



NCDOT Bus Stop and Pedestrian Crossing Guidance

NCDOT Traffic Safety Unit

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NCDOT Bus Stop and Pedestrian Crossing Guidance



Purpose

The NCDOT Bus Stop and Pedestrian Crossing Guidance document is intended to support NCDOT Division, Traffic Safety Unit (TSU), and other project staff across the Department to engage with transit agencies and local governmental agencies (LGA) to improve pedestrian safety near bus stops. This guidance describes the elements and decision-making processes NCDOT should consider when evaluating the alignment and placement of bus stop locations relative to marked crossings on higher volume and higher speed roadways. Although this guidance provides recommendations for local and express service bus stops, the principles may be applied to stop locations for other transit types such as Bus Rapid Transit (BRT) and traditional bus service along lower speed residential roadways.¹ This guidance is also intended to provide connections to existing NCDOT resources on pedestrian safety countermeasures, encroachment agreements, and roadway design.

The guidance contains the following sections:

- Importance of Pedestrian Safety and Bus Stop Access
- NCDOT Role in Bus Stops and Pedestrian Crossings
- Guidance for Evaluating Bus Stops and Marked Crossings for Improved Safety
- Improvement Options
- Transit Agency Bus Stop Placement Considerations
- Implementation and Planning Opportunities to Apply the Guidance
- Additional Considerations
- Appendix

¹ Local bus service is characterized by higher relative stop frequency relative to other types, shorter trip lengths, stop placement across many different land uses, and consistent service across the day. Express bus service is characterized by fewer stops that are placed in key locations such as major destinations, longer trip lengths, and limited service during the morning and evening periods (often to match commuting patterns). Bus Rapid Transit features elements such as a dedicated lane, off-board fare payment, platform level boarding, and traffic signal priority that are intended to reduce trip times and establish high ridership service in key areas.



Importance of Pedestrian Safety and Bus Stop Access

The integration of pedestrian safety and bus stop access is a priority for NCDOT, and it is reflected within NCDOT guidance, policies, programs, and plans. These include:

- The Highway Safety Improvement Program (HSIP)—supported by the Strategic Highway Safety Plan (SHSP) pedestrian emphasis area which acknowledges the need for safe access to pedestrian and transit facilities—works with local municipalities to improve or construct pedestrian crossings and connections to public transit.²
- The Project Delivery Network (PDN) specifies the review of pedestrian improvements, including crossings, by the Regional Traffic Engineer (RTE) and Safety Planning Engineer in Stage 2, Activity 2TS1, *Complete Safety Analysis and Operational Review*.
- The NCDOT Bus Shelter & Bus Stop Guidelines directs District Engineers to review transit agency bus stop and shelter encroachment requests for placement in locations that ensure safe and efficient operations of pedestrian traffic.³
- The Complete Streets Policy requires that NCDOT evaluate state transportation projects for opportunities to include all modes. This includes pedestrians and transit riders and their respective facilities along roadways, at intersections and other crossing locations that improve mobility and safety.⁴
- The 2019 Public Transportation Strategic Transportation Plan identifies the building of quality transit stops and safe pedestrian crossings as a key plan tactic to connect North Carolinians to opportunities.⁵ The tactic's recommended actions include improving the bus stop location decision making process and improving engagement and coordination between NCDOT and local government agencies. Pedestrian safety and bus stop placement are interconnected. Bus stops are pedestrian generators, and pedestrians are expected to cross the roadway to either access or alight transit service depending on their origin, final destination, or transfer to another transit route or mode. The presence of a bus stop is an identified risk factor for both pedestrian and bicyclist crashes.^{6,7} Additionally, pedestrians are expected to cross the roadway at locations that reduce overall walking distance; pedestrians are unlikely to add significant route deviation to cross at a distant marked crossing location. Bus stops and marked crossings should be aligned to improve pedestrian route directness and visibility of the crossing pedestrian.

² The 2019 SHSP is here: <https://connect.ncdot.gov/groups/echs/Documents/2019/2019%20NC%20SHSP.pdf>

³ The NCDOT Bus Shelter & Bus Stop Guidelines is located here: <https://connect.ncdot.gov/business/Transit/Documents/2017%20NCDOT%20Bus%20Shelter%20&%20Bus%20Stop%20Guidelines.pdf>

⁴ The NCDOT Complete Streets Policy is here: <https://connect.ncdot.gov/projects/BikePed/Pages/Complete-Streets.aspx>

⁵ The 2019 Public Transportation Strategic Transportation Plan is available here: <https://www.ncdot.gov/divisions/integrated-mobility/public-transit-services/statewide-strategic-plan/Pages/default.aspx>

⁶ National Academies of Sciences, Engineering, and Medicine. 2018. *Systemic Pedestrian Safety Analysis*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25255>.

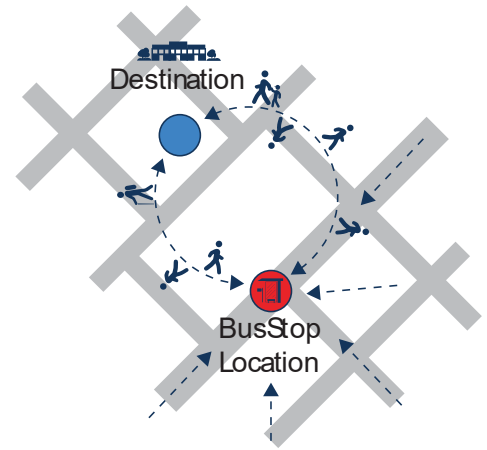
⁷ Craig, C., et al, "Pedestrian Safety and Driver Yielding Near Public Transit Stops," 2019, <https://doi.org/10.1177%2F0361198118822313>.





NCDOT Role in Bus Stops and Pedestrian Crossings

NCDOT's role in the placement of bus stops and marked crossings will vary depending on issues such as roadway maintenance, impact to the right-of-way (ROW), safety issues, need for encroachment agreements, and specific transit agency action, request, or study. NCDOT can support and help guide the decision-making process for bus stop placement and pedestrian crossings through improved coordination and identifying opportunities to apply this guidance.



Transit Agency and NCDOT Coordination

There are often multiple departments and agencies at various governmental levels involved in improving pedestrian safety and pedestrian access to bus stops. This can create barriers to successful implementation of safety improvements. In many instances, the transit agency may own and maintain the bus stop and shelter, the LGA maintains the connecting sidewalk, and NCDOT maintains the roadway, pavement markings, curb ramps, crossing location (for NCDOT maintained roadways), and approves the relevant encroachment agreements. Further, the departments and agencies may have different priorities, standards, and schedules for improving their respective transportation elements. For example, this can create a challenging environment when addressing community requests for bus stop improvements, coordinating local capital infrastructure projects, integrating with NCDOT programmed transportation projects, and securing agreements among the parties for facility maintenance given limited funding.

The NCDOT project staff should consider taking the following actions when coordinating with a transit agency and the LGA to improve pedestrian crossing safety near bus stops:

- Make safe pedestrian crossing access to a bus stop a priority in the project under review.⁸
- Engage transit agencies, planning organizations, and local governments early in transportation planning processes, project, or studies.⁹
- Look for opportunities to incorporate bus stop and safety improvements into larger corridor or area-wide developments.¹⁰
- Promote the consistent application of decision-making processes and agreements with respect to bus stops and pedestrian crossings.
- Approach the review of bus stops and pedestrian crossings with input from a multidisciplinary team.

⁸ National Academies of Sciences, Engineering, and Medicine. 2015. *Better On-Street Bus Stops*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/22175>.

⁹ See the NCDOT Public Transportation Strategic Transportation Plan.

¹⁰ National Academies of Sciences, Engineering, and Medicine. 2021. *Transit Agency Relationships and Initiatives to Improve Bus Stops and Pedestrian Access*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26166>



Guidance for Evaluating Bus Stops and Marked Crossings for Improved Safety

When evaluating a bus stop and crossing location to improve pedestrian safety, the NCDOT project staff should consider the characteristics of the bus stop and evaluate it with the criteria below.



Approximate activity or ridership level: What is the existing bus stop activity or anticipated activity? Estimates may be used to support considerations of pedestrian exposure, risk, appropriate countermeasures for the context, and potential to move or consolidate the stop. A review of overall boarding and alighting (ridership) statistics, frequency of stops, and typical duration of stops will inform the level of activity at the stop. For example, bus stops with exceptionally low or no ridership may be recommended for consolidation to nearby stops with recurring trips, and stops with higher ridership levels may be prioritized for crossing improvements compared to low or no volume stops.



