Benches

Benches along trails allow users to rest, congregate or contemplate. Trail benches should comfortably accommodate the average adult. They should be located at the primary and secondary entrances to the trail and at regular intervals, and should be set back three feet from the trail edge.

The graphics below illustrate a bench that can be manufactured using recycled plastic lumber or conventional treated wood lumber. The prefabricated plastic lumber units cost more initially but last longer and require little or no maintenance.

Typical Bench Detail
Bollards

Bollards are intended to provide separation between vehicles and trail users. They are available in a variety of shapes, sizes, and colors and come with a variety of features. Lighted bollards are intended to provide visitors with minimum levels of safety and security along trails which are open after dark. Bollards should be chosen according to the specific needs of the site and should be similar in style to the surrounding elements. Typical construction materials for bollards include painted steel or aluminum, with halogen or metal halide lights in weather tight casings. Removable bollards can be installed to provide trail access for emergency and maintenance vehicles. The graphic below illustrates several typical bollard examples.

Typical Bollard Details
Trail Lighting

Particularly during winter months when trips to and from work are made in the dark, adequate lighting can make the difference in a person’s choice to bicycle or walk. However, due to liability and security concerns, many off-road bicycle paths are closed at night, and therefore unlit. Lighting for multi-use trails should be considered on a case-by-case basis in areas where 24-hour activity is expected (such as college campuses or downtown areas), with full consideration of the maintenance commitment lighting requires.

Various Lighting Types

- Wall Lighting
- Up Lighting
- Path Lighting
- Spot Lighting
Bike Rack

It is important to choose a bicycle rack design that is simple for cyclists to operate. Bicycle racks should be designed to allow use of a variety of lock types. It may be difficult initially to determine the number of bicycle parking spaces needed. Therefore, bike racks should be situated on-site so that more can be added if bicycle usage increases.

The design shown below has proven popular and effective in numerous communities. It is inexpensive to fabricate locally, easy to install, vandal resistant and works well with popular high-security locks. In addition, it can be installed as a single unit, on a sidewalk, or in quantity, at major recreation nodes.

Location Criteria:

- Racks should be located within 50’ of building entrances (where bicyclists would naturally transition into pedestrian mode).

- Racks should be installed in a public area within easy viewing distance from a main pedestrian walkway, usually on a wide sidewalk with five or more feet of clear sidewalk space remaining (a minimum of 24” clear space from a parallel wall and 30” from a perpendicular wall).

- Racks are placed to avoid conflicts with pedestrians. They are usually installed near the curb and at a reasonable distance from the building entrances and crosswalks.

- Racks can be installed at bus stops or at loading zones (only if they do not interfere with boarding or loading patterns and there are no alternatives). Bike racks on busses also facilitate bike-on-transit travel.
Bridges

Bridges are an important element of almost any trail project. The type and size of bridges can vary widely depending on the trail type and specific site requirements. Some bridges often used for multi-use trails include suspension bridges, prefabricated span bridges and simple log bridges. When determining a bridge design for multi-use trails, it is important to consider emergency and maintenance vehicle access. Bridges intended for occasional vehicular use must be designed to handle up to 10,000 pound loads safely and at least 14'-wide to allow for vehicle passage.

Foot Bridge

Urban Trail Bridge

Span Bridge

Note: Prefabricated span bridges are ordered directly from the manufacturer. Approximate cost is $100/foot. For examples and quotes, see www.steadfastbridge.com.
Underpass

Trail underpasses and overpasses can be used to avoid undesirable at-grade intersections of trails and freeways or high volume arterial highways. Neither should be used frequently in suburban, fringe or rural areas. Underpasses typically utilize existing overhead roadway bridges adjacent to a stream or culverts under the roadway that are large enough to accommodate trail users. There are several key issues that must be addressed in the design of the roadway underpass:

1. The vertical clearance of the underpass must be at least 10 feet
2. The width of the underpass must be at least 12 feet
3. Proper drainage must be established to avoid pooling of stormwater inside the underpass
4. It is recommended that underpasses be lighted for safety

Roadway underpasses that utilize box culverts can sometimes be installed as part of a roadway improvement or construction project at a greatly reduced cost.
Overpass

Trail overpasses can be used in high traffic volume areas where underpasses are not possible. Overpass options include sidewalks on bridges, freestanding pedestrian/bike bridges or lanes attached to an existing bridge. AASHTO requires that bridges be a minimum of 36 inches, but prefers that they are at least as wide as the trail. Forty-two inch high railing is also required. A fenced cover, as shown below, provides a safer environment over highways and busy streets. The NCDOT should be referenced for height requirements, which vary depending on the type of road. ADA should also be referenced for ramp requirements.

