

SEAS

S O U T H E A S T A R E A S T U D Y

U P D A T E

Archer Lodge | Benson | Clayton | Four Oaks | Garner | Kenly | Micro | Pine Level | Selma |
Smithfield | Wilson's Mills | Parts of Raleigh, Johnston County, and Wake County

MULTIMODAL INTERSECTION CONTROL EVALUATION (ICE) TOOLKIT



Photo: NCDOT

What is ICE?

Intersection Control Evaluation (ICE) is a performance-based process and framework used to consider alternatives and identify optimal solutions for intersection improvements. The central goals of ICE are to improve **transparency**, **flexibility**, and **adaptability** during the intersection improvement process.

An ICE is a two-step process of **screening** potential intersection design alternatives and **selecting** the ultimate preferred alternative.

What About Other Modes?

The term “multimodal” includes a variety of road users in addition to the driver, including **people walking and rolling**, **biking**, and **taking transit**. As the Southeast Area grows and builds out plans for sidewalks, greenways, transit service, new roadways, and mixed-use centers, it will become increasingly important for **access**, **mobility**, and **safety** to include accommodations for multimodal users in roadway design.

Intersection Control Evaluations typically focus on safety and delay reduction benefits; however, some ICEs focus more heavily on delay first and vehicle safety second, and have very limited focus on how alternative designs impact the safety and convenience of multimodal users. **The needs of multimodal users must be considered from the beginning to ensure that intersections are safe and efficient for everyone.**



Including multimodal accommodations in roadway and intersection projects at the outset of a project can avoid added costs from retrofitting infrastructure at a later date.

Why is it Important to Design Intersections for Multiple Modes?

Infrastructure makes a difference.

Between 2007 and 2021, roughly 98% of recorded pedestrian fatalities and serious injuries in the Southeast Area were in places without sidewalks and 100% of bicyclist fatalities and serious injuries were in places without bike facilities.

Multimodal design should serve all kinds of users.



People walking or rolling

Intersections are a critical part of the pedestrian network. Crossings need to be short, direct, and predictable with enough time for people of all ages and abilities to cross safely. Crossings also need to be designed for accessibility, with design elements like accessible ramps and signals with audio cues to assist vision-impaired users.



People biking

To be bike-friendly, intersections need to be designed to get people biking safely through the intersection, with dedicated space, minimized conflicts with car lanes, and clear indications of how to navigate the space.



Transit riders

Transit stops are often located near major destinations but riders may have to cross busy intersections to get to their desired destination, making intersections designed for safety critical to ensuring transit is accessible.



Drivers

Intersections that take speed, signal-timing, sight-distance, user behavior, inclement weather conditions, and other safety factors into account can help prevent severe and fatal car crashes.

Intersection design is critical.

Intersections are major conflict points between people walking and biking and fast-moving multi-ton vehicles. Intersections designed only for traffic flow limit where people can comfortably walk and bike and jeopardize the safety of people who have to cross.

Multimodal design should provide access and mobility to more people.



People with no vehicle access

4.1% of Southeast Area households have no access to a vehicle.



People in one vehicle households

23.9% of Southeast Area households have access to one vehicle- but it may not always be available if there are conflicting travel needs or repairs.



Children too young to drive

20.8% of Johnston County's population and 19.6% of Wake County's population are under the age of 15 and too young to get a learner's permit in North Carolina.



Seniors no longer able to drive safely

2018 research by Hedges & Company found that across the US, around 6.5% of people ages 50-69, 15.1% of people ages 70-84, and 39.9% of people over 85 lacked a driver's licenses.



People with disabilities that prevent driving

Only 60.4% of people ages 16-64 with disabilities in the US have licenses compared to 91.7% of people without disabilities.

People outside cars are at the most risk.

In the US, pedestrian fatalities have risen 77% since 2010 and bicycle fatalities have risen 44% since 2011. More people walking were killed by vehicles in 2022 than in any year since 1981. In spite of these striking numbers, research shows pedestrian and bike crashes are still consistently underreported.

Multimodal design should provide alternatives to worsening congestion.