Existing infrastructure: What are the locations and quality of the existing marked crossings, warning signage, signals, lighting, other bus stops, and connecting pedestrian routes? What are the distances to other stops, marked crossings, and signals? A review of the existing infrastructure may identify opportunities for the transit agency and LGA to coordinate on sidewalk connections and for NCDOT to refresh or update pavement markings and signage.



Roadway characteristics: What are the vehicle speeds, vehicle volumes, turning movements, visibility, sight distance, and curb activities (e.g., parking) at the bus stop location? Understanding these characteristics will support identification of countermeasures and consideration of other crossing locations.



Purpose of the stop: Does the stop serve as a transfer location (e.g. priority stop serving several routes), stop pair (e.g. stops serving same route(s) on both sides of the roadway), one-way, time of day, or limited service stop (e.g. higher boardings and alightings at less frequent stops)? Was the stop established in response to a community request? The findings will help inform pedestrian crossing expectations and the transit agency's flexibility in stop relocation or consolidation.



Evaluation Criteria Checklist: The following are general criteria for determining the adequacy of the bus stop and crossing. If any of these criteria are not met, the NCDOT project staff should consider improvement options detailed below to support safer pedestrian crossing to the bus stop. Engineering judgement should be applied when evaluating the crossing.

- The bus stop is in proximity to a marked crossing (i.e. <150'-300').
- There are clear sightlines of the bus stop's marked crossing.
- The existing marked crossing includes crossing countermeasures that are appropriate for the roadway or intersection context.
- The bus stop and crossing are connected by accessible pedestrian facilities that are appropriate for the context.
- The bus stop and crossing are positioned to reduce the risk of a near-lane vehicle yielding to a crossing pedestrian and blocking the view of an approaching far-lane vehicle (known as a multiple-threat crash).
- The bus stop is a sufficient distance to other bus stops serving the same route. Typical minimum bus stop spacing for local bus service is 800' and longer for high-frequency, limited-stop routes.





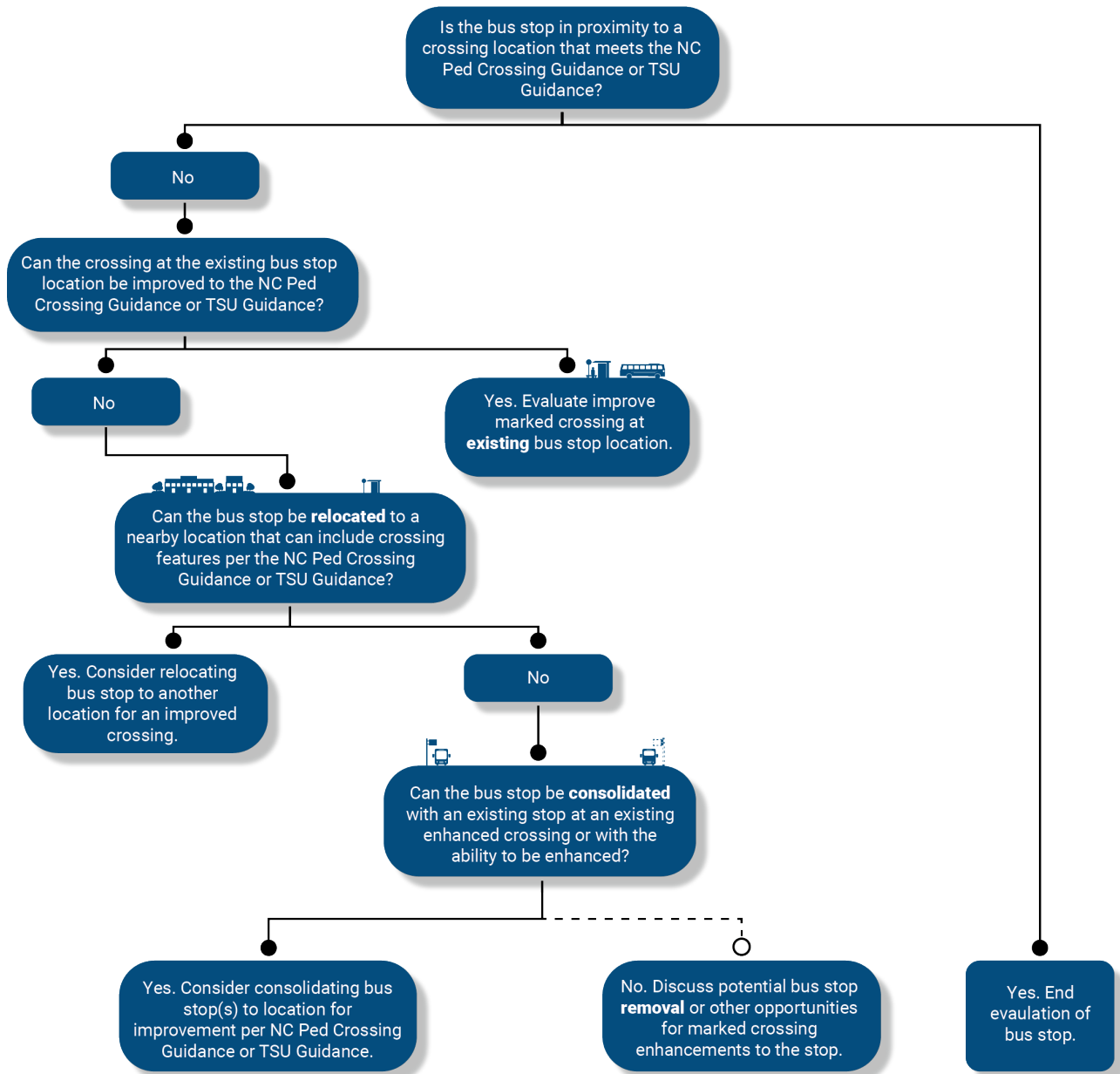
Improvement Options

There are three primary improvement options that the NCDOT project staff may recommend after completing the guidance evaluation process:

- 1. Improve, establish or formalize the existing crossing location near the bus stop:** Recommended where the crossing near the bus stop(s) can be added or improved per the NCDOT Pedestrian Crossing Guidance for uncontrolled locations and TSU/RTE guidance for controlled locations.
- 2. Relocate the bus stop to an improved crossing location:** Recommended where the bus stop(s) may be repositioned to a crossing location that can be improved per the NCDOT Pedestrian Crossing Guidance for uncontrolled locations and TSU/RTE guidance for controlled locations. Signalized intersection locations are generally preferred to uncontrolled locations. Relocating stops with existing amenities such as shelters and benches will require additional coordination. The preferred location for most bus stops at signalized intersections is on the “far side” of the intersection. Special consideration should be made for traffic operations, pedestrian destinations, and visibility when relocating bus stops to the far side of the intersection.
- 3. Consolidate the bus stop to a location with an improved crossing:** Recommended where the stop is in close proximity to another stop that serves the same route and may be combined to a location with an improved crossing.
- 4. Removal of the bus stop:** This recommendation is not an improvement option, should rarely be made, and it is intended for stops that reduce pedestrian safety; it should occur only after consideration of the other improvements options above and in close coordination with the transit agency, State Traffic Engineer, and Division Engineer.

For each of these options, the NCDOT project staff should reference the NCDOT Pedestrian Crossing Guidance for uncontrolled crossing locations¹¹ and the TSU or Regional Traffic Engineer for controlled locations and evaluate engineering improvements (e.g., parking restrictions, sight lines, and distance), connecting facilities, and the provision of amenities.¹² Figure 1 illustrates the evaluation process, Figure 3 shows a range of issues along an example corridor, and Figures 3-5 provide conceptual scenarios with safety problems and corresponding improvements.

Figure 1 - Bus Stop Evaluation Process



¹¹ The North Carolina Pedestrian Crossing Guidance is located here: https://connect.ncdot.gov/resources/safety/Teppi/TEPPL%20All%20Documents%20Library/Pedestrian_Crossing_Guidance.pdf

¹² The provision of bus stop amenities is typically at the discretion of the local transit agency through its amenities improvement program and supporting decision making process.



Figure 2 illustrates common safety issues for bus stop locations and pedestrian crossings along a conceptual suburban corridor. These issues may include:



Bus stops that are located long distances from marked crossings: Pedestrians are anticipated to cross at locations that present the smallest deviation (time and distance) to their destination, regardless of a marked crossing location hundreds of feet away. This may include crossing at unmarked mid-block locations or away from a signalized intersection.