It is important to remember that pedestrians and cyclists will opt not to use an overpass or an underpass if it takes more than twice the time as crossing the street at-grade. For this reason, at-grade fencing should be considered in some instances.

![Typical Roadway Bridge with Sidewalk](image-url)
Vegetative Clearing

Vegetative clearing refers to the amount of vegetation removal that is required for various levels of trail development. The amount of vegetative clearing required for any one trail will depend on the type of trail being developed. While footpaths or hiking trails require little or no vegetation removal, paved pathways may require significantly more.

Single-tread, multi-use trails are the most common trail type in the nation. These trails vary in width, can accommodate a wide variety of users and are especially popular in urban areas. While the vegetative clearing needed for these trails varies with the width of the trail, the graphic below outlines typical requirements.

Typical Tree Trimming Distances

Clearing and grubbing consists of tree, shrub and stump removal. The minimum width for clearing and grubbing of a 14'-wide trail is 16 feet (2'-wide shoulders). Selective thinning includes removal of underbrush and limbs to create open pockets within a forest canopy. Selective thinning increases sight lines and distances and enhances the safety of the trail user. Selective thinning does not include the removal of the forest canopy.
Trail Culvert

Proper installation of trail culverts is important to ensure proper stormwater runoff drainage, trail user safety and longevity of the trail surface. Pipe length, diameter and material specifications will vary depending on specific site needs. Two materials typically used for trail culverts are reinforced concrete pipe (typically required when the trail is within NCDOT Right of Way), and High Density Polyethylene (HDPE) recycled plastic pipe. Plastic pipes are typically less expensive on a per foot basis. Outlet protection varies per site needs and in some cases a flow spreader may be required at the outlet location. Rock check dams can be placed after the outlet to slow and filter drainage. The graphic below outlines proper installation parameters for greenway trail culverts.
Tree Plantings

Trees are important to greenways and trails for both aesthetic and environmental reasons. Not only do they contribute to the appearance of a trail, their shade cools the environment for trail users and provides habitat for birds and wildlife. Trees also help keep streams healthy by providing shade (which regulates the temperature), filtering pollutants in storm runoff and adding leaf litter to feed small insects and fish. When choosing trees and shrubs for greenway corridors, it is recommended that indigenous and well-adapted species be used. This will reduce the need for chemical and water applications as a part of long term maintenance. The following graphics represent common installation practices used for several different types of plant material.

Ball and Burlap Tree Planting Detail

Bare Root Tree Planting Detail
Shrub Plantings

The amount of planting needed will vary depending on the project. While some projects will require little or no planting, other projects may require it for vegetative screening, habitat restoration, erosion control or aesthetics. The graphics below illustrate planting techniques for two types of shrub material (ball & burlap and bare root) which can be used.
Bike Considerations - Wide Curb Lanes

There are three types of on-road bicycle facilities: wide curb lanes, bike lanes and paved shoulders. Wide curb lanes, or outside lanes, are wider than the standard 12’ travel lane and can provide more space for cyclists and easier passing for motorists. Under most conditions, automobiles and bicycles can coexist in a 14’ wide curb lane, without the need for the motorist to move into the next adjacent lane.

Location and Width
Wide curb lanes best accommodate advanced cyclists, as these riders are more comfortable operating directly in traffic. The wide curb lane is always the furthest right-hand lane, and should optimally be 14’-16’ wide, not including the gutter pan (curb lanes that are wider than 16’ are not recommended). Wide curb lanes are not required to have curb and gutter. In order to achieve the extra space needed for a 14’ wide outside lane, the roadway may either be physically widened or restriped to reduce the lane width of inner lanes and increase the width of outer lanes. Restriping proposals should be reviewed by a transportation engineer to ensure adequate safety for the motorists as well as bicyclists.

Signage
There is no special “wide curb lane” sign, however, on high volume urban arterials, the designer may choose to install “Share the Road” warning signs (standard bicycle warning plate with a subplate stating SHARE THE ROAD).

