7. Design Standards and Guidelines

Trail Designs

Innovative Roadside Treatments

Signing and Striping

Amenities

Safety On and Around the Trail

Roadway Crossings

7. Design Standards and Guidelines

Trail Designs

The following cross sections illustrate standard treatments for the primary trail, walkway, and bikeway design opportunities in Wilsonville. This section should be supplemented with other trail design documents, including ODOT's Bicycle and Pedestrian Master Plan, Metro's "Green Trails: Guidelines for Building Environmentally Friendly Trails," AASHTO, the MUTCD, and City standards.

Table 14. Standard Trail Treatments

Design Designation	Width	Surface	Treatment	Function
Sidewalk	5-10 ft	Concrete	Separated vertically on curb or horizontally by planting strip.	Typical treatment for local access walkways. Pedestrian and wheelchair users, provides access to homes and businesses.
Bike Lane	5-6 ft	Asphalt	On-street lane striped and signed to City standards	For bicyclists on roadways. Wherever a bicycle system intersects with a signalized intersection, the signals should not be vehicle actuated unless the signal will also recognize all bicycles.
Signed Shared Roadways	N/A	N/A	Signed shared roadways are roadways identified as desirable bicycle routes, enhanced by the presence of directional signs for bicyclists and informational signs for motorists noting the presence of bicyclists. May either be a low volume (less than 3,000 cars per day) roadway with traffic calming and signage to create a safe shared use environment, OR a higher volume roadway with wide (14-ft) outside lanes.	Used in combination with sidewalks or shared use paths on one side of road. Wherever a bicycle system intersects with a signalized intersection, the signals should not be vehicle actuated unless the signal will also recognize all bicycles.
Shared-Use Path	10-14 ft	Asphalt, concrete, or other smooth hard surface	Designed to City standards. Separated from roadway by planting strip or vertical curbing.	Typical application for regional trail and some community walkways and bikeways. Accommodates bicycles, pedestrians, wheelchairs. Minimizes potential trail crossing confilcts with autos.
Hiking Path	3-12 ft	Earthen or gravel surface	Vegetation cleared, slope stabilized.	Typical application for in-park non-primary circulation trails. Provides walking routes for pedestrians. May be designed for equestrians and bicyclists.

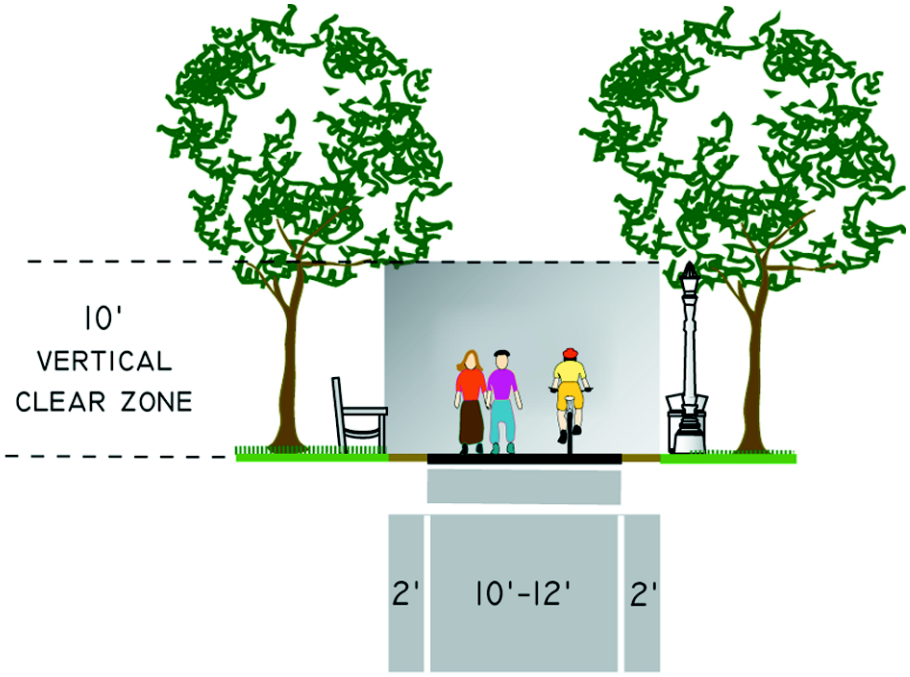


Figure 10. Regional Trail

Regional Trail

Figure 10 illustrates a typical shared use path design that is appropriate for regional trails and some community trails. This trail is designed to accommodate two-way bicycle and pedestrian traffic, typically has its own right-of-way (for a minimum of 75% if its length, although portions of the trail can be on-street), and can accommodate maintenance and emergency vehicles. This type of trail is typically paved (asphalt or concrete) but can also be a surface that provides a smooth surface, as long as it meets ADA requirements. Wider soft shoulders should be provided for runners/joggers if space allows.