Bus stops near crossings without complete networks: While the bus stop may be located near a signalized or marked crossing, the crossing itself may lack elements such as pedestrian signal heads, signage, and visibility enhancements that support crossing.



Bus stops with limited sight distance and or low visibility: Vegetation, on-street parking, low lighting levels, and roadway geometry may reduce motorist and bus operator sight distance and visibility of the bus stop, related crossing location, and pedestrian.



Bus stops in close proximity of other stops without supporting crossings: Bus stops within close distance to other stops creates additional demand for marked crossing locations in areas that could be served by consolidated improved crossing location(s).

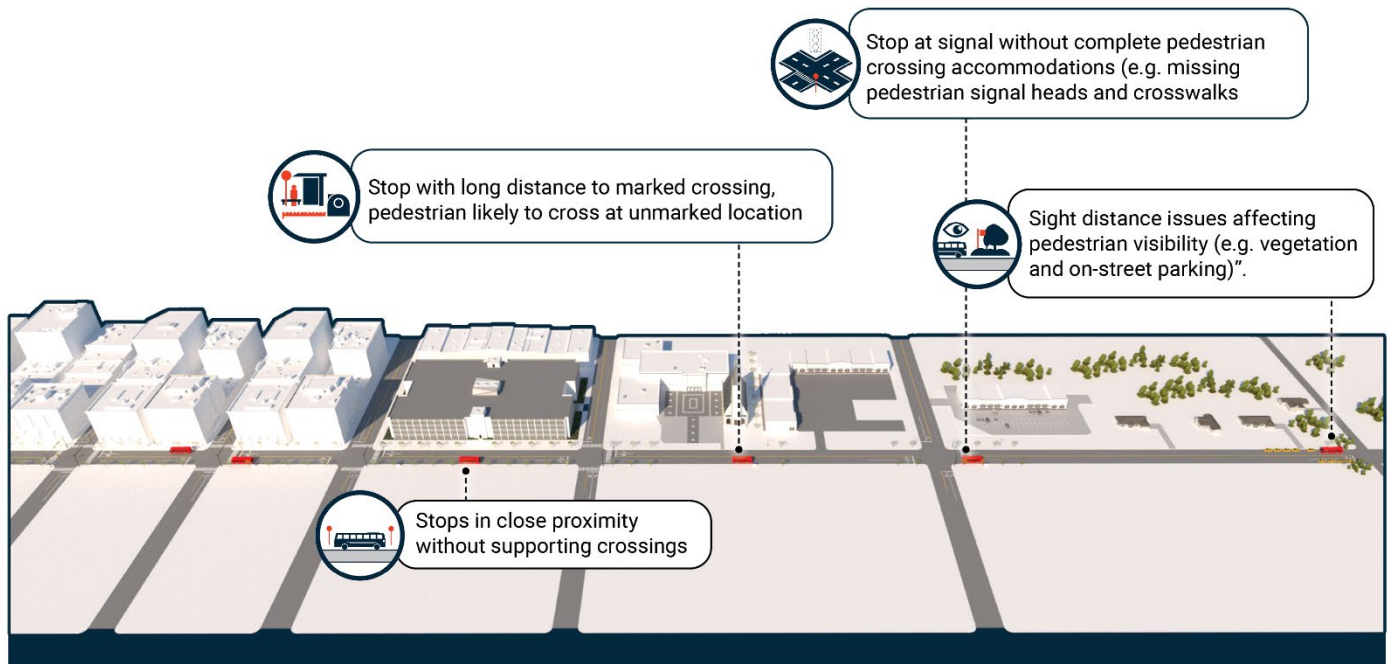


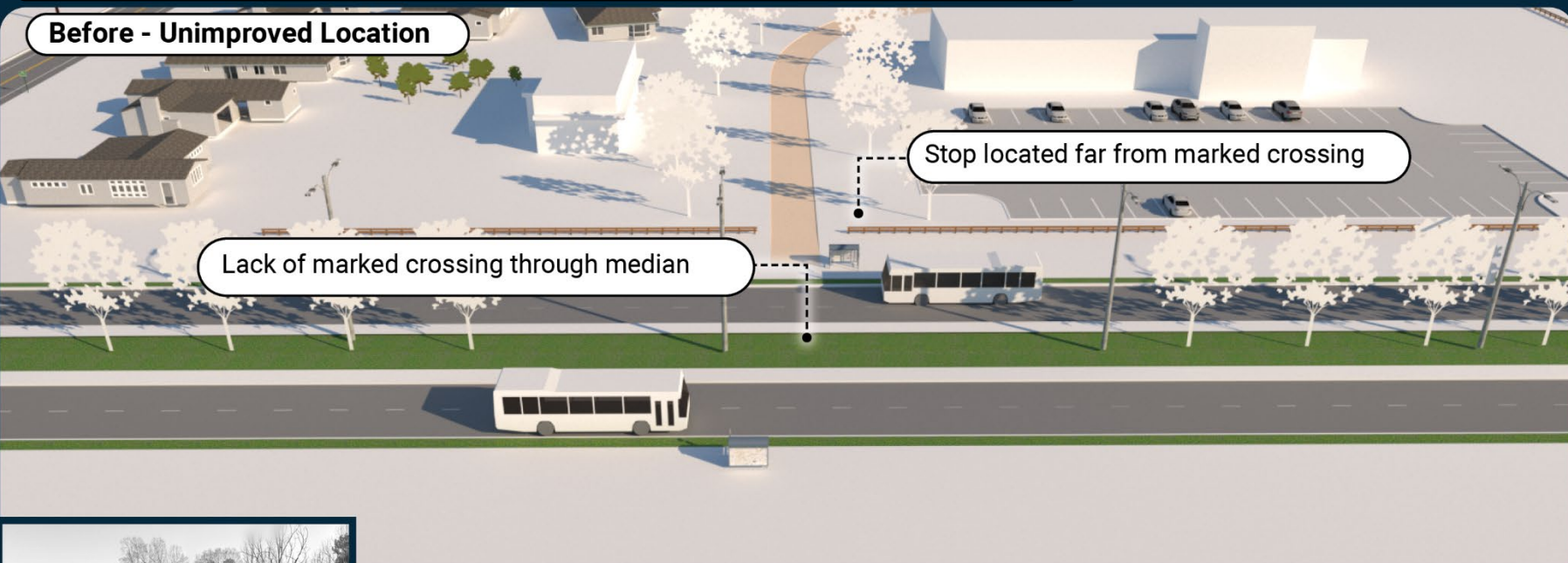
Figure 2 - Potential Bus Stop and Crossing Safety Problems Across a Conceptual Corridor