Intersection Design
When the curb lanes approach intersections with turning lanes, the 14’ wide lane should continue through the intersection as the outside through-lane.

Design Issues
Acceptance: Bicycle programs in numerous communities have found that less experienced bicyclists seldom see a difference when wide curb lanes are provided. Therefore, if the desired outcome is greater numbers of bicyclists or a visible “pro bicycle” statement, this option will not satisfy the need.

Traffic: Wider curb travel lanes may tend to increase motorist speeds. Whether a marginal increase in speeds is important in a particular situation should be a subject for analysis.
Bike Considerations - Bike Lanes

Bicycle lanes in Wake County should conform to the standards in AASH-TO’s Guide for the Development of Bicycle Facilities (2000). Bicycle lanes are an on-road type of facility. They should not be separated from other motor vehicle lanes by curbs, parking lanes, or other obstructions. General standards for width, striping, and intersections are provided below.

Location and Use

Bicycle lanes serve the needs of experienced and inexperienced bicyclists in urban and suburban areas, providing them with their own travel lane. Bicycle lanes are always located on both sides of the road (except when they are constructed on one-way streets). By this design, cyclists are encouraged to follow the rules of the road, which require them to travel in the same direction as adjacent motor vehicle traffic.

Width

The minimum width of bike lanes should be 4', exclusive of the gutter pan. On roads with parallel parking, bike lanes should be a minimum of 5' wide, and should be installed adjacent to the motor vehicle lanes, rather than between the parking lane and the curb. Along streets in Wake County with higher motor vehicle speeds and traffic volumes, 6' wide bike lanes are recommended.

Signage

The MUTCD specifies standard signage for bicycle lanes. According to section 9B-8, the R3-16 sign should be used in advance of the beginning of a designated bicycle lane to call attention to the lane and to the possible presence of bicyclists. The MUTCD requires that the diamond lane symbol be used with both the R3-16 and R3-17 signs. (See page xx for signage examples.)

According to Section 9B-11 of the MUTCD, the R7-9 or R7-9a signs can be used along streets where motorists are likely to park or frequently pull into the bike lane.

Striping

Bicycle lane stripes should be solid, 6"-wide white lines. Care should be taken to use pavement striping that is skid resistant. Bicycle-shaped pavement symbols and directional arrows should be placed in the bicycle lane to clarify its use. pavement letters that spell “ONLY BIKE” are also highly recommended. Symbols should be installed at regular intervals, immediately after intersections, and at areas where bicycle lanes begin.

Bike lane striping at intersections is challenging. Traffic has a tendency to mix at intersections: motorists who are turning right must cross paths with cyclists who wish to continue straight, and cyclists who wish to turn left must cross into left-hand turn lanes. Several intersection striping patterns are provided by AASHTO’s Guide for the Development of Bicycle Facilities (2000) and the MUTCD.
Bike Route

A bicycle route is a “suggested way” for a cyclist to get from a point of origin to a destination. Bike routes do not necessarily require physical improvements in order to accommodate bicyclists, given that they meet minimum safety criteria in their present condition (see below). Bike routes can be preferable for a number of reasons including directness, scenery, less congestion and lower speed limits.

Location and Use

Bicycle routes may be used by all types of cyclists. In urban areas bike routes are most often designated on residential streets with low traffic volumes, and are typically used to direct cyclists to a destination within the community, or to provide a through-route for bicyclists. In rural areas, bike routes are most often designated on roadways that are popular touring routes for recreational cyclists, or long-distance commuting routes for advanced cyclists.

Safety Criteria

A street does not necessarily have to be physically widened in order to be designated as a bicycle route. A road with standard 12’ wide lanes can be designated as a bike route with the appropriate signage, given that each condition below is met:

- In its present state (or with planned improvements), the roadway sufficiently accommodates cyclists. The evaluation should take into account roadway width and traffic volumes. Candidate bike routes should have good sight distances and adequate pavement conditions. In addition, traffic should not regularly exceed posted speed limits.

- All bicycle hazards have been removed from the roadway or otherwise remedied, including unsafe drainage grates and angled railroad crossings.

- The bicycle route is designated as one segment within an interconnected system of bicycle facilities.