Community Walkways and Bikeways

As noted earlier, the design of community walkways and bikeways will vary according to the functional classification of the facility as well as the average daily traffic (ADT) on the adjacent roadway. The following designs illustrate the application of community walkways and bikeways on High Volume Roadways, such as Wilsonville Road and Elligsen Road, and Low Volume Roadways such as French Prairie Drive or Wilson Lane. These figures are conceptual and are provided to look at the bicycle and pedestrian portion of the right-of-way, and are not intended to change travel lane widths.

High-Volume Roadways

On roadways with 3,000 or more vehicles a day, bicycle lanes should be used to improve bicyclist safety and comfort. A buffer or curb must separate the shared use path or sidewalk from the roadway for pedestrian safety. The width of the bicycle lane, buffer, and sidewalk or path should appropriately reflect the volume and speed of the vehicles using the roadway.

Figure 11 on page 123 illustrates typical bicycle and pedestrian accommodation in urbanized areas. The width of the sidewalk should depend on anticipated use; more users warrant a wider walkway. Sidewalks should be a minimum of six feet exclusive of curb and obstructions. This width allows two pedestrians to walk side by side, or pass each other comfortably. It also allows two pedestrians to pass a third pedestrian without leaving the sidewalk. Where it can be justified and deemed appropriate, the minimum width may be five feet. On high volume roadways, sidewalks are preferably designed with a five-foot or wider planting strip to create greater separation between the pedestrian and the roadway. Where on-street parking is permitted, the bike lane must be between parking and the travel lane (Figure 12 on page 123). The minimum bike lane width is five feet from the face of a curb, guardrail, or parked cars, with six feet the preferred width in urbanized areas.