Figure 3 - Improve Crossing at Existing Bus Stop Location – Mid-block

Before - Unimproved Location

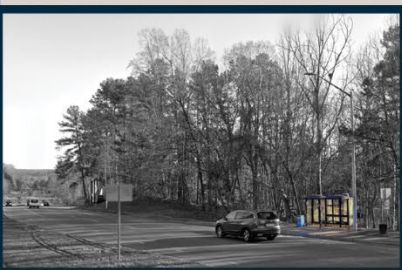
Lack of marked crossing through median

Stop located far from marked crossing



Example

Multi-lane roadway Median, Bus stops on both sides of roadway

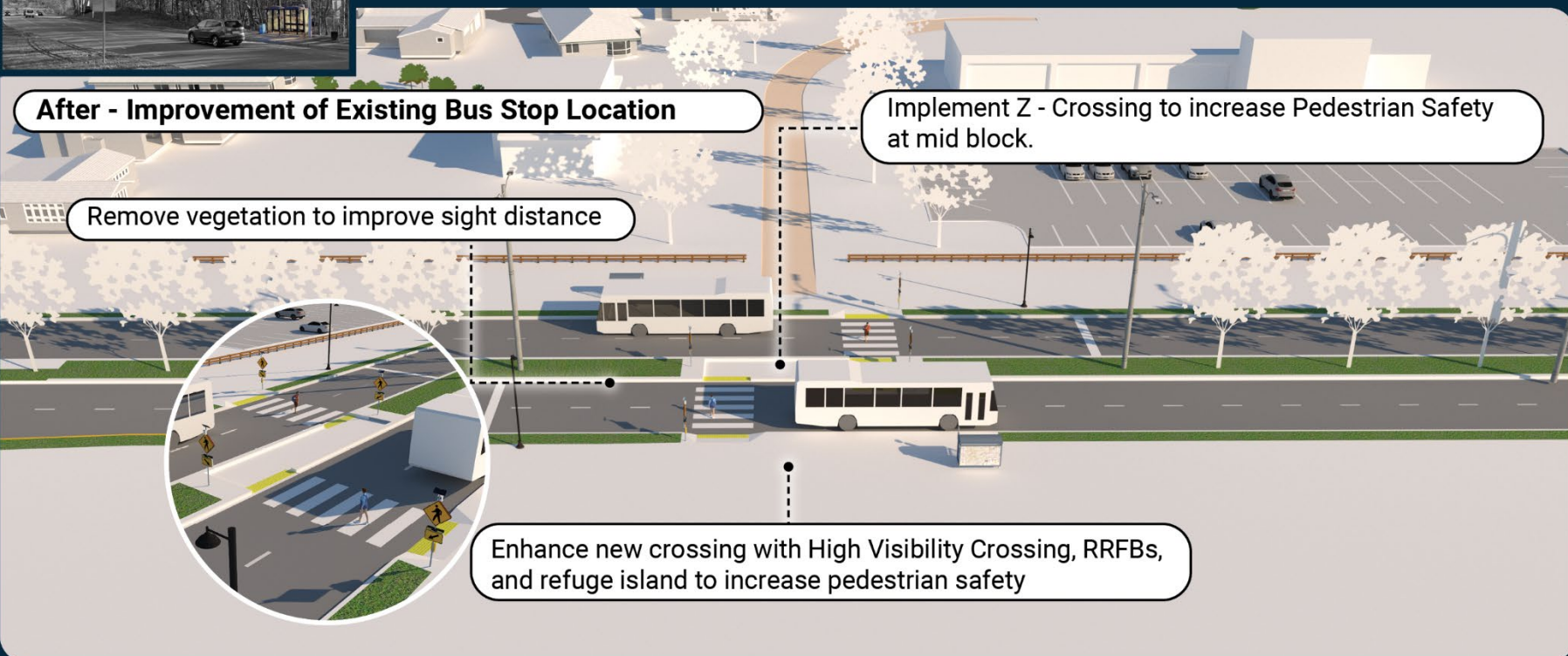


After - Improvement of Existing Bus Stop Location

Remove vegetation to improve sight distance

Implement Z - Crossing to increase Pedestrian Safety at mid block.

Enhance new crossing with High Visibility Crossing, RRFBs, and refuge island to increase pedestrian safety



Safety Issues



Distance



Incomplete Network



Visibility

Figure 3 first illustrates a bus stop pair along a multi-lane arterial with a raised median and no marked crossing. The existing stops are located mid-block approximately 500' from marked crossings at upstream and downstream intersections. Pedestrians may be anticipated to assess gaps in traffic and cross through the median at locations without visibility enhancements. The second image shows how establishing a marked crossing enhanced with a median refuge island, high visibility crosswalk marking, Rectangular-Rapid-Flashing Beacon (RRFB), relocation of the stops to the far-side of the new mid-block crossing, and treatment of vegetation can significantly increase the safety of transit riders crossing to board or alight the bus. The configuration also shows an offset pedestrian crossing, where the pedestrian enters the refuge area and turns to face oncoming traffic before reentering the roadway to cross travel lanes. Bus operations are not expected to be affected since the stop remains at the same general location.

For mid-block locations generally, the bus stops should be downstream of the enhanced uncontrolled crossing location and not on the crosswalk approach. This is especially important on multi-lane corridors, as the pedestrians are directed to cross behind the bus and are visible to oncoming vehicles travelling in the same direction as the bus. This allows for the pedestrian to assess gaps in traffic, actuate the RRFB or Pedestrian Hybrid Beacon (if applicable), and determine that vehicles are yielding or stopping before initiating the crossing.

Alternative modifications could include relocating the stops to the nearest controlled intersection or placing barriers or fencing in the median to discourage crossings.