Each person driving is another car on the road adding to traffic. Multimodal design provides alternatives that can help mitigate congestion by getting more cars off the road.



People have options for getting around besides driving on congested roads



People who choose alternative modes take cars off the road

Designing for all modes early can even help minimize project costs and cost increases by:



Avoiding paying to redo work and retrofit infrastructure completed in earlier phases/projects



Avoiding cost inflation from delayed construction

How do I Include Multiple Travel Modes when Doing an ICE?

Prioritize safety first and traffic flow second.

To design for safe and efficient movement of all modes when screening alternatives, in order of importance, *prioritize...*

1  **Safety of People Outside Vehicles**

Safety for all people using the road should always be the goal. However, **keeping all users safe requires first designing for the safety of the most vulnerable road users.** People outside of vehicles, whether walking, rolling, or biking, are the most at risk of getting seriously injured or killed if involved in a car crash.

2  **Safety of People Inside Vehicles**

Designing for the safety of all road users also means emphasizing safety for people driving or riding in vehicles. Designs should **prioritize preventing the types of crashes that cause the most serious and fatal injuries.**

3  **Traffic Flow**

Multimodal design should ensure that users of **all modes can move efficiently** through an intersection. Designing for the movement of all modes can help reduce conflicts between modes that hinder both efficiency and safety.

Think “Location, location, location”



Not all locations need to be inclusive of all modes, but intersections should safely incorporate all modes expected based on existing routes, destinations, and future plans. When screening alternatives, ask yourself, *is the intersection...*

-  **On the pedestrian network?**
-  **On a bike route or shared use path?**
-  **On a transit route or near a transit stop?**
-  **Near destinations people would walk or bike to?**
-  **Where land use supports or is planned to support walking and biking?**
-  **Where it would be difficult and expensive to add multimodal provisions later?**

Multimodal Design Principles

There are a variety of proven intersection solutions that keep people walking, biking, and taking transit safe.

Safety-focused principles

-  **Deter high speeds**
Speed is one of the largest threats to safety for all road users. The higher the speed a pedestrian or bicyclist is hit at, the more likely they are to die. Speed also impacts the severity of car crashes and can be the difference between a fender-bender and a catastrophic fatal collision.
 - Traffic calming methods like **raised crossings** and **narrowed lanes** can help discourage deadly speeds through an intersection. Specific intersection designs like **roundabouts** and **protected intersections** can also encourage reduced speeds and increased caution.
 - **Signal timing** can also be used to keep cars from gaining too much speed between signals.
-  **Ensure visibility**
 Intersections need to be designed for **clear visibility and safe sight distances.** Drivers need to be able to see people crossing on foot or on bikes with enough time to stop, and other users such as transit riders, people walking, and people biking need to be able to see each other and drivers too.
 - Removing parked cars, trees, and other visual obstacles closest to the corner (sometimes called “**daylighting an intersection**”) can help improve visibility.
 - **Curb extensions** can also help in places with on-street parking by bringing the sidewalk as far out towards the intersection as possible and preventing illegal parking that would block sight lines.



Example of a raised crossing. Source: NACTO

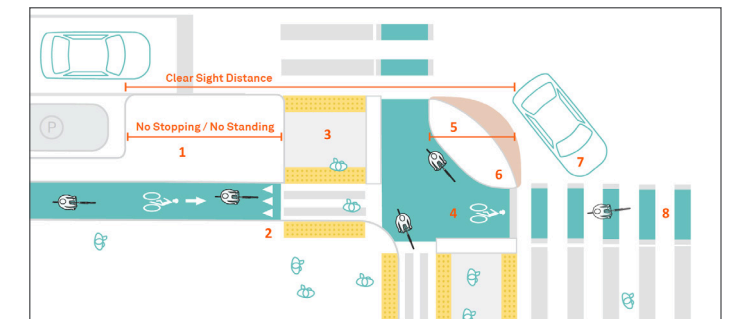
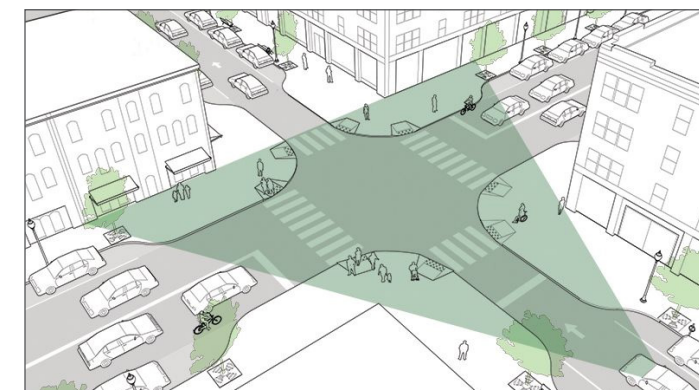


