5-foot bicycle lane, shared-lane markings are an appropriate treatment in conjunction with other traffic-calming measures, such as curb-extensions.

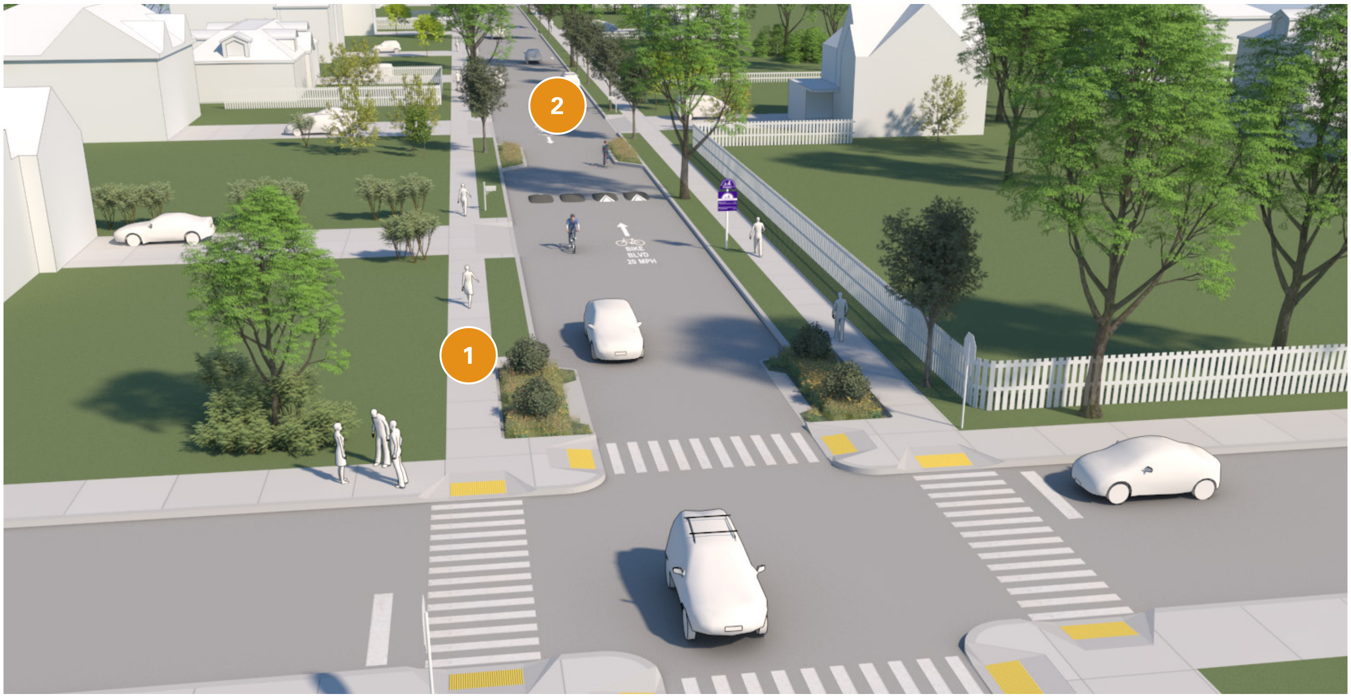
Suburban/Rural Residential (Low-Volumes)

Many low-volume residential streets in New Jersey feature constrained cartways that cannot accommodate dedicated space for all modes. Instead, design of the streets should focus on creating safe and comfortable shared spaces with design and posted speeds of 25 mph or less. In certain contexts, bicycle boulevard treatments are appropriate to discourage through traffic and/or high vehicle speeds. Many of these streets in New Jersey can be considered what NACTO refers to as a "Two-Way Yield Street," where a narrow cartway width and 40 to 60 percent on-street parking utilization allows drivers in opposite directions to yield to and pass one another.



Existing Conditions

The above illustration depicts a typical low-volume suburban/rural residential street in New Jersey. The street features a narrow sidewalk, wide planting strip, and an unstriped street where two directions of traffic and on-street parking share the 30-foot cartway. While these streets are typically low stress, an unmarked and straight roadway can encourage higher vehicle travel speeds when there are no or few parked cars.



Recommendations

1 A wider sidewalk and narrower planting zone provides more room for pedestrians and increases accessibility for those with mobility limitations.