Figure 4 - Relocate Bus Stops to Improved Crossing Locations - Signalized

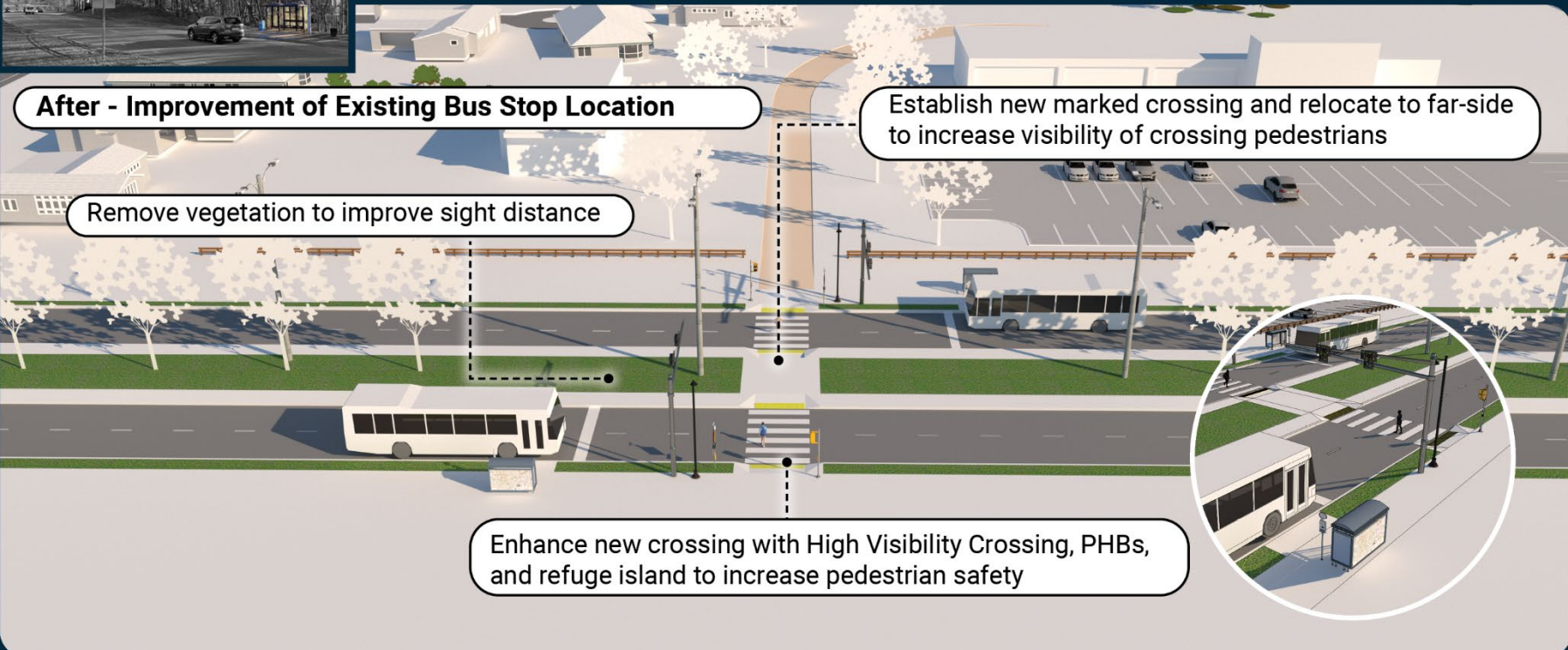
Before - Unimproved Location



Example

Multi-lane roadway Median, Bus stops on both sides of roadway

After - Improvement of Existing Bus Stop Location



Safety Issues



Distance



Incomplete Network



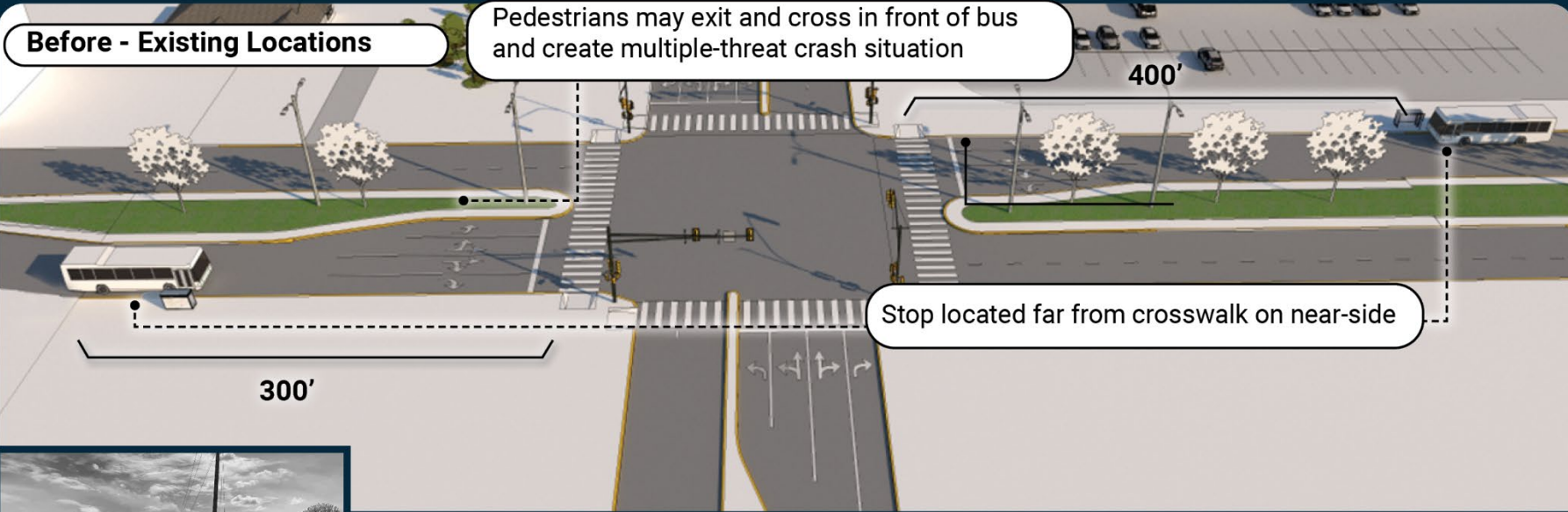
Visibility

Figure 4 first illustrates a bus stop pair along a multi-lane arterial with a raised median and no marked crossing. The existing stops are located mid-block approximately 500' from marked crossings at upstream and downstream intersections. Pedestrians may be anticipated to assess gaps in traffic and cross through the median at locations without visibility enhancements. The second image shows how establishing a marked crossing enhanced with a median refuge island, high visibility crosswalk marking, Pedestrian Hybrid Beacon (PHB), relocation of the stops to the far-side of the new mid-block crossing, and treatment of vegetation can significantly increase the safety of transit riders crossing to board or alight the bus. Bus operations are not expected to be affected since the stop remains at the same general location. In Figure 4, the bus is shown stopping at a bus stop located on the near side of the PHB crossing. All vehicles, including buses, are required to stop for pedestrians in the crosswalk when the PHB is actuated. Alternative modifications could include relocating the stops to the nearest controlled intersection or placing barriers or fencing in the median to discourage crossings.

Figure 5 - Relocate Bus Stops to Improved Crossing Locations - Signalized

Before - Existing Locations

Pedestrians may exit and cross in front of bus and create multiple-threat crash situation



Safety Issues



Distance



Visibility

Example

Multi-lane roadway, Stop located in advance of signalized intersection



After - Relocation

Relocation of stop to far-side allowing pedestrians to cross behind the bus

≥10'

Relocation closer to marked crossing increasing the visibility of pedestrians

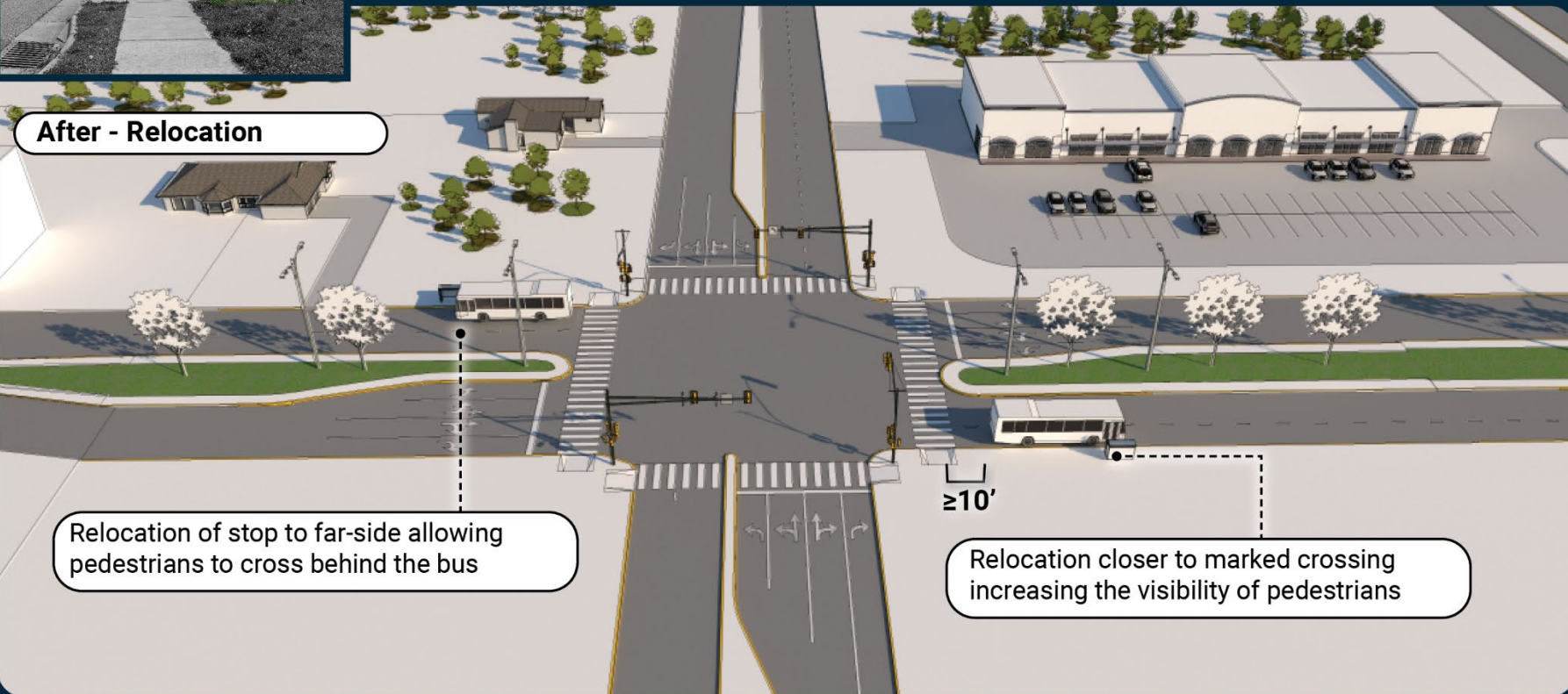


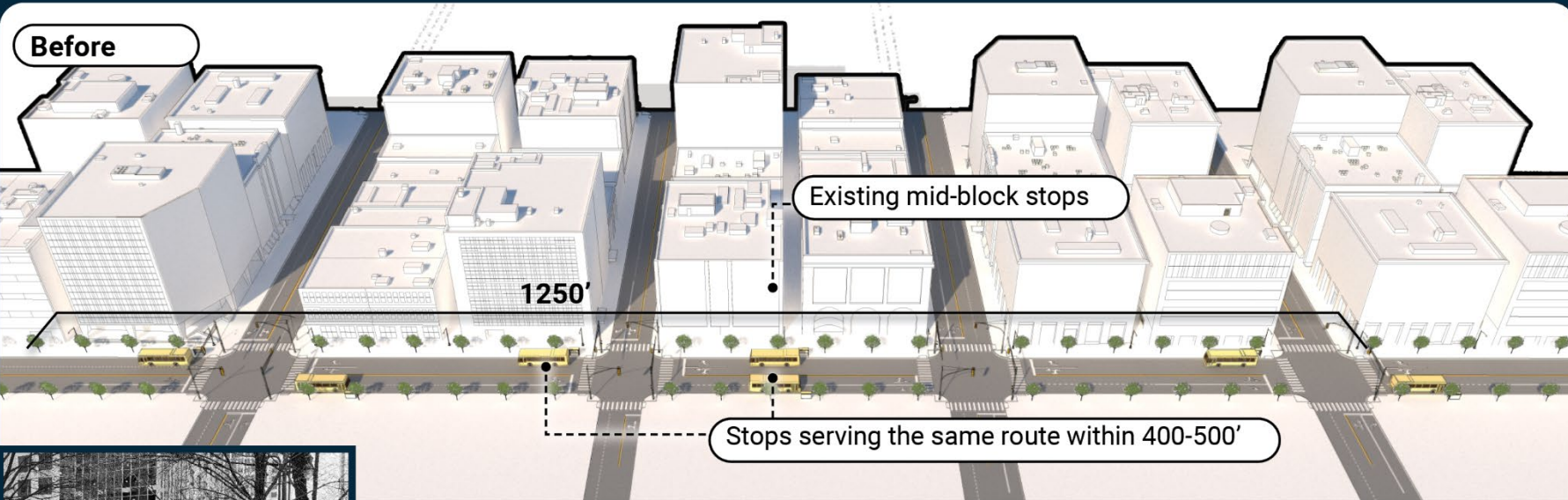
Figure 5 first illustrates bus stops on the near-side of a signalized intersection of two-way streets. While the intersection has pedestrian crossing infrastructure, the bus stops are placed far in advance of the marked crossings, and pedestrians may be expected to cross the roadway away from the intersection and in front of the bus. The second image shows how relocating the bus stops to the far-side of the intersection reduces the distances pedestrian must walk to reach a marked crossing location and encourages the alighting pedestrians to cross behind the bus, thereby improving visibility to oncoming vehicles. In addition to pedestrian safety, special consideration should be paid to right-turning vehicle volumes, through lane volumes, and bus stop frequency and stopping duration when evaluating bus and motor vehicle operations tradeoffs for near-side and far-side placements. See Table 2 for advantages and disadvantages for bus stop placement relative to intersections.