Diagram of a corner of a protected intersection. Source: NACTO



Example diagram of intersection visibility. Source: NACTO

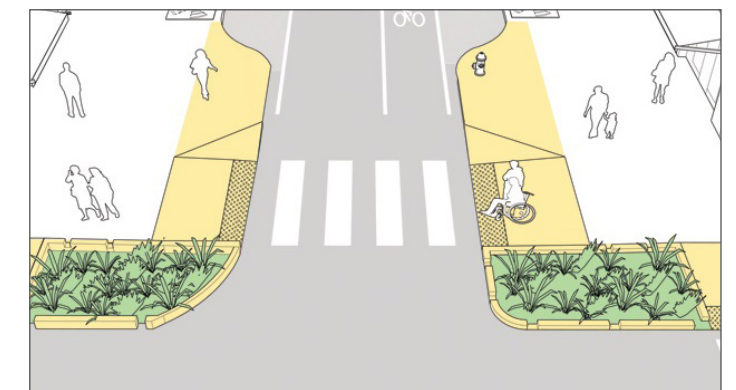


Illustration of a curb extension. Source: NACTO

Safety-focused principles (continued)



Prevent wide and fast turns

One in four vehicle-pedestrian crashes in the Triangle region occur when a car is turning at an intersection or driveway. Many intersections are designed with large radii, wide turning slip lanes, and medians that end far back from the intersection, allowing for and encouraging fast turns. However, **fast, sweeping turns can be deadly**, and make it harder for a turning driver to see or stop in time for a person crossing.

- **Avoid slip lanes**, as they encourage blind turns that put people crossing at risk. Where turn lanes exist, **require turning traffic to yield and avoid making turning vehicles merge through bike lanes**.
- **Minimize curb radii** to discourage wide and fast right turns by rebuilding the corner with a smaller radius, **curb extensions** on streets with parking, or by using **road markings** or **street art** to square off corners (preferably paired with bollards or planters for protection).
- **Centerline hardening**, typically extending the median or centerline out into an intersection with either concrete/planters or flex posts and modular curbs, can help discourage wide and fast left turns.



Minimize turn conflicts

Turn conflicts can be extremely dangerous, especially when signals can give both a turning driver and crossing pedestrians or bicyclists the go ahead. **This puts people crossing directly in danger — even when both drivers and pedestrians/bicyclists follow signals.**

- **Ensure signal phases don't put people crossing in harm's way.** Make sure that turning traffic isn't given a green light that would conflict with a walk signal or bike green light.
- **Leading Pedestrian Intervals (LPIs)** and **Leading Bicycle Intervals (LBIs)** can be implemented at signals to give people crossing time to get farther across the street and be visible before vehicles can proceed.
- **Dedicated left-turn phases** and **restricting right-turns-on-red** can help avoid blind turns where drivers are looking more at oncoming traffic than people crossing on foot or bike.