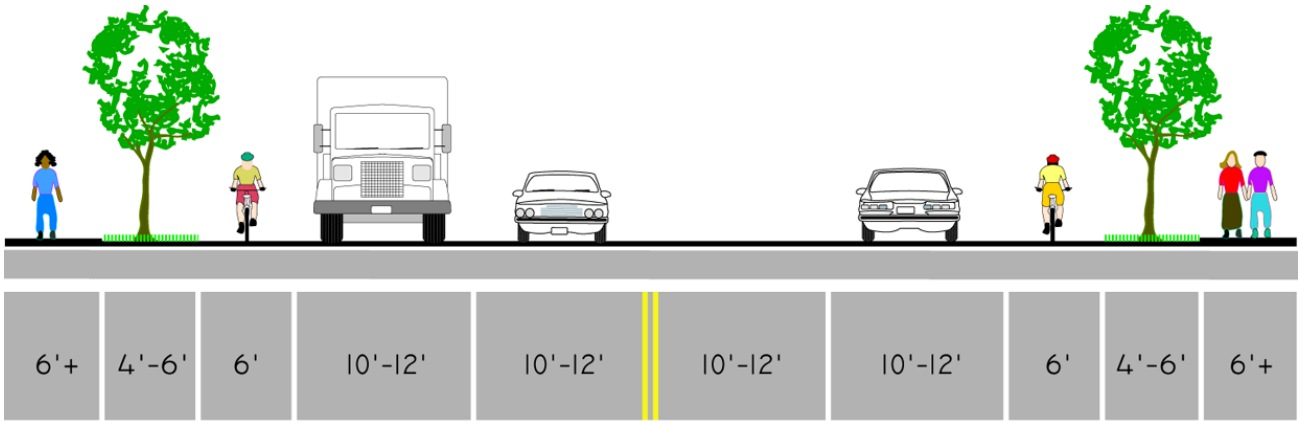


Figure 11. Option 1: High-Volume, High-Speed Roadway

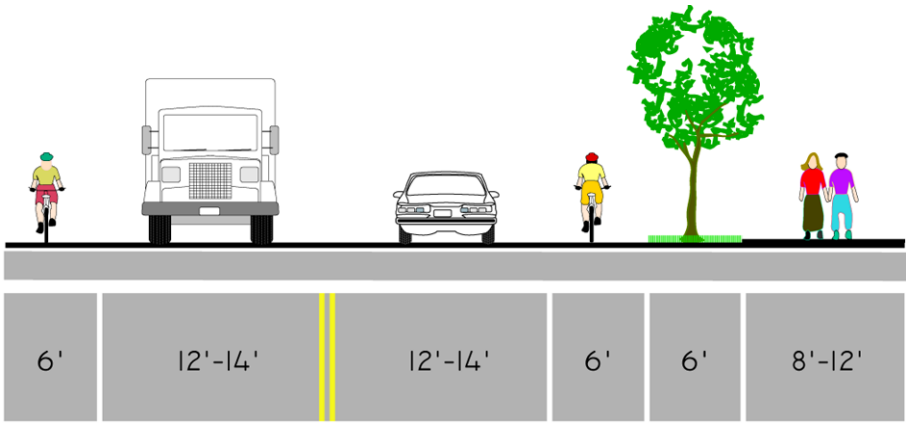


Figure 12. Option 2: Shared Use Path with Bike Lanes on a High-Volume, High-Speed Roadway

Some arterials and major collectors can accommodate a shared use path on one side of the roadway and on-street bicycle lanes for bicyclist commuters (Figure 12). The shared use path provides a comfortable walking space for pedestrians and enables children and recreational bicyclists to ride without the discomfort of riding in a busy street. This configuration works best along roadways with limited driveway crossings and with services primarily located on one side of the roadway.

Sometimes a shared use path can provide accommodation on high-volume, high-speed roadways (Figure 12). This type of trail works best in corridors where there are limited driveway/intersection crossings and more desirable destinations along one side of the roadway, or where no roadway space is available to provide bike lanes, yet the road travels past a number of desirable locations. This type of treatment may be appropriate for Town Center Loop and portions of Boones Ferry Road. The trail should be at least 10 feet wide (preferably 12-15 feet) with a six-foot or greater vegetated buffer where possible.

Moderate-Volume Roadways

On moderate volume roadways, such as minor collectors, on-street parking is often permitted. Where on-street parking is permitted, and a bike lane is provided, the bike lane must be between parking and the travel lane (Figure 14 on page 124).

According to the 2003 Wilsonville TSP, bicycle lanes do not need to be striped on minor collectors until traffic volumes reach 1,500 vehicles per day, or as determined by the City Engineer. Up to that point, the travel lanes will each be 17 feet wide with parallel parking bays on either side. If travel speeds become excessively high, striping bicycle lanes may serve as traffic calming devices by narrowing the travel lanes to 12 feet wide.

