

NCDOT Transportation Mobility and Safety Division

NCDOT Trail Crossing Guidance



Improving Visibility at Trail Crossings

Purpose

The purpose of this document is to provide North Carolina Department of Transportation (NCDOT) and other decision-makers specific trail crossing guidance to improve pedestrian and bicycle safety at trail crossing locations. The focus of this guidance is on roadways owned and maintained by NCDOT, but local agencies may consider applying this guidance to locally-maintained roadways. There is limited existing guidance on improving bicycle and pedestrian safety at trail crossings, both at the state and federal levels. This guidance will fill that gap by describing countermeasures and strategies for improving safety for trail users at trail crossings based on local context and trail user needs.



Trail Crossing with a Pedestrian Hybrid Beacon

Application

While there are several types of trails, trail crossings, and trail safety

concerns, this guidance is primarily focused on improving trail user visibility and vehicle yielding behavior where paved, shared use paths cross roadway at-grade. This guidance may be applied to existing NCDOT system trail crossings, new projects, or roadway improvements such as resurfacing projects. This guidance does not address unimproved trails, which are not paved and are not required to meet accessibility standards at the roadway crossing.

This guidance is a key resource for NCDOT traffic safety and district engineers, as well as for trail planners and designers. Opportunities to use this guidance include when reviewing bicycle and pedestrian and other State Transportation Improvement Program (STIP) projects, when considering proactive trail crossing improvements as part of a Highway Safety Improvement Program (HSIP) investigation.

Need

Trail crossings are intersections, presenting safety concerns both similar and unique when compared to other pedestrian crossings. Trail crossings are distinct due to the variety of people using trails and where they are located along roadways. This means trail crossings must be safe to navigate for young children, older adults, people using wheelchairs, confident cyclists, first-time cyclists, locals and tourists unfamiliar with the area and local expectations or rules. Creating a crossing that all people can safely navigate requires both drivers and trail users understand how they are expected to cross the roadway and that trail users have time and space to cross without being exposed to conflicts with vehicles.

Trails also serve a variety of modes including pedestrians, bicyclists, scooters, and other micro-mobility users. The variety of trail users operate differently when crossing roads which can confuse expectations at crossing locations and lead to vehicle-trail user conflicts. Bicyclists and people using scooters or other personal micro-mobility devices may approach crossings at high speeds, reducing their stopping sight distance, the time they have to make decisions about gaps in traffic, and motorists' reaction time to people crossing. Trails and greenways are popular for transportation and recreation and often have moderate to high pedestrian and bicycle activity, which may create frequent bicycle and pedestrian crossings and the conditions for conflicts with vehicles. Bicyclists and pedestrians also often walk or ride in groups on trails, especially in rural areas, increasing exposure at crossings.

Definitions

The terminology and standards used in this guidance are from the NCDOT Roadway Design Manual, Section 4.14.1.1 Shared-Use Paths, Sidepaths, and Greenways. This guidance focuses on paved, shared use path crossings.

Shared-use paths (SUP), often referred to as greenways or multi-use paths, are paths physically separated from motor vehicle traffic and used by pedestrians, bicyclists, skaters, wheelchair users, and other non-motorized users. Most shared-use paths are designed for two-way travel.



Shared use path approaching an intersection.

Sidepaths are a type of shared-use path located

immediately adjacent to and parallel to the roadway or within the right of way.

Shared-use paths are wider than sidewalks, accommodate bicyclists and pedestrians, and are used for both transportation and recreational uses. The width of a shared-use path may vary based on expected user volumes and context but are typically 10-14 feet wide except in especially constrained locations where they may be a minimum of 8 feet. Shared-use paths follow federal requirements for accessibility per the U.S. Access Board and the U. S. Department of Justice. Refer to the proposed Public Rights-of-Way Accessibility Guidelines (PROWAG) Chapter 3 Section R302.5 and R302.6. Trail crossings must follow the current standards as adopted by the NCDOT and consistent with the American with Disabilities Act (ADA).

NCDOT Role and Process for Improving Trail Crossings

While trails are most commonly built and maintained at a local or regional level, there are several opportunities for NCDOT to support trail crossing improvements through review during project development and the Highway Safety Improvement Program (HSIP). This guidance and other resources cited should be consulted for both existing and proposed trail crossings.