2 A bicycle boulevard with traffic-calming features such as curb extensions, speed cushions, chicanes, and lower speed limits create a more comfortable environment for bicyclists and pedestrians at all times of day.

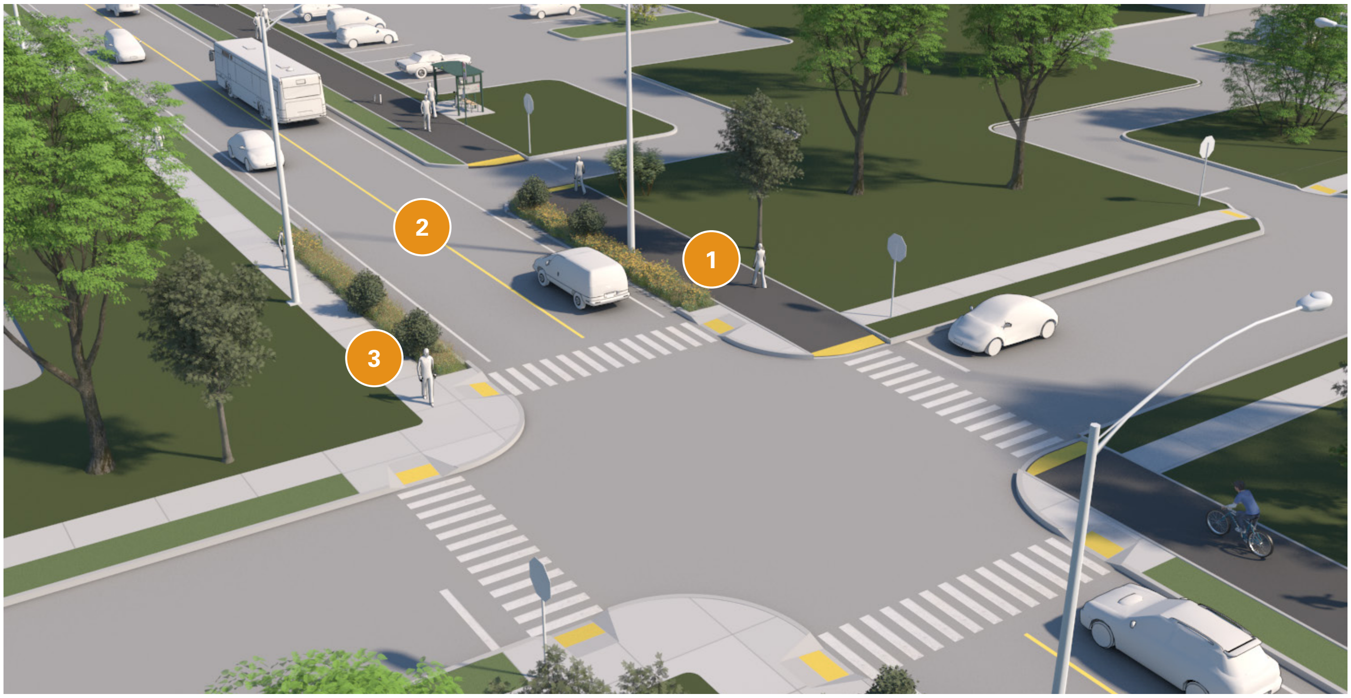
When creating a bicycle boulevard, a traffic diverter is an effective treatment for reducing motor vehicle volumes along the designated route.

Office/Light Industrial Center

Many (if not most) office/light industrial developments in New Jersey are designed and oriented for automobile access. This often leads to very wide streets and a lack of pedestrian or bicycle infrastructure. This design restricts access to those who wish to or need to arrive by other means of transportation, including nearby public transportation. While office/light industrial centers will typically continue to be auto-centric due to their surrounding land use patterns and need to accommodate deliveries or truck traffic, they should also incorporate the needs of other modes in order to support more transportation options and improved internal circulation. Design treatments should focus on creating streets with appropriate travel lane width and internal circulation for pedestrians and bicyclists, as well as connections to nearby bicycle, pedestrian, and transit networks.

Existing Conditions

The above illustration depicts a typical office/light industrial center street. The street features a 27-foot cartway with no striping that carries two directions of traffic. Grass areas on each side of the cartway are often used by employees to walk around the development or to nearby destinations outside of the development. The lack of sidewalks or facilities for cyclists discourages this type of use and does not provide any accessible facility for non-motorized users with limited mobility.