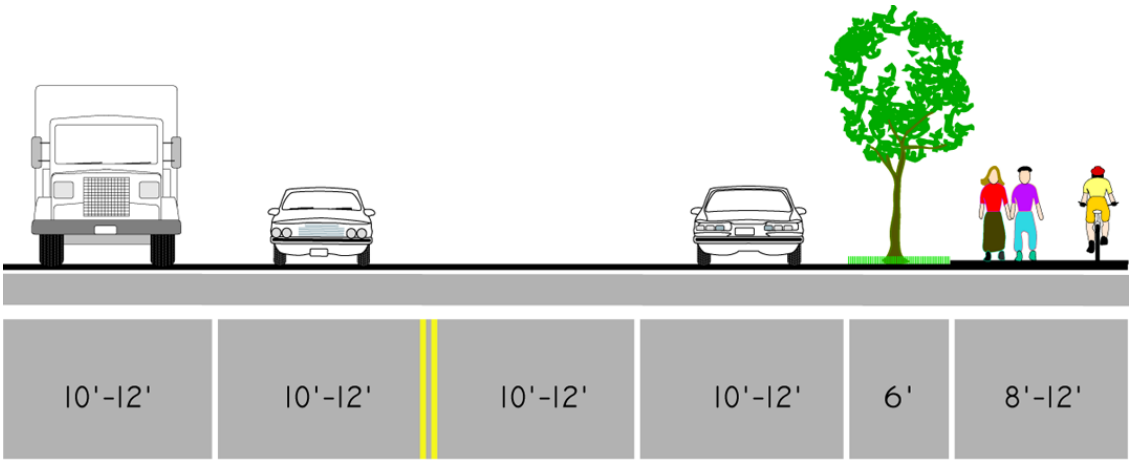


Figure 13. Option 3: Shared Use Path on a High-Volume, High-Speed Roadway

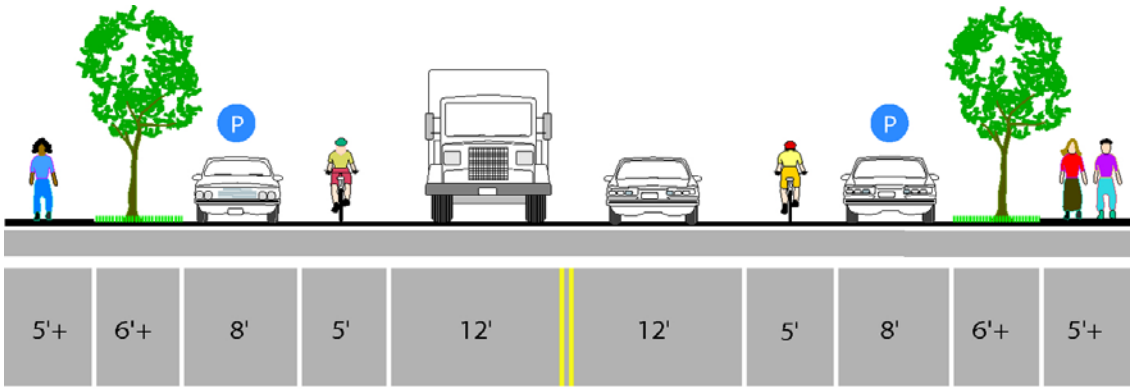


Figure 14. Option 1: Bike Lane with On-Street Parking on Moderate-Volume Roadway

Low-Volume Roadways

On a low-volume, low-speed roadway (i.e., residential or neighborhood streets such as Country View Lane, Willamette Way, and Orchard Drive), many bicyclists can safely share the road with vehicles (Figure 15). Pedestrians should be separated from the roadway with a buffer or a curb. A curb must be present if there is insufficient space for a buffer. The width of the sidewalk or trail should depend on the traffic volume and speeds of the adjacent roadway. This design corresponds to the residential street standards in the 2003 TSP.

Bicycle Boulevards

To further identify the street as a preferred route for bicyclists, the operation of lower volume roadways – such as Camelot Street and Meadows Loop – may be modified to function as a through street for bicycles while maintaining local access for automobiles (Figure 16 on page 126). Traffic calming devices, such as medians or traffic circles, reduce traffic speeds and through trips while limiting conflicts between motorists and bicyclists. The addition of bikeway signage (see Signing and Striping on page 131) enhances the experience for bicyclists by providing directional information to increase the comfort and confidence of the cyclists.

Local Trail: City Trail

City trails, such as those found in Town Center Park and Memorial Park, provide access for most, if not all, trail users within neighborhoods, parks, greenspaces, and other recreational areas.(Figure 17 on page 127) They are similar to regional trails in that they typically have their own right-of-way and serve only non-motorized users. These trails should be at least six feet wide and at least eight feet wide if bicycle use is anticipated. All efforts should be made so that at least one ADA accessible trail is available and serves the most desirable parts of the area (i.e., picnic areas, viewpoints, playground equipment, etc.)