Existing Trail Crossing Review

Trails or shared use paths cross roadways maintained by NCDOT and local governments in every large city and NCDOT Division. While many cross roads that carry little vehicle traffic, such as neighborhood streets, other trails cross major roads and higher speed arterials carrying higher traffic volumes. The following outlines several circumstances when existing trail crossing locations can be reviewed by NCDOT for potential improvement:

- Local Agency Request or Resident Complaint Upon receiving a request from a local agency to review the crossing due to local safety concerns, NCDOT Division office will coordinate with the Regional Traffic Engineer (RTE) and review the trail crossing to determine if additional improvements or countermeasures are needed.
- *HSIP investigation* Improvements for trail crossings will be identified and reviewed for improvements by the RTE when in the vicinity of a location being studied as part of an HSIP investigation or larger scale study.
- *Resurfacing* When a resurfacing project includes a road that is crossed by a trail, the District Engineer and RTE will coordinate and review the existing trail crossing and identify needed improvements.

A field review of the trail crossing should examine current conditions at the trail crossing, in comparison with best practices. Review sight distance from all approaches to the trail crossing, at distances equivalent or greater to stopping sight distance (based on design speed of the roadway). Field review should also include observations

about existing signage, pavement markings, trail user speeds and crossing maneuvers, lighting conditions, driver yielding behaviors, and traffic speeds.

Each location should be reviewed based on risk for serious injury or fatal pedestrian and bicyclist crashes. As approaching vehicle speed, traffic volumes, and crossing distance increase, so does the likelihood that a crash may result in a serious injury or fatality. Recent crash history can also be reviewed to describe contributing circumstances leading to those crashes, such as lighting conditions at the time of the crash, driver actions, trail user crossing actions, and other human factors.

Field review should also identify destinations that may generate demand for crossings and influence the types of trail users. For instance, bus stops, schools, parks and social service centers may generate more pedestrian and bicyclist activity and exposure at the trail crossing. Distance between the trail crossing and other pedestrian crossings should be reviewed.

Field review and consideration of risk and other factors are inputs to selecting potential improvements for the trail crossing. Improvements will vary based on context, such as if the crossing is located at a signalized intersection, at an unsignalized crossing or midblock location, or crosses a side street. Consult Table 1 for more information on resources to be considered when selecting proposed improvements at existing trail crossings. Consult with the Regional Traffic Engineer to discuss the proposals and options for funding the improvements.

Existing Trail Crossings: Review Process



Proposed Trail Crossing Review

For locations where trails are proposed to run alongside or cross a roadway, consideration should be made for where trail crossings will be established and for additional pavement markings, signs and traffic controls needed to reduce crash risk. The following outlines several circumstances when proposed trail crossing locations can be reviewed by NCDOT for review and recommended improvements:

- *STIP Projects* The NCDOT project manager will coordinate with the Regional Traffic Engineer to review STIP projects for improvements to existing or recommended trail crossings in the project study area.
- Encroachment Request When an encroachment request is submitted to NCDOT by the local government including an existing or proposed trail crossing, the District Engineer should review the trail crossing, and coordinate with the Regional Traffic Engineer (RTE) as needed, for recommended improvements.
- *Bicycle / Pedestrian Project Review* When a trail is planned as a locally administered bicycle/pedestrian project and the trail is expected to cross a roadway at-grade, the local government and Division should coordinate with the RTE to review the scope of the project for needed crossing improvements.

The project owner may be asked to collect data along the corridor to better describe existing pedestrian and bicycle activity and travel routes. Helpful data can include pedestrian and bicyclist counts and bus stop ridership. The context of the corridor should also be considered, including current and future land development that may generate demand for crossings and influence the types of trail users. Distance between expected crossing locations or controlled intersections should be reviewed in context of the proposed trail network. Where the trail is located on the opposite side of the roadway from land development that is likely to generate demand for walking or bicycling, trail spur crossings should be considered.

Each corridor and potential crossing locations should be reviewed based on risk for serious injury or fatal pedestrian and bicyclist crashes. As approaching vehicle speed, traffic volumes, and crossing distance increase, so does the likelihood that a crash may result in a serious injury or fatality. If the trail network is being proposed along an existing roadway, recent crash history can also be reviewed to describe contributing circumstances leading to those crashes, such as lighting conditions at the time of the crash, driver actions, trail user crossing actions, and other human factors.

Risk and other factors are inputs to selecting potential improvements for the trail crossing. Improvements will vary based on context, such as if the crossing locations are proposed for signalized intersections, at unsignalized crossing or midblock locations, or continues as a sidepath crossing side streets. Consult Table 1 for more information on resources to be considered when selecting improvements for proposed trail crossings. Consult with the Regional Traffic Engineer to develop final recommendations and identify options for funding the improvements.