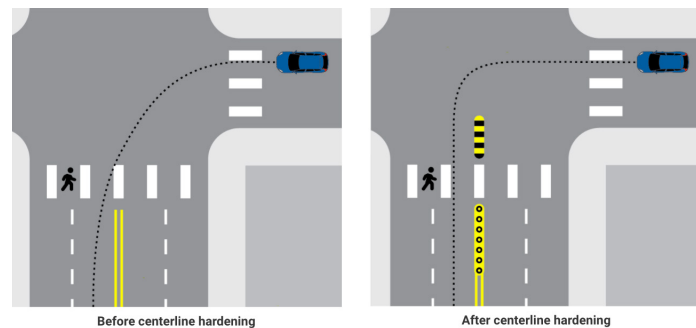


Diagram of centerline hardening. Source: IIHS

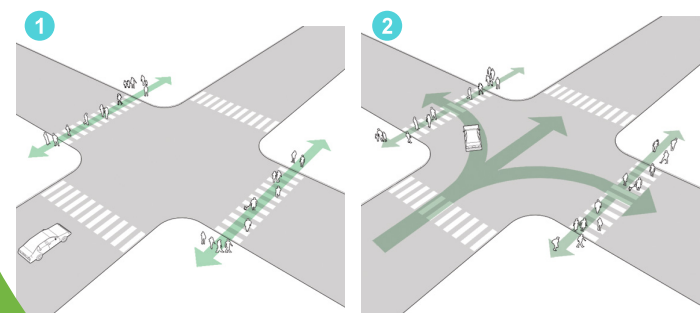
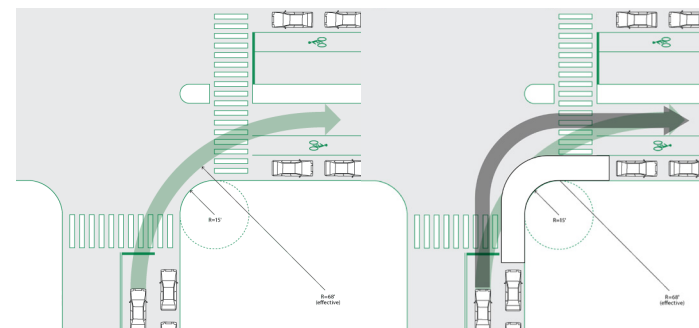


Diagram of a Leading Pedestrian Interval. Source: NACTO



Example of using a curb extension to reduce turn radii. Source: NACTO

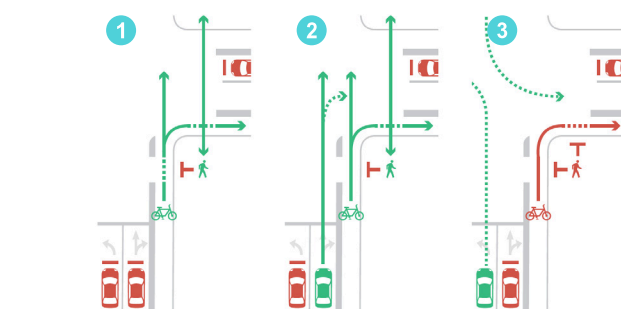


Diagram of a Leading Bicycle Interval. Source: NACTO

Flow-focused principles



Time signals for flow of all modes

Traffic flow is just as important for transit riders and people walking, rolling, and biking as it is for drivers. **Make sure all modes can move reasonably quickly and safely through the intersection.** This may mean prioritizing people walking/biking and transit vehicles over longer phases for drivers in locations with heavy pedestrian traffic or along major transit routes.