Alternative modifications could include moving the stops closer to the near-side intersection, relocating or consolidating the stops to adjacent intersections that have shorter distances to a marked crossing, relocating the stops to a mid-block location if greater than 300' from a non-signalized intersection or 400' from a signalized intersection, improving the signalized intersection for pedestrians (e.g. high visibility crosswalk markings, pedestrian signal heads, and Leading Pedestrian Interval), and enhancing wayfinding signage to the existing crossing.

Figure 6 first illustrates bus stops on the near-side of a signalized intersection along a multi-lane arterial. The bus stops are placed far in advance of the marked crossings; and, similar to Figure 5, pedestrians may be expected to cross the roadway away from the intersection and in front of the bus, creating a multiple-threat crash situation. The second image shows how relocating the bus stops closer to the intersection, on the near-side, reduces the distances pedestrian must walk to reach a marked crossing location. Alternative modifications could include moving the stops closer to the far-side intersection, improving the intersection for pedestrians (e.g. high visibility crosswalk markings, pedestrian signal heads, and Leading Pedestrian Interval), and adding refuge islands to allow for people cross the intersection in stages.

Figure 6 - Consolidate Bus Stops to Improved Crossing Location

Before

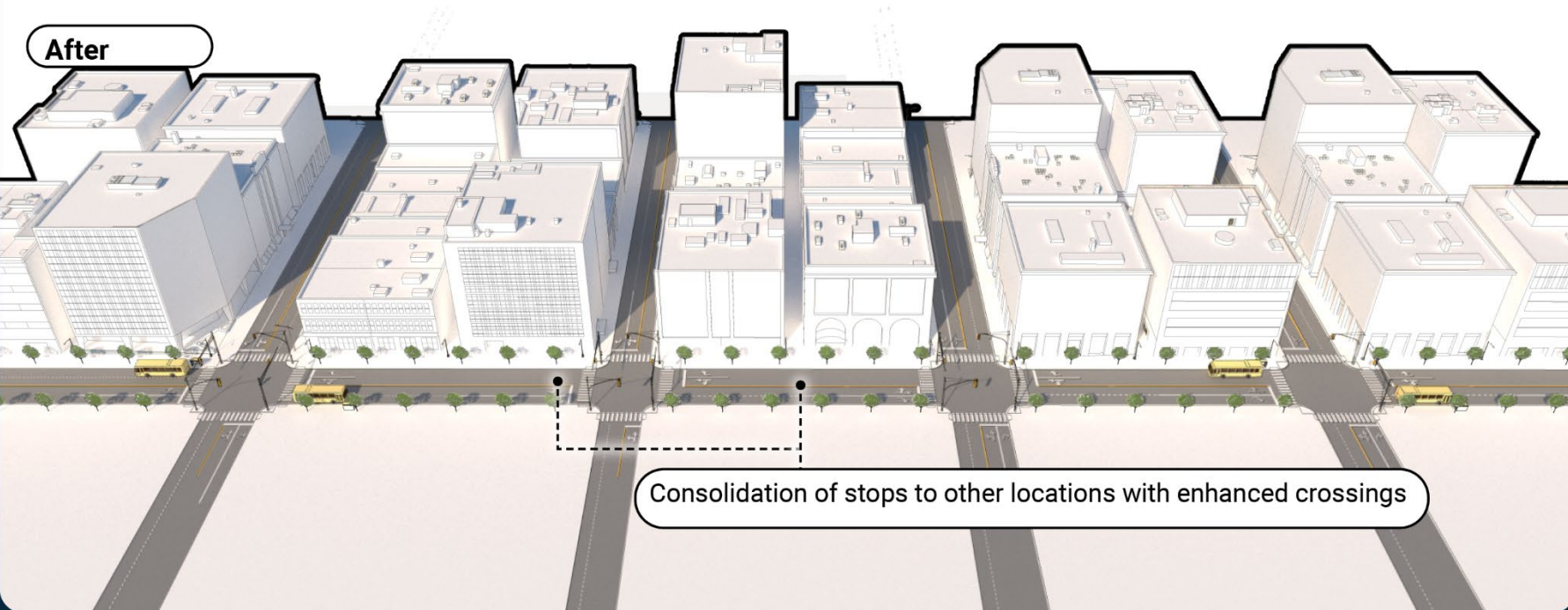


Example

Urban area, Frequent stop locations



After



Safety Issues



Distance



IClose Proximity

Figure 7 first illustrates numerous bus stops at locations along four-block corridor (~1,250'). The stops are located at near-side, far-side, and mid-block locations and are within 400'-500' of other stops serving the same routes. The pedestrian crossings near the bus stops also vary in their levels of enhancements. While the number of available bus stops provides pedestrians with reduced walking distance to reach a stop, the placement increases the number of crossing locations to be enhanced to meet the need. The second image shows how consolidating or balancing bus stops to locations that support enhanced marked crossings can improve pedestrian safety with minimal reductions in pedestrian access. Reducing bus stop frequency by removing low utilization stops and stops with poor pedestrian accessibility and safety can also increase overall bus performance and on-time reliability for riders, as well as reduce vehicle delay from buses stopping in-lane or re-entering the travel lane from a bus stop.

Alternative modifications may include enhancing the crossings for each stop pair (e.g. high visibility crosswalk markings, pedestrian signal heads, and Leading Pedestrian Interval), and relocating stops to locations that have or would support crossing enhancements.



Transit Agency Bus Stop Placement Considerations

Transit and transportation agencies consider many factors when locating a bus stop. Each site should be considered in context of traffic operations, pedestrian destinations, sight distance and traffic speeds. These factors may be generally categorized into two groups and include—but are not limited to—the following:

System Performance



Ridership/demand: Locating the stop in areas with observed or anticipated ridership or community requests. The justification for the community request may predate the transit agency staff's knowledge. Bus routes with frequent headways or stops (i.e., every 15 minutes or less during peak hour) should be evaluated for ridership at each stop.



On-time performance: Locating the stop in areas to reduce conflicts and delay associated with turning vehicles, signals, and other potential conflicts that may impact scheduled arrivals. The duration of the stop (i.e., average number of seconds spent at each stop picking up or dropping off passengers) may also influence decisions for bus stop placement.



Distance between stops: Balancing interest of requests for frequent stops (e.g., less than 400' apart) with system goal of improving on-time performance through increasing distances between stops.



Available space for stop and amenities: Locating stops at areas that are suitable for a flat and level landing area, provide pedestrian access, support pedestrian crossings, and can be secured through an encroachment agreement.

Operator and Rider Safety



Sight distance: Locating the bus stop in an area with sufficient sight distance for both the pedestrian to cross to the stop and for the operator to reach the stop and re-enter the travel lane; may also include instituting parking restrictions near the bus stop.



Lighting: Locating the bus stop in an area with sufficient lighting to support pedestrian crossing to the stop and pedestrian security while waiting at the stop.



Relationship to a marked crossing: Locating the bus stop in close proximity to a marked crossing at either the near-side or far-side of the intersection or at a mid-block location. Far-side placement encourages pedestrians to cross behind the bus at the marked crossing, and it is the generally preferred stop placement.¹³ Table 2 at the end of the guidance provides a comparative summary analysis of bus stop locations.



Sidewalk access: Locating the bus stop in areas with existing or programmed sidewalk access.



Vehicle turning conflicts and speeds: Locating the bus stop away from areas with frequent curb cuts and driveway access, heavy turning vehicles, and high speed areas.