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Proposed Trail Crossings: Review Process



Table 1: References and Guidance for Trail Crossing Review

Resource	Description
NCDOT TMSD	This resource provides general guidance for pavement markings, signage and
Multimodal Guidance	traffic controls for bicyclist and pedestrian networks along roadways, and
<u>(2023)</u>	treatments for signalized intersections and unsignalized crossings.
NCDOT Pedestrian	This guidance was developed by NCDOT to identify countermeasures for
Crossing Guidance	midblock or unsignalized crossing locations. Traffic controls, pavement markings
	and signs used must be consistent with the current MUTCD.
NCDOT Signal Design	This manual includes guidance and details for installing signal phasing or timing
Section Design Manual	options for pedestrians and bicyclists.
NCDOT Roadway	This is a resource for standard drawings for pavement markings and signs for all
Standard Drawings	roadway users, including new guidance for bikeway crossings.
NCDOT Roadway Design	The roadway design manual references best practices for implementing geometric
<u>Manual</u>	improvements as part of the roadway network, including refuge islands and
	separated networks.
AASHTO Design	The AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities
Guidance (various)	and the AASHTO Guide for the Development of Bicycle Facilities are key resources
	for designing shared use paths, including information about signs and features to
	be considered at trail crossings.

Trail Crossing Considerations

Trail crossing improvements should be guided by local context, including user needs, roadway characteristics, land use, and location. Considerations for trail crossings are outlined below. In cases where multiple considerations apply, additional safety countermeasures may be needed.

User Needs



Families, young children – Families and young children using a trail might need more time to cross the road or move in a group traveling at varying speeds. Young children are less able to judge approaching vehicle speeds and gaps in traffic to predict when it is safe to cross. Families may also need more space in pedestrian refuge islands, particularly with strollers and bicycles pulling trailers.

Older adults – Older adult trail users may be less agile than other trail users and need more time to cross the roadway. If the trail or greenway is near a senior adult community or housing development, then an increased number of older adults may use the trail or greenway.

Visitors – Trails and greenways are often attractions for visitors on vacation in the mountains, at the beach, and in other areas. In these locations, trail traffic may be particularly heavy during certain times of year, trail users may be more likely to travel in larger groups and need more wayfinding to correctly navigate between the trail and nearby destinations.

Accessibility- Making trail crossings accessible for users that use a wheelchair or mobility device, have mobility issues, or otherwise need extra crossing accommodations is vital. Many trail crossing considerations related to accessibility are the same as for other groupsensuring trail users have enough time to cross the street without being exposed to vehicle conflicts. Additional accessibility considerations include ensuring all users have enough information to cross the road safely and are able to use existing infrastructure. Pedestrian signals can be made accessible with tactile arrows and locator tones. Curb ramps should be wide enough, free from obstructions, and aligned with the marked crosswalk. Detectable warnings surfaces should be appropriately placed to inform low vision and blind pedestrians when they are stepping into the roadway.

Roadway and Development Characteristics



Sight distance – Driver stopping sight distance varies with approaching traffic speeds; the faster vehicles are traveling, the longer it will take drivers to stop their vehicle for a bicyclist or pedestrian in the trail crossing. Vegetation, buildings, and other visual obstructions due to objects or the alignment of the crossing with the roadway can narrow the driver's approaching sight triangles, limiting their ability to see bicyclists and pedestrians in enough time to stop and potentially avoid a collision. Visual obstructions can also obscure bicyclists and pedestrians' view of the road. Bicyclists traveling at higher speeds approaching crossings may limit stopping sight distance for both bicyclists and drivers.



Speed – In addition to increasing driver stopping sight distance, higher vehicle speeds increase the risk that a crash with a trail user will be fatal or result in a severe injury, making it imperative that trail users have time and space to cross the roadway safely. This is especially true for uncontrolled and midblock crossing locations. When speeds are high enough or combined with heavy traffic volume, trail crossings may require grade separation, or a traffic signal or PHB be considered.



Crossing distance and proximity to intersections – Crossing distance is determined by the number of travel lanes on a roadway and the angle the trail crosses the road. A longer crossing distance means a longer crossing time for trail users and more time exposed to potential vehicle conflicts. Crossing distance can be shortened by including wide curb extensions or installing wide refuge islands at intersections with multiple through and turn lanes.