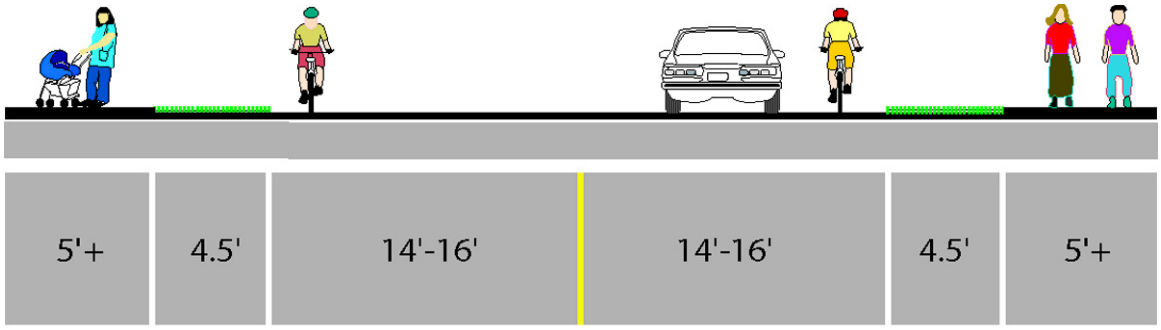


Figure 15. Low-Volume, Low-Speed Roadway

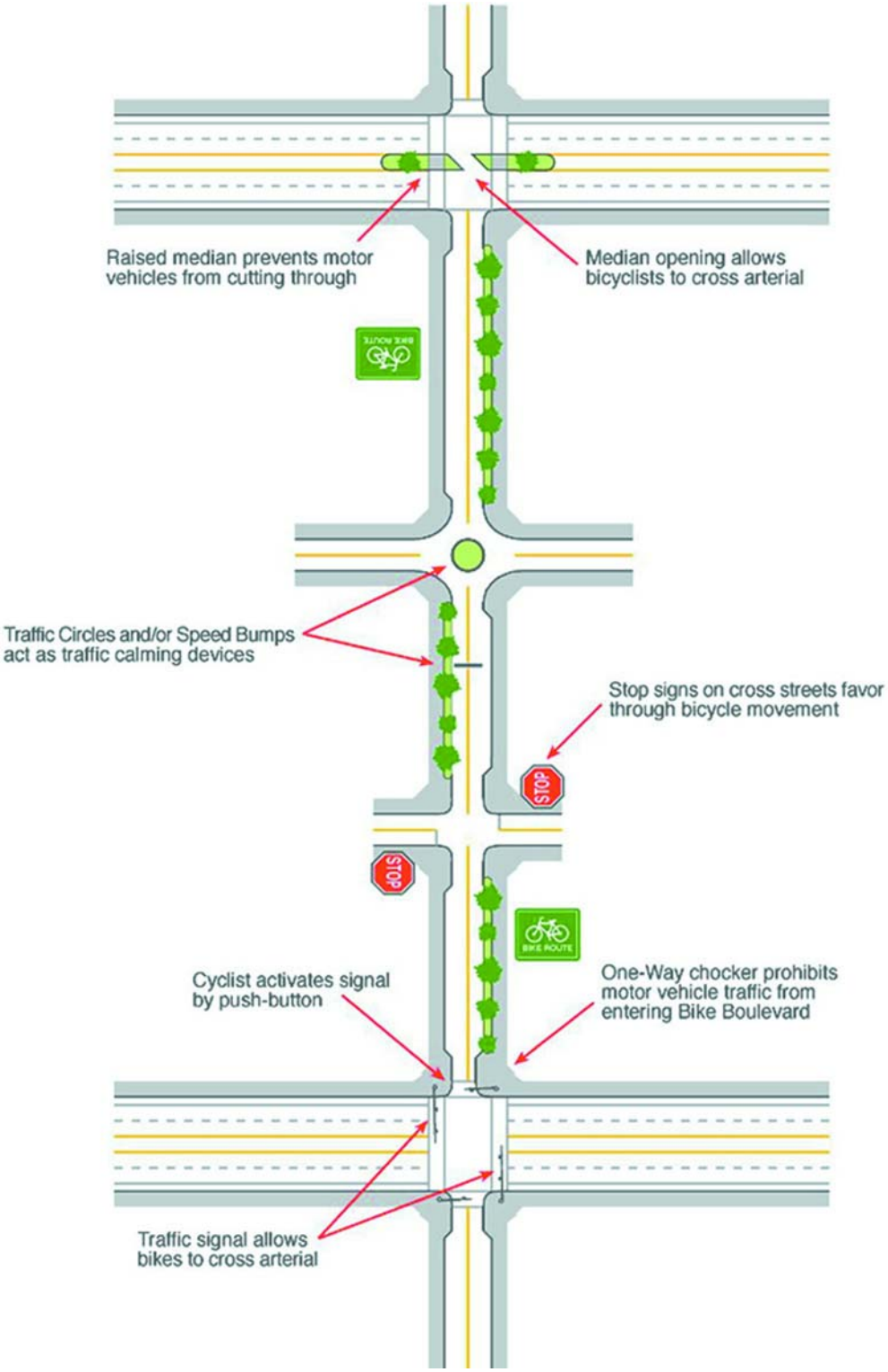


Figure 16. Bicycle Boulevards

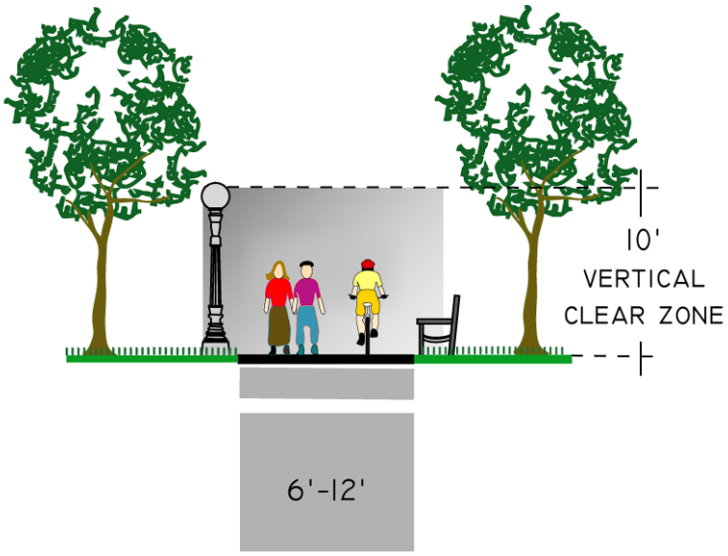


Figure 17. Paved City Trail

Local Trail: Natural Trail

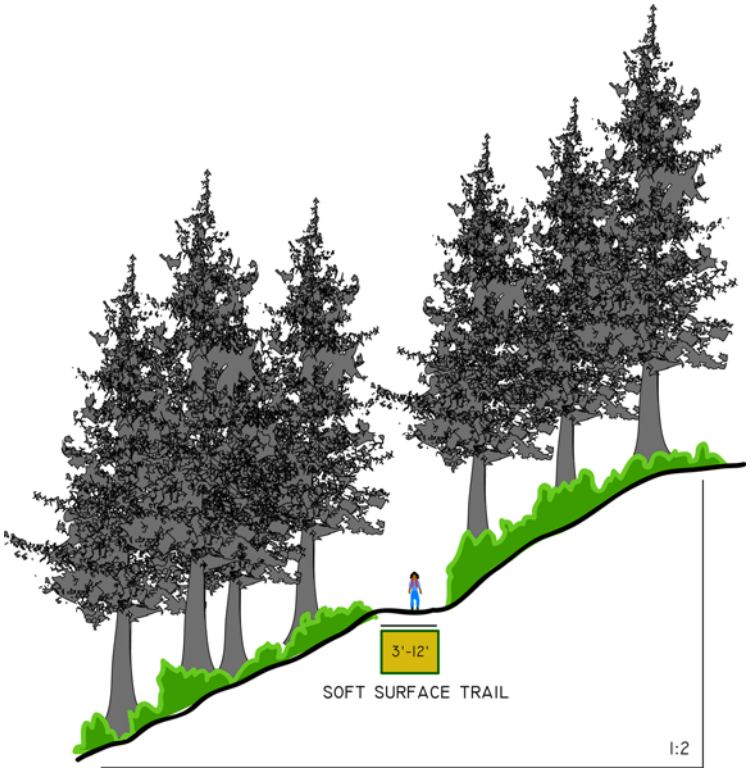


Figure 18. Natural Trail

Natural trails are usually considered when a trail is desired next to a natural resource. (Figure 18) Trail width will vary depending on the existing topographic and environmental conditions. Natural trails should take into account drainage, erosion, compaction/impaction from anticipated use, presence of waterways and sensitive riparian areas, habitat areas, environmental guidelines, such as "Green Trails" Guidelines for

Environmentally Friendly Trails" by Metro, and regulations found in Wilsonville's City Code.

Trail width will depend on intended users. For example, narrower widths should be used in environmentally constrained areas with only hiking uses intended. Wider widths are desirable for shared bicycle and/or equestrian use. Areas with natural trails (i.e., natural parks and greenspaces) should have a complimentary accessible route that meets or exceeds ADA standards in addition to the natural trails.

Local Trail: Accessway

Accessways provide direct connections for trail users to schools, parks, community centers, retail areas, neighborhoods, and other trails. (Figure 19) They are intended to be short, direct connections to reduce unnecessary out-of-direction travel for bicyclists and pedestrians. Accessways in parks, greenways, or other natural resource areas may have a five-foot-wide gravel path with wooden, brick, or concrete edgings.