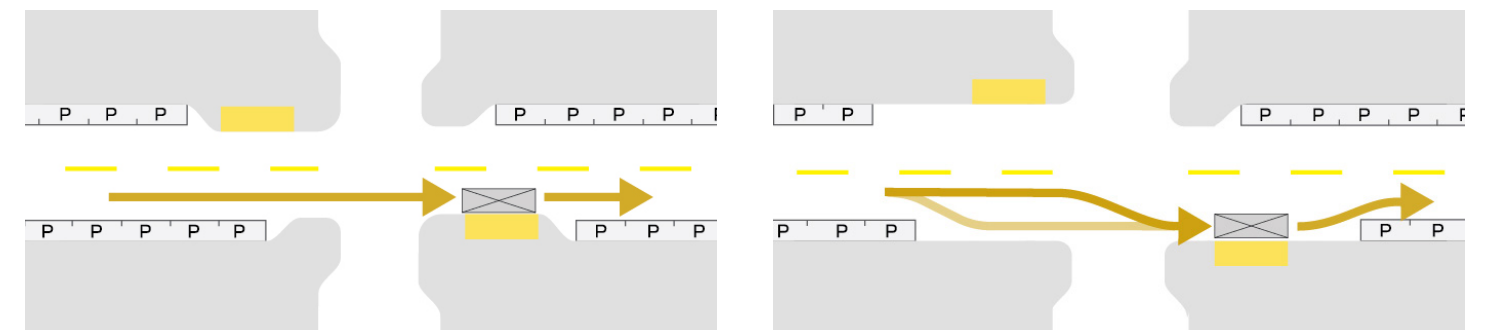
- **Keep signal phases reasonably short.** By cycling quickly through several shorter phases rather than longer ones, no one is left waiting too long for an opportunity to proceed. This also helps discourage jaywalking and crossing against the signal.
- **Give people walking enough time to cross.** While phases should be reasonably short, it's important to ensure people who may be slower or have a disability can still safely get across without rushing.
- Keep crossings for people walking and biking as **short and direct** as possible. Where roads are wide enough that it would be difficult for some to cross in one short signal phase, **provide pedestrian refuge islands** in the median that people can safely cross to and wait at for the next pedestrian signal.
- **Time signals as part of a corridor.** Timing consecutive signals to match an intended speed can help keep vehicles moving smoothly and reduce the number of red lights drivers hit if they're traveling at the designated speed.



Include space for transit stops where applicable

Where transit routes are planned, transit stops should be placed in locations where buses can stop without substantially delaying buses and cars, causing traffic backups, or impeding the safety of transit users in the boarding process.

- **In-lane stops on the far side of an intersection** are best in most cases for keeping buses moving efficiently. These stops can often be placed on a curb extension and work especially well where bus lanes exist.
- In cases where an in-lane stop would cause traffic to back up into the intersection, consider a **pull-out stop**. Pull-out stops are sometimes paired with shared right-turn lanes that allow buses to proceed straight through the intersection to the stop; however, pull-out stops can add additional delay for buses as they re-enter the traffic lane.
- **Where bike lanes and in-lane bus stops overlap, divert bike lanes behind the stop.** This ensures people biking can proceed without the risk of hitting someone boarding or deboarding a bus.