Land development - Land development around a trail crossing informs driver and trail user expectations. In urban areas, drivers are more likely to expect pedestrian and bicycle traffic and vehicle speeds tend to be lower due to lower speed limits and road features (e.g., lane width, landscaping, etc.) Urban areas may also have more buildings that act as visual obstructions and increase stopping sight distance. There is also more likely to be transit and destinations that may draw trail users.

In suburban and rural areas, drivers are less likely to expect pedestrian and bicycle traffic and speeds tend to be higher because speed limits are higher and there are fewer intersections where vehicles must stop or slow. There may also be less roadway lighting in these areas, especially pedestrian scale lighting, making it harder for drivers to be aware of trail users in low light conditions. Suburban areas also tend to have more lanes, increasing trail crossing distance.



Signalized intersection – Trail crossings at signalized intersections typically look like regular pedestrian crossings, with bicycles expected to cross at the same time and in the same space as pedestrians. Wide intersections with many through lanes and turn lanes create long crossing distances for trail users. More complex intersections may require multi-stage crossings due to the width of the intersection and traffic patterns. Trails may cross a signalized intersection at two approaches or turning volumes may be heavy, increasing trail user exposure to vehicle conflicts. Also, if an intersection is skewed or has channelized turn lanes, vehicles may be able to turn without slowing significantly, making it more difficult for trail users to judge vehicle speeds and gaps in traffic or cross with sufficient time.



Unsignalized intersection or midblock – Because there tend to be no vehicle controls at trail crossings at unsignalized or midblock locations, stopping sight distance is a primary concern. Vehicles travelling at higher speeds need longer to come to a complete stop, which they may not be expecting to do if there are not traffic controls. Enhancing trail user visibility should be a focus at this type of crossing, both structural and environmental. Trails crossings should be perpendicular to the roadway, vegetation and other visual obstructions removed, and visibility enhancements in place like signage.



Proximity to other roadway features – Visibility and increasing sight distance are paramount at trail crossings that are near other roadway features, such as rail crossings, bridges, intersections, and transit stops. These roadway features create situations where drivers' attention is divided and informational and warning signs for the other features may cause visual clutter. Trail crossings should be placed at an appropriate distance away from these features so that drivers have time to navigate them before encountering the trail crossing. For example, if a crossing is near but not at an intersection, the crossing should be placed so a driver has appropriate sight distance after fully turning at the intersection. Or if a trail crossing is near a transit stop, it should be placed so a stopped bus does not obstruct the view of drivers behind the bus or in an adjacent lane.



Sidepath crossing – Trails that run parallel to a roadway (sidepaths) require crossings across side streets perpendicular to the main roadway. The visibility at these crossings is very important because trail users encounter conflicts from vehicles turning onto the side street from the main roadway, who may be focused on avoiding other vehicle traffic rather than looking for, and yielding to, pedestrians or bicyclists on the sidepath. Vegetation and other visual obstructions may also block drivers' ability to see trail users traveling in either direction. Additionally, vehicles on the side street waiting to turn onto the main roadway may stop on the crosswalk while waiting to turn, obstructing the crossing, and reducing visibility of the crossing for trail users and other vehicles.

When should grade separation be considered?

Roadway characteristics and conditions can create situations where an at-grade crossing is not adequate to keep trail users and drivers safe and grade separation should be considered. Trail crossing locations that should be considered for grade separation include those with high traffic speeds approaching the crossing, especially in suburban and rural contexts where traffic signals are few and far apart, and places with heavy traffic volumes where it may be more feasible to grade separate the trail crossing than to stop traffic.

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Best Practices

All Trail Crossing Locations

Trail crossings should include overhead lighting, high visibility markings, wide markings (matching the width of approaching paved trail), warning signs at the crossing, and meet accessibility standards for curb ramp and approach design. Additionally, where the trail is crossing a roadway with 3 or more lanes, refuge islands may be considered to allow trail users to cross the roadway or intersection in multiple stages. Where a refuge island is included at the crossing, the island should be designed to accommodate a group of pedestrians or bicyclists pulling a trailer. Consider designing the refuge island to include an offset that changes the direction of the trail user to face oncoming traffic before continuing the crossing. Site specific conditions, such as limitations to electricity, or local policies governing the use of trails should also be considered when reviewing the crossing to install overhead lighting. Refer to Section 9E.13 and Figure 9E-14 of the MUTCD (2023 edition) for additional guidance on crossing markings for trail crossings where pedestrian and bicycle movements are separated.