In Wilsonville, another unique type of accessway is a path between houses connecting two streets (Figure 20). This accessway should be a minimum of eight feet wide with two-foot planted shoulders on either side. On occasion, the path may cross an alleyway that serves the adjacent houses. In these instances, the path should be marked with SLOW markings as well as a large warning stripe prior to the path/alleyway intersection. The path itself should have YIELD signs (MUTCD sign R1-2) for bicyclists and pedestrians to yield to automobiles in the alleyway. The crossing should be marked in a manner that is easily identifiable to motorists, through striping and possibly coloring as well. "XING" markings should also be marked along the alleyway prior to the crossing to provide additional information to the motorist. Since visibility for both path users and motorists will be greatly reduced, mirrors should be located to allow motorists to see down the path and bicyclists and pedestrians to see the alleyway. A concern is that some bicyclists may travel at excessive speeds and not cross the alleyway in a safe manner. If the markings and signage are not sufficient in encouraging safe behavior, there are several options, that could be used such as a speed table or speed bumps to the path. Speed bumps would be difficult for some users to navigate, particularly younger children and in-line skaters. Fencing could be installed prior to the crossings, requiring bicyclists to either dismount or greatly reduce speed before crossing. This type of option makes it very difficult for bicyclists with trailers, pedestrians with strollers, or other users with mobility devices to use the path.

Innovative Accessways

There are also other innovative ways to provide direct access, particularly in topographically constrained areas (i.e., on steep hills, over waterways, etc.) Stairs, alleyways, bridges, and elevators can provide quick and direct connections throughout the city and can be designed so they are safe, inviting, and accessible to most trail users. For example, stairways can have wheel gutters so that bicyclists can easily roll their bicycles up and down the incline and boardwalks can provide access through sensitive wet areas and across small waterways (see Figure 21).