Example of a far side, in-lane transit stop. Source: NACTO

Example of a far side, pull-out transit stop. Source: NACTO

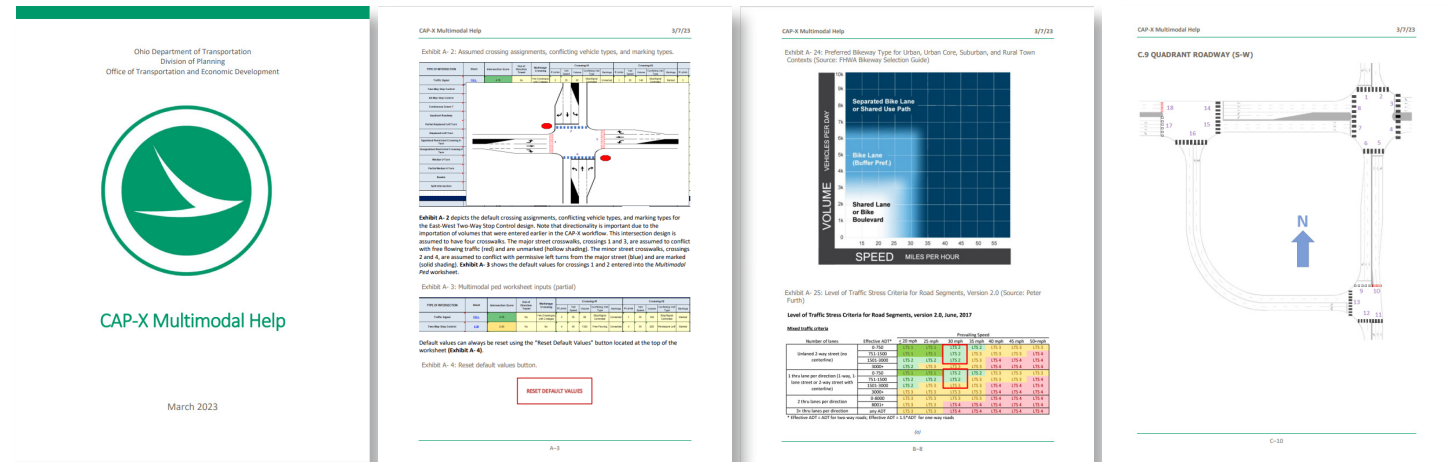
Case Studies and Resources

The following section provides a sample of resources that can help in choosing intersection design options that incorporate the needs of road users of all modes. Some are specific to Intersection Control Evaluations, while others provide general best practices for designing safe and convenient streets for people walking, rolling, biking, and taking transit.

ICE Examples

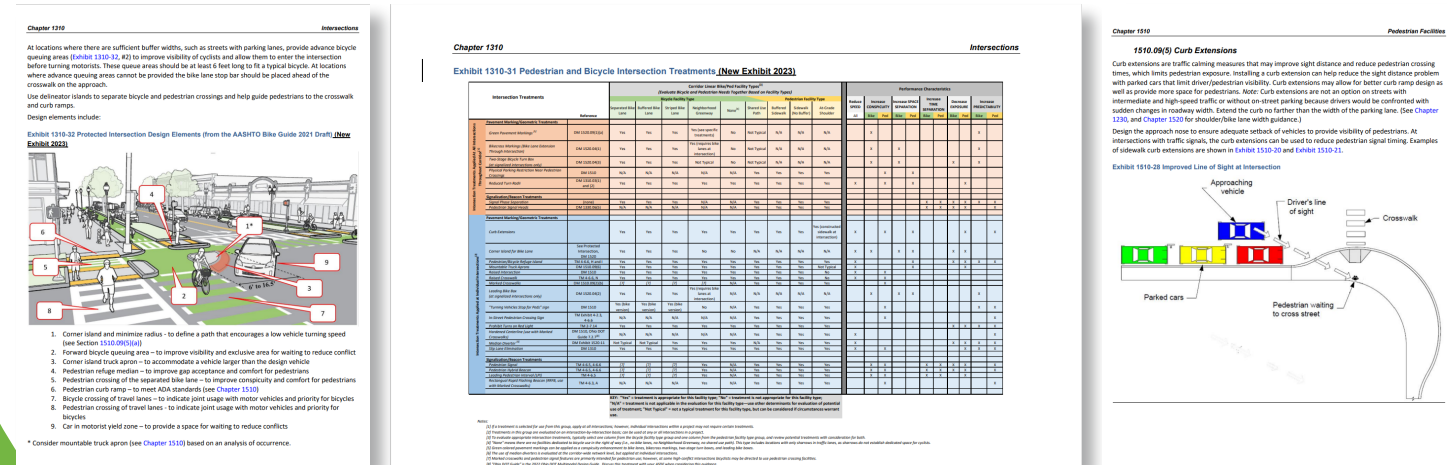
Ohio DOT (ODOT) CAP-X Multimodal Help Guide

As part of their ICE process, ODOT provides a guide that details how to use the spreadsheet-based CAP-X (Capacity Analysis for Planning of Junctions) tool for multimodal analysis. CAP-X scores performance for pedestrians and bicyclists based on design elements such as crossing length and directness. It also includes a variety of common intersection designs with their default pedestrian crossing locations, as well as specific considerations for bicycles.