- Overhead lighting (as feasible, based on context)
- □ High visibility markings
- □ Wide markings (matching the width of approaching paved trail)
- Warning signs at the crossing (W11-15 with W16-7P plaque)
- Meet accessibility standards for curb ramp and pathway approach







Signalized Intersection

Trails crossing signalized intersections should always include pedestrian countdown signal heads. Leading Pedestrian Interval (LPI) should be considered for all trail crossings to allow trail users to enter the intersection crossing before turning vehicles. Turning restrictions, such as No Right on Red (R10-11) or Turning Vehicles Yield To (R10-15b) signs, may be used for the trail crossing. Pedestrian Recall should also be considered where pedestrians frequently approach or to assist bicyclists who otherwise may have to dismount to actuate a push-button signal head. Bicycle detection should be considered for signalized intersections where Pedestrian



Signalized Intersection Trail Crossing

Recall is not a viable option. If refuge islands are installed at the signalized intersection, a push button should be installed in the island but the WALK phase should be timed to allow for trail users to cross in a single stage.

Safety Problems	Improvement Options
High speed turns; poor yielding at crossings	Curb extensions; LPI; Turning restrictions or Yield-To signs at intersection
Complicated crossing maneuvers	Refuge Island; Protected WALK phase
Longer crossing distances	LPI; Refuge Island; Reduced turn radius
Increased exposure or trail user activity	Pedestrian Recall; Bicycle detection



Unsignalized Intersection or Midblock

All trail crossings form an intersection, whether or not the location is controlled or signalized. Trails crossing midblock or unsignalized locations should always be improved by countermeasures for pedestrian crosswalks. Consult the NCDOT Pedestrian Crossing Guidance for suggested countermeasures based on roadway characteristics, traffic speed and context. Crosswalks should be marked where sight distance is optimal, and advance warning signage may be needed where sight distance is limited. STOP signs should be placed on the trail at the roadway crossing, to designate right of way, unless the crossing is improved with a PHB or traffic signal. Refer to <u>Section 9B.01</u> of the MUTCD (2023 edition)



Unsignalized Midblock Crossing

for more guidance on placing STOP or YIELD signs on shared-use paths at roadway crossings.

Context	Safety Problems	Typical Improvement Options
Multilane road; posted speed ≥35 mph; Suburban or urban area	Higher risk for serious injury or fatal crash; Moderate to high trail user activity	Traffic signal (with WALK) or PHB; Refuge Island
Multilane road; posted speed <35 mph; Urban area	Longer crossing distances; High trail user activity	Refuge Island RRFB Advance yield signs and markings STOP signs for trail users
Rural, posted speed ≥40 mph	Unexpected crossings and poor yielding; Low to moderate trail user activity	Traffic signal (with WALK) Refuge Island, if multilane Advance warning signs STOP signs for trail users
Low traffic volume; posted speed <35 mph; Suburban or neighborhood area	Frequent crossing locations; Moderate trail user activity	RRFB Advance warning signs STOP signs for trail users



Sidepath and Driveway Crossings

Trails running parallel to the major roadway cross minor intersecting streets and driveways. Sidepath crosswalks should be designed considering traffic controls present at the intersection. If the intersection is signalized, pedestrian countdown signal heads should be installed on the sidepath trail crossing approach. Additionally, because bicyclists may ride against traffic at the sidepath crossing, signs (such as the R10-15b "Turning Vehicles Yield to" sign) can be installed near the signal heads to emphasize potential conflicts at the sidepath crossing. If the side street approach is controlled by a STOP sign, then consideration should be made toward sight distance. Sidepaths can be recessed, or offset from the road, by distance of at least one vehicle where vehicles may



Sidepath crossing in the Outer Banks, NC.

otherwise encroach on the crosswalk to look for gaps in traffic.

Additional features, such as raised crossings or STOP signs for approaching trail users, may need to be considered to further designate right-of-way expectations and slow approaching traffic at the sidepath crossing.

Safety Problems	Typical Improvement Options
Heavy turning movements	Turning restrictions or Yield-To signs (R10-15b) at intersection
Poor visibility	Recessed crossing; Improve sight lines (i.e., vegetation
	removal)
Increased exposure or high trail user activity	Raised crossing; STOP signs for trail users







Recessed sidepath crossing with STOP signs on trail approaches.



Raised sidepath crossing with STOP signs on trail approaches.