Bicycle route signage should be used according to the standards in the MUTCD, which provides several choices in styles. Bicycle route signs should be placed at all areas where new traffic enters the roadway. The distance between signs should not be greater than two miles. In urban areas, it is helpful to include directional arrows and captions that indicate nearby destinations, particularly at intersections.
Bike Pavement

Bike lane pavement and sub-base should always have the same depth and quality as the adjacent roadway. Bike lanes are not required to have a curb and gutter.

Every effort should be made to provide a smooth and even surface for bicycles, particularly for designated bicycle routes and lanes. Bicycles are much more vulnerable to surface irregularities than motor vehicles, because they rely on very narrow, highly pressurized wheel with no suspension. A simple pothole that might cause a slight jarring to the passengers of a car can cause a serious crash for a cyclist.

Potholes aren’t the only surface hazard for cyclist. Bumps, corrugations, seams, rumble strips, unraveled pavement and bridge expansion joints can cause bicyclists to lose their balance. In addition, temporary roadway construction zones often include surface hazards such as milled pavements and sudden pavement changes. Temporary signage can be used to warn bicyclist of upcoming irregularities.

When paved shoulders or bicycle lanes are added to the edge of the existing roadway, a resulting seam between the two can be hazardous to bicyclists. One solution is to install 10’ wide strips of asphalt, partially overlapping the existing motor vehicles lanes.

Pavement with large aggregates can also put additional stress on the mechanical parts of road bikes, especially for distance riders. Smooth pavement is preferred to avoid accidents due to the loss and/or looseness of bike parts.
Bike Intersections

Trail/Roadway intersections can become dangerous conflict areas if not carefully designed. For at-grade intersections, there are usually several design objectives:

1. Site the crossing area at a logical and visible location.
2. Warn motorists of the upcoming crossing.
3. Maintain visibility between trail users and motorists.
4. Inform trail users of the upcoming intersection.

Typical Signalized Intersection Plan View

Intersections and approaches should be on relatively flat grades. In particular, the bicyclist should not be required to stop at the bottom of the hill. If the intersection is more than 75 feet from the curb to curb, it is preferable to provide a center median refuge area, per ADA (Americans with Disabilities Act) or ANSI (American National Standards Institute) standards. If crossing traffic is expected to be heavy, it may be necessary to provide a traffic signal that responds to bicycles and/or can be pedestrian activated.

Typical Bollard Placement
Bike Intersections

Typical Intersection Signage
Layout Plan View

Optional:
To be used in areas with high incidence of wrong-way riding.

Optional:
To be used in areas with high incidence of illegal parking in bike lanes.

200 mm (8") solid white stripe

100 mm (4") white stripe

Typical Perpendicular Trail and Road Intersection

Typical Trail Crossing at Local Street
(from Contra Costa County Trail Design Guidelines)
Sidewalk Considerations

Sidewalks are a critical component of this Open Space and Greenways Plan. They not only encourage walking, but they also improve the safety of pedestrians. An individual's decision to walk is as much a factor of convenience as it is the perceived quality of the experience. Pedestrian facilities should be designed with the following factors in mind:

**Sufficient width**
Sidewalks should accommodate anticipated volumes based on adjacent land uses, and should at a minimum allow for two adults to walk abreast (min. 5 feet, prefer 6 feet).

**Protection from traffic**
High volume and/or high speed (greater than 35 mph) motor vehicle traffic creates dangerous and uncomfortable conditions for pedestrians. Physical (and perceptual) separation can be achieved through a combination of methods: a grassy planting strip with trees, a raised planter, bicycle lanes, on-street parallel parking, etc.

**Street trees**
Street trees are an essential element in a high quality pedestrian environment. Not only do they provide shade, they also give a sense of enclosure to the sidewalk environment which enhances the pedestrian’s sense of a protected environment.

**Pedestrian-scaled design**
Large highway-scale signage reinforces the general notion that pedestrians are out of place. Signage should be designed to be seen by the pedestrian. Street lighting should likewise be scaled to the level of the pedestrian (14 feet tall), rather than providing light poles that are more appropriate on high-speed freeways.

**Continuity**
Pedestrian facilities are often discontinuous, particularly when private developers are not encouraged to link on-site pedestrian facilities to adjacent developments and nearby sidewalks or street corners. New development should be designed to encourage pedestrian access from nearby streets. Existing gaps in the system should be placed on a prioritized list for new sidewalk construction.