Washington State DOT (WSDOT) Design Manual

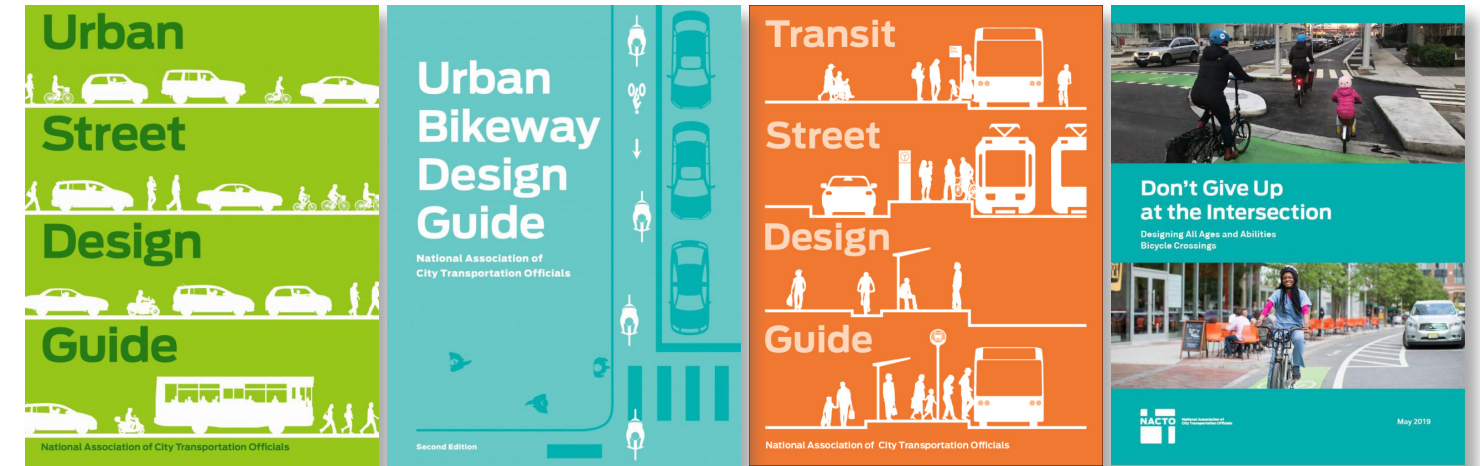
The WSDOT ICE design manual includes guidance on accommodating other transportation modes by detailing considerations for speeds, cycle lengths, turning movements, and ways to measure pedestrian demand. The ICE section has a matrix of potential intersection design interventions based on the characteristics of the specific location. Other sections of the manual provide more specific design guidance for intersections that include pedestrian crossings, shared use paths, or bike routes.



Other Resources

NACTO Design Guides

The National Association of City Transportation Officials (NACTO) provides a free series of design guides featuring options and best practices for urban streets, transit streets, urban bikeways, and more. Each guide includes intersection specific guidance.



North Carolina DOT (NCDOT) Complete Streets Project Evaluation Methodology

This methodology lists a series of steps for selecting a facility type and a matrix of potential facilities based on anticipated bike and pedestrian need, demand, and safety risk. The guide also directs readers to facility specifications in the NCDOT Roadway Design Manual for sidewalks, shared use paths, and bike lanes.

FHWA Separated Bike Lane Planning and Design Guide

The FHWA Separated Bike Lane Planning and Design Guide provides the tools to identify locations to include separated lanes, various intersection designs, midblock lane design considerations, and pavement markings.

Sources

- FHWA; Separated Bike Lane Planning and Design Guide; https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/separatedbikelane_pdg.pdf
- NACTO; Transit Street Design Guide; <https://nacto.org/publication/transit-street-design-guide/>
- NACTO; Urban Street Design Guide; <https://nacto.org/publication/urban-street-design-guide/>
- NACTO; Urban Bikeway Design Guide; <https://nacto.org/publication/urban-bikeway-design-guide/>
- NACTO; Don't Give Up at the Intersection; <https://nacto.org/publication/urban-street-design-guide/>
- NCDOT; Complete Streets Project Evaluation Methodology; <https://connect.ncdot.gov/projects/BikePed/Documents/Complete%20Streets%20Evaluation%20Methodology.pdf>
- ODOT; CAP-X Multimodal Help; https://www.transportation.ohio.gov/wps/wcm/connect/gov/c03b7448-e2ee-4ba4-b2c0-5a7664221630/CAP-X+Multimodal+Help+File.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE.Z18_K9I401S01H7F40QBNJU3S01F56-c03b7448-e2ee-4ba4-b2c0-5a7664221630-orr52qR
- WSDOT; Design Manual; see chapters 1300, 1510, 1515, and 1520; <https://www.wsdot.wa.gov/publications/manuals/fulltext/M22-01/design.pdf>
- Watch For Me NC; Crash Facts; <https://www.watchformenc.org/crashfacts/#:~:text=One%20in%20four%20vehicle%2Dpedestrian,Triangle%20happen%20in%20parking%20lots.>
- Hedges & Company; How Many Licensed Drivers Are There in the USA?; <https://hedgescompany.com/blog/2018/10/number-of-licensed-drivers-usa/>
- Bureau of Transportation Statistics; Travel Patterns With Disabilities; <https://www.bts.gov/travel-patterns-with-disabilities>