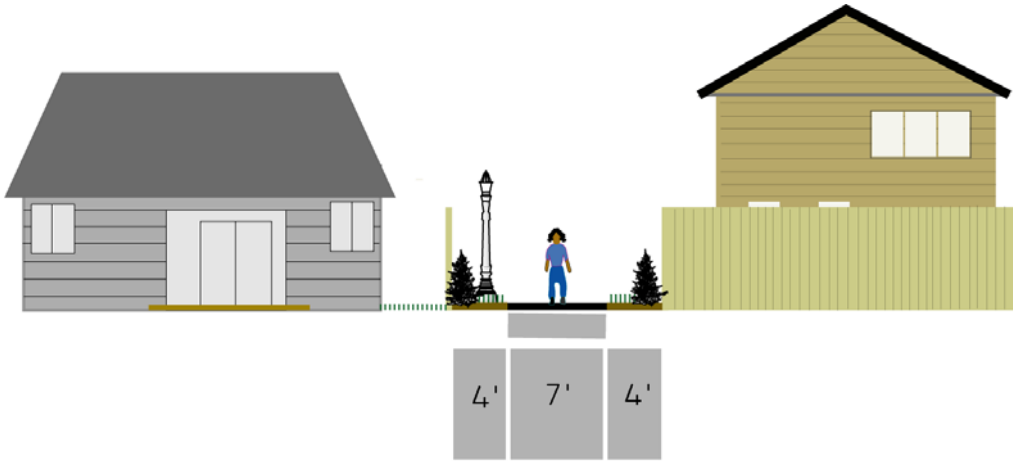


Figure 19. Bicycle and Pedestrian Accessway

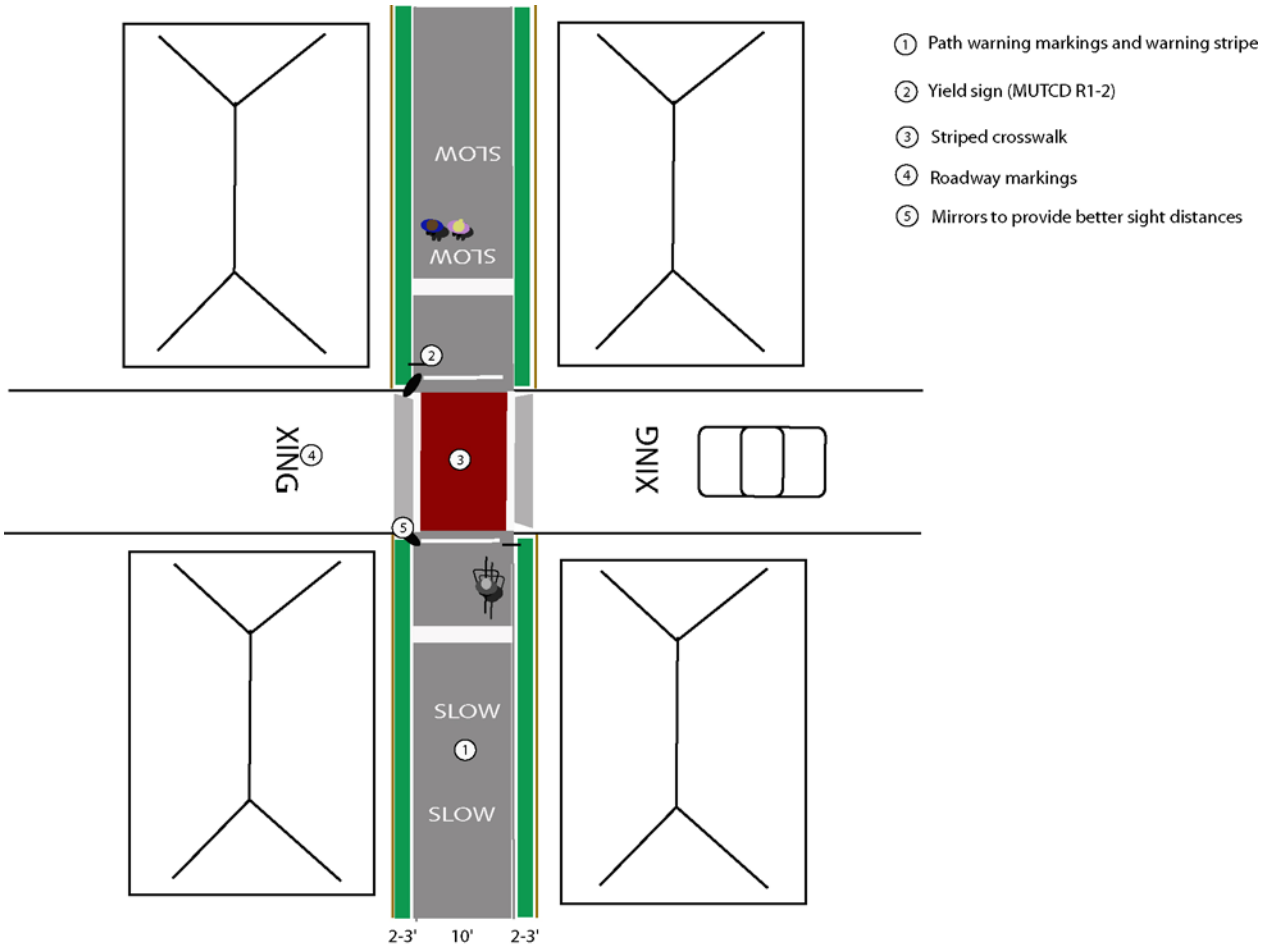
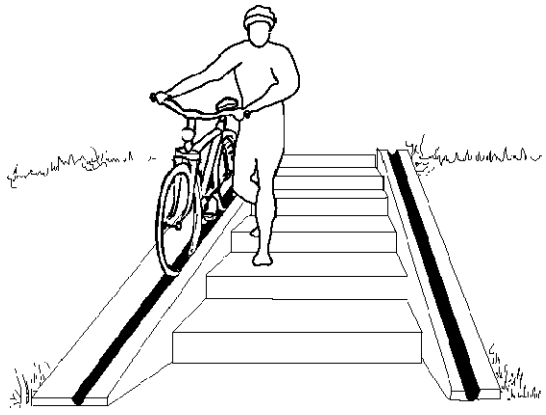


Figure 20. Alley Intersection



Bicycle wheel gutters on stairs

Boardwalk bridge

Figure 21. Innovative Accessways

Innovative Roadside Treatments

Filter strips and bio-swales are innovative ways to retain and treat stormwater from impervious surfaces and work well with roadside trails. The design guidelines for filter strips and swales are similar; both methods use grassy vegetation or aggregate to remove sediment from stormwater runoff. Use of filter strips and swales can be limited in retrofit situations due to slope, soil, right-of-way conditions, and existing underground utility locations.

Filter Strips

Filter strips (Figure 22 and Figure 23) are gently sloped grassy and aggregate areas that are used to treat small quantities of sheet flow runoff. They are often used to pretreat stormwater flow of minimal depth (.5 inches) as it passes from an impervious area, like a parking lot or roadway, into a swale or infiltration area. Sidewalk width illustrated is a minimum.