**Clearances**
Vertical clearance above sidewalks for landscaping, trees, signs and similar obstructions should be at least 10 feet. In commercial areas and the downtown, the vertical clearance for awnings should be 10 feet. The vertical clearance for building overhangs which cover the majority of the sidewalk should be 12 feet.
**Conformance with national standards**
Sidewalk design should be consistent with Americans with Disabilities Act requirements and/or ANSI requirements. Specific guidance is provided by the Architectural and Transportation Barriers Compliance Board’s American with Disabilities Act Accessibility Guidelines.

**Sidewalk Obstacles**
Street furniture and utility poles create obstacles to pedestrian travel when located directly on the sidewalk. At a minimum, there should be 36 inches of sidewalk width to allow wheelchairs to pass. Where possible, utilities should be relocated so as not to block the sidewalk. Benches should not be sited directly on the sidewalk, but set back at least 3 feet. The design of new intersections or re-design of existing intersections presents an opportunity to improve pedestrian circulation. Street furniture located near intersections can block sight lines. In general, the designer should consider the impact on sight distance for all features located in the vicinity of roadway intersections.

**Sidewalk pavement design**
Sidewalks and roadside pathways should be constructed of a solid, debris-free surface. Regardless of the type of surface chosen, it must be designed to withstand adequate load requirements. Pavement depth should reflect site specific soil conditions but never be less than 4.5 inches. Brick and concrete pavers are popular materials for more decorative sidewalks. The use of stylized surfaces is encouraged, however they must be installed properly or they will deteriorate more rapidly.

**Sidewalk width and setback guidelines**
It is important to note that there are some areas that warrant wider sidewalks. For example, sidewalks in and around local universities and colleges must accommodate a much higher volume of pedestrians and, therefore, warrant additional width. The recommendations below are based upon standards used by other pedestrian-friendly communities in the U.S. Following the recommendations below ensures that basic needs of pedestrians are addressed in developing areas. In existing residential and commercial areas that lack sidewalks, new sidewalk construction (independent of new development) should occur first in locations that demonstrate the most need.

**Sidewalks on local streets in residential areas:**
Five-foot wide sidewalks are recommended on at least one side of the street, with a 5 feet wide planting strip. The planting strip may need to be slightly wider to accommodate the roots of street trees, if they are included in the design. Sidewalks are not necessary on cul-de-sacs that are less than 500 feet in length.

**Sidewalks on collector streets in residential and commercial areas:**
Five-foot wide sidewalks are recommended on both sides of the street. However, one option may be to install a 6 feet wide sidewalk on the side
of the street that generates the most activity. A 7 foot wide planting strip is recommended.

**Sidewalks on arterial streets in residential and commercial areas:**
Six foot sidewalks are recommended on both sides of the street, with an 8’ wide planting strip.

**Sidewalks on streets within 2000’ of schools:**
Width and setback should be based on the specific roadway type as described above. For all roadway types, however, sidewalks should be installed on both sides of the road, and should include well-marked crosswalks and school crossing signs.

**Sidewalks on streets with no curb and gutter**
Sidewalks located immediately adjacent to “ribbon pavement” (pavement with no curb and gutter) are not recommended. However, if no other solution is possible, sidewalks adjacent to ribbon pavement have a much greater setback requirement, depending on roadway conditions. Engineers should consult the AASHTO *Policy on Geometric Design of Highways and Streets* for more specific guidelines.

**Sidewalks in rural areas**
In most rural areas, the low volume of pedestrians does not warrant sidewalk construction. In most cases, 4’-6’ wide paved shoulders can provide an adequate area for pedestrians to walk on rural roadways, while also serving the needs of bicyclists. Exceptions should be made in areas where isolated developments such as schools, ballparks or housing communities create more pedestrian use. For example, motorists might regularly park along a rural road to access a nearby ballpark. A sidewalk may be warranted in this circumstance so that the pedestrians can walk separately from traffic. Sidewalks in rural areas should be provided at a width based on anticipated or real volume of pedestrians, with 5’ being the minimum width.

![Typical Street Section](image)
Roadside Treatments

Typical Median Shrub Planting

Typical Scenic Road Corridor

Typical Road with Adjacent Sidewalk

Typical Median Planting