Southeast Area Study Update

This booklet is a product of the Southeast Area Study (SEAS) Update and is intended to serve as a technical resource to help planners, engineers, and developers advance the *guiding principles of the study...*



LIVABILITY

Enhance and promote our region's quality of life through transportation and land use decisions that equitably support public health, education, parks and recreation, public art, and local character.



TRAFFIC FLOW

Make it easier to move within and through our region by reducing congestion and improving roadway operations.



SUSTAINABLE GROWTH

Blend development decisions and transportation strategies to promote and sustain employment and population growth by offering housing and neighborhood choices to meet diverse needs while preserving the area's natural features.



TRAVEL SAFETY

Promote a safer, more secure transportation system by reducing crashes, enhancing reliability and predictability, and improving emergency coordination.



ACTIVE TRANSPORTATION

Integrate our transportation network to provide travel choices, especially walking and cycling, for all users, regardless of age and ability.



NETWORK CONNECTIVITY

Link local and regional destinations through improved connections and enhanced integration among travel modes.



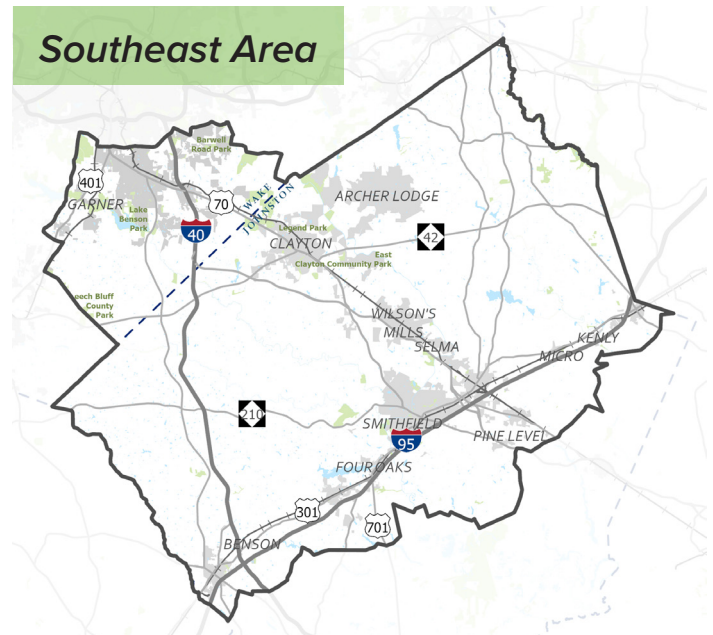
ECONOMIC VITALITY

Grow our economy through a transportation network that connects residents to jobs, goods, services, and opportunities within and beyond our region.



FREIGHT MOVEMENT

Support global competitiveness of our region through a transportation network that efficiently moves goods and services.



As the Southeast Area grows and changes, **multimodal design will be increasingly important to advancing these principles.** The SEAS Update includes recommendations for multimodal facilities and intersection improvements, and this toolkit provides guidance and resources for choosing alternatives that meet the needs of all users, whether driving, walking, rolling, biking, or taking transit.

Find out more about the SEAS Update at: www.campo-nc.us