Stop amenities to improve comfort and safety when waiting.

¹³ Federal Transit Administration, "Stops, Spacing, Location and Design," 2015, <https://www.transit.dot.gov/research-innovation/stops-spacing-location-and-design>

! Implementation and Planning Opportunities to Apply the Guidance

The NCDOT project staff should evaluate improving pedestrian crossing safety at bus stops through both programmed projects and those in planning or study stages. Programmed projects and encroachment approvals provide the most direct connection to implementation of safety improvements, while longer-range studies allow for coordination of future needs.

Encroachment Approvals: NCDOT requires encroachment agreements for features within state-maintained ROW. The request for an encroachment agreement from a transit agency or local government agency (LGA) to the District Engineer for a new stop or enhanced bus stop (such as the addition of a shelter) should trigger application of this guidance. NCDOT’s Bus Shelter & Bus Stop Guidelines describes the process for reviewing LGA requests.¹⁴ Transit agencies may face challenges when locating bus stops, such as aligning with existing community requests and needs, serving anticipated riders, securing suitable and accessible space for a bus stop, and identifying locations with enhanced crossings.

Programmed Projects: There are numerous NCDOT and locally administered project review stages that could trigger the application of the guidance to bus stop locations and pedestrian crossings (see Table 1). The goal of the project staff—through this guidance—should consist of advance review and consideration of stop locations in project development and design across project types.

Table 1 – Implementation Opportunities within Programmed Projects

Programmed Project Type	Implementation Opportunity
State Transportation Improvement Program (STIP) projects	<i>Regional Traffic Engineer (RTE) evaluate during project scoping or preliminary design.</i>
Highway Safety Improvement Program (HSIP)/safety/crossing projects	<i>RTE evaluates bus stop placement within range of HSIP field review.</i>
Transit improvement projects	<i>Project staff evaluates project milestones such as conceptual design or encroachment agreements.</i>
Sidewalk and other pedestrian improvement projects	<i>Division and local government project staff evaluate as part of project scoping and preliminary design.</i>
Maintenance and resurfacing projects	<i>Division and local government staff evaluate prior to the development of the pavement marking plan.</i>

Transportation and Planning Studies: These are long-range plans that establish visions where NCDOT is a participant and can recommend application of the guidance or its principles to support consideration of pedestrian crossings and bus stop locations. Plans such as corridor studies, pedestrian and multimodal plans, transit plans, and safety studies present key opportunities for prioritizing installation of sidewalk along transit corridors and to better connect pedestrians to bus stops and crossing locations (Table 4 in the Appendix describes these plans and the associated evaluation opportunities).

+ Additional Considerations

There are other safety-related issues that the NCDOT project staff should consider when evaluating bus stops and pedestrian safety. The bus stop location, countermeasure placement network connectivity, and

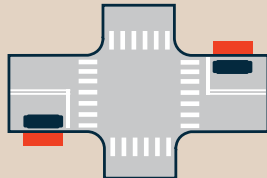
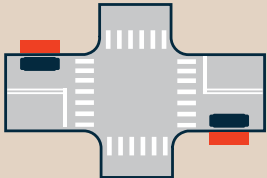
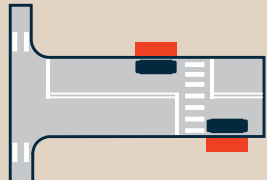
¹⁴ The NCDOT Bus Shelter & Bus Stop Guidelines is located here: <https://connect.ncdot.gov/business/Transit/Documents/2017%20NCDOT%20Bus%20Shelter%20&%20Bus%20Stop%20Guidelines.pdf>.

user needs impact how the pedestrian accesses and waits at the stop. The transit agency or LGA is often the key decision-maker that determines the location and level of bus stop amenities to meet user needs, and the NCDOT project staff should discuss these topics during the evaluation process.

Bus Stop Location Considerations

The location of a bus stop relative to an intersection has potential advantages and disadvantages for motorists, the transit operator, and the pedestrian (Table 2). Many of the noted impacts are associated with vehicle conflicts, operational impacts, and visibility of the pedestrian boarding or alighting the stop. The next section, Bus Stop and Countermeasure Placement, identifies issues related to the placement of countermeasures like PHBs and RRFBs at uncontrolled crossing locations with bus stops.

Table 2 - Comparative Analysis of Bus Stop Locations and Intersections (Adapted from FTA 2015)

Stop Type	Advantages	Disadvantages
Near-side 	<ul style="list-style-type: none"> Minimizes interference when traffic is heavy on the far-side of the intersection Allows passengers to access buses closest to crosswalk Intersection available to assist in pulling away from curb Prevents double stopping Allows buses to service passengers while stopped at a red light Provides driver with opportunity to look for oncoming traffic including other buses with potential passengers 	<ul style="list-style-type: none"> Increases conflicts with right-turning vehicles Potentially obscures curbside traffic control devices and crossing pedestrians Potentially obscures sight distance for crossing vehicles stopped to the right of the bus Potentially blocks the through lane during peak periods by queuing buses Increases sight distance problems for crossing pedestrians
Far-side 	<ul style="list-style-type: none"> Minimizes conflicts between right turning vehicles and buses Provides additional right turn capacity by making curb lane available for traffic Minimizes sight distance problems on approaches to intersection Encourages pedestrians to cross behind the bus Accommodates shorter deceleration distances for buses Creates gaps in traffic flow for buses re-entering the flow of traffic at signalized intersections 	<ul style="list-style-type: none"> Potentially blocks intersections during peak periods by queuing buses Potentially obscures sight distance for crossing vehicles Increases sight distance problems for crossing pedestrians Interferes with bus operations and all traffic control in general when stopping after a red light Potentially increases number of rear-end crashes since drivers do not expect buses to stop again after stopping at a red light
Mid-block 	<ul style="list-style-type: none"> Minimizes sight distance problems for vehicles and pedestrians Minimizes pedestrian congestion in passenger waiting areas Reduces conflicts with different movements of vehicles (vehicles turning right and left) and can eliminate turning lanes 	<ul style="list-style-type: none"> Necessitates additional distance for no-parking restrictions Encourages patrons to cross street at potentially unmarked locations Increases walking distance for patrons crossing at intersections

Bus Stop and Countermeasure Placement

The placement of crossing countermeasures and bus stops may vary based on the roadway configuration, signal operations, and visibility of the pedestrian boarding or alighting the bus stop. Table 3 describes the recommended placement of the bus stop relative to the crossing countermeasure at uncontrolled locations. The NCDOT project staff should review the site conditions and use engineering judgement when ultimately recommending countermeasure placement.



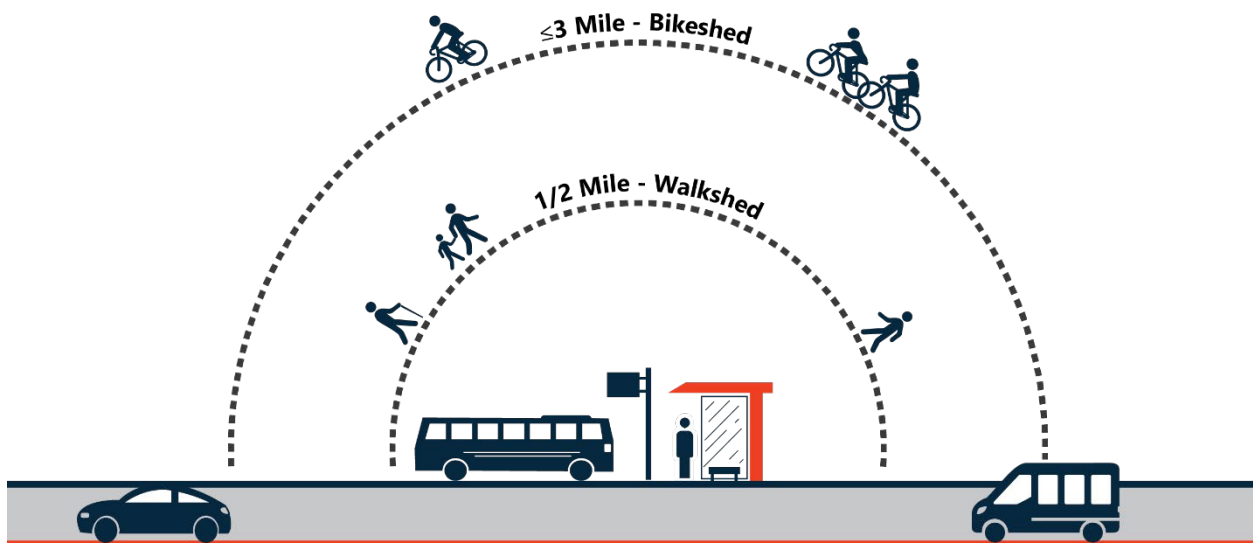
Table 3 – Bus Stop and Countermeasure Placement Considerations