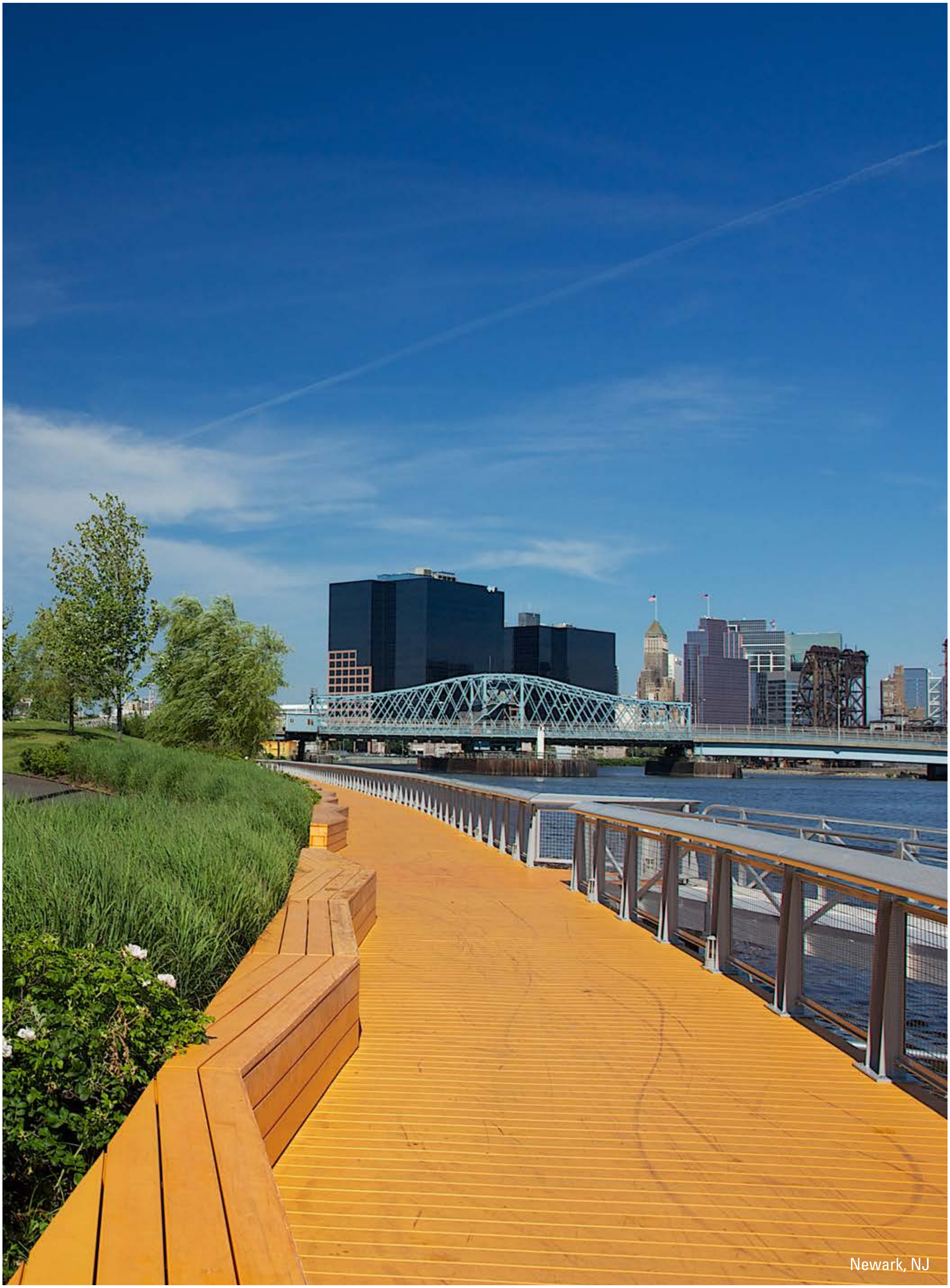
Recommendations

1 A multi-use path can be installed in the wide planted area to provide accommodations for bicyclists and pedestrians. The path should feature lighting and be well marked at intersections and driveways.

2 Narrower travel lanes discourage speeding.

3 A continuous sidewalk provides an accessible pedestrian facility throughout the development.

Where space allows in the cartway, or insufficient space exists within the planting strip, on-street bicycle lanes are an appropriate treatment within an office/light industrial center development.



Newark, NJ

New Jersey State Department of Transportation
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