Roadway Context and Countermeasure	Recommended Bus Stop Placement to Crossing Countermeasure	Rationale
Multilane roadway with an actuated and 'hot'-response PHB	Before PHB and crossing	Upon PHB activation, vehicles will stop, and the pedestrian will cross similar to a near-side signalized intersection.
Multilane roadway with actuated and coordinated PHB	After PHB and crossing	With a delayed activation, pedestrians may try to cross as vehicles proceed through the dark PHB. Placement after the PHB improves pedestrian visibility to oncoming vehicles before activation.
Multilane roadway with RRFB	After RRFB and crossing	RRFBs are a conspicuity device, and crossing behind the bus improves pedestrian visibility to oncoming vehicles after RRFB activation.
Two-lane roadway (curb & gutter or no shoulders)	Before countermeasure and crossing	Where the bus stops in-lane and blocks following vehicles from passing around the bus, crossing in front of the bus improves pedestrian visibility to oncoming opposing vehicles.
Two-lane roadway with wide shoulders	After countermeasure and crossing	Where the bus pulls to the shoulder for boarding and alighting, crossing behind the bus improves pedestrian visibility to oncoming/passing vehicles.

Network Connectivity

Transit routes and stops are one part of multimodal networks that also serve motorists, pedestrians, and bicyclists. Bus stops should be located in areas that are accessible for pedestrians and bicyclists, including marked crossing opportunities, connecting sidewalk and bicycle facilities, and accessible boarding areas. It is best practice for transit agencies to review the bus stop vicinity for pedestrian and bicycle connections to evaluate access to the bus stop; common distances are ½ mile for pedestrian connections (referred to as the walkshed) and 3 miles for bicyclist connections (referred to as the bikeshed), though distances will vary based on user mobility needs, type of transit service, and land use context (Figure 7).¹⁵ Access should be evaluated for safety, directness, and comfort of the non-motorized users. Where there are gaps in the network to the bus stop, the transit agency may coordinate with other agencies like the LGA and NCDOT to install improvements like infill sidewalk, curb ramps, and bicycle lanes to integrate access to and from the bus stop.

Figure 2 - Typical Pedestrian and Bicycle Access Distances to Transit



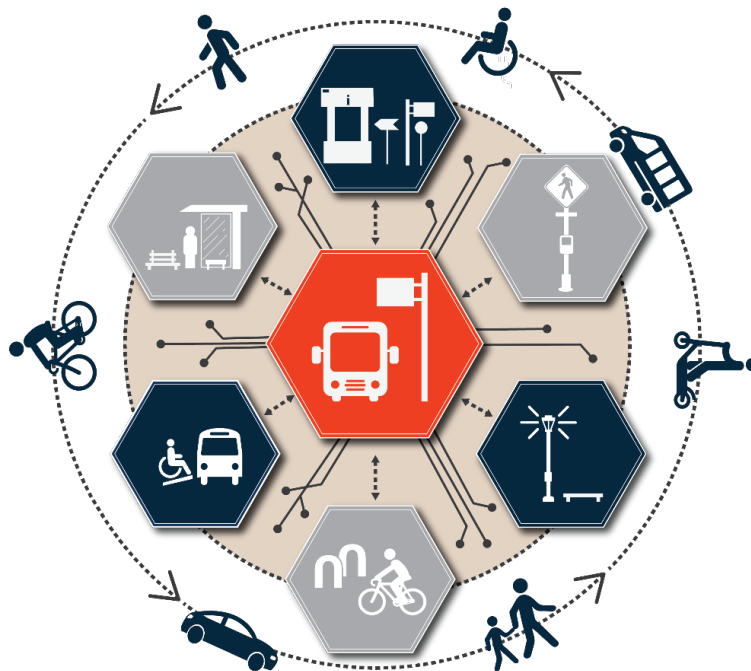
¹⁵ FHWA, Improving Safety for Pedestrians and Bicyclists Access Transit, 2022. For example on walkshed variations, research has shown that most transit riders walk ¼ mile or an equivalent of 5 minutes to reach their bus stop, walk ½ mile to reach BRT, and walk ¾ mile or 15 minutes when accessing commuter rail.



User Needs and Amenities

Transit users come from the community and reflect a wide spectrum of needs and abilities for accessing transit. When considering user needs and bus stop amenities, it is recommended to review for the following:

- **Pedestrian Signal Modifications:** The pedestrian signal near a bus stop can be modified to meet the needs of pedestrians with slower walking speeds and those with visual impairments. This can include Leading Pedestrian Interval (LPI) or extending the WALK phase for pedestrians who may walk at a lower walking speed.
- **Bus Stop Area Lighting:** Lighting to and at the stop can improve pedestrian visibility when accessing the stop, and lighting can also increase pedestrian comfort and sense of personal safety when accessing and waiting at the stop.
- **Signage:** Directional signage should be clear, placed within pedestrian sight lines, and include graphic elements that are easily understood by those unable to read English.
- **Bus Stop Shelters and Benches:** Structures such as benches and shelters increase the comfort for pedestrians as they wait to ride or transfer to another bus. Shelters provide protection from the elements for all riders, and benches and other seating can improve the comfort of seniors, pregnant women, and people with disabilities or injuries, among others. Transit agencies often evaluate locations for shelters and benches based on available ROW, assessment of user/community needs, bus stop activity, and available funding.
- **Bus Stop Accessibility:** The bus stop platform area should be flat, clear of obstructions, and of sufficient length and depth to provide access for riders with mobility devices such as wheelchairs. Refer to the U.S. Access Board for more information.
- **Bicycle Amenities:** The bus stop area could include places to securely lock or store a bicycle. However, the bicycle rack should not be placed so as to obstruct access to the bus stop.



Appendix

Table 4 displays the various plans that establish visions where NCDOT is a participant and can recommend application of the guidance or its principles to support consideration of pedestrian crossings and bus stop locations.

Table 4 – Evaluation Opportunities within Transportation and Planning Studies

Study Type	Evaluation Opportunity
Corridor Study	Corridor studies are comprehensive transportation reviews of a corridor that address existing and future land use, existing operations for all modes, and document recommendations from area plans. A corridor study identifies recommendations for improving the corridor transportation system, coordinating land use to support community goals, and supporting policy and implementation recommendations. The NCDOT project staff may recommend attention to the safety issue of aligning bus stops with pedestrian crossings for corridors with existing or planned transit service.
Pedestrian Plan	While pedestrian plans primarily address pedestrian facilities (e.g. sidewalk, shared-use paths, and crossings), they can also identify sidewalk infill and safety improvements for access to other modes, like transit, and incorporate policy recommendations for aligning bus stops, sidewalks, and crossings. The NCDOT project staff may recommend attention to the safety issue of aligning bus stops with pedestrian crossings.
Multimodal Plan	Multimodal plans and studies address the mobility, accessibility, and safety needs of all modes, often through recommendations to improve network connectivity. Recommendations can include crossing improvements and transitions between modes. The NCDOT project staff may recommend attention to the safety issue of aligning bus stops with pedestrian crossings.
Safety Study	Safety studies may be focused on a corridor, small area, city, or metropolitan area and may encompass specific modes, users, or remain all inclusive (such as Vision Zero). These plans or studies may identify and prioritize specific locations for improvements or recommend policies and guidance to reach a safety goal. The NCDOT project staff may recommend the inclusion of pedestrian access to bus stops as a key consideration to help reach the intended safety goal.
Transit Plan	<p>Transit plans are often led by the local transit agency with stakeholder participation from local governments in the service area, community representatives, and NCDOT (depending on the roadway ownership). The scopes for transit plans range from review of system performance, realignment of service and fair structure, establishment of new routes and service, and targeted revisions to specific corridors, emphasis, or station areas.</p> <p>As a project team partner, NCDOT may be asked to review bus routes, stop locations, and pedestrian access with regards to operational and safety impacts for NCDOT-maintained roadways. These studies may have titles such as Better Bus Study, Transit Development Plan, and Station Area Plan. The project staff may also be asked to review stops on a case-by-case basis, recurring schedule, or as bundle of bus stops along a corridor.</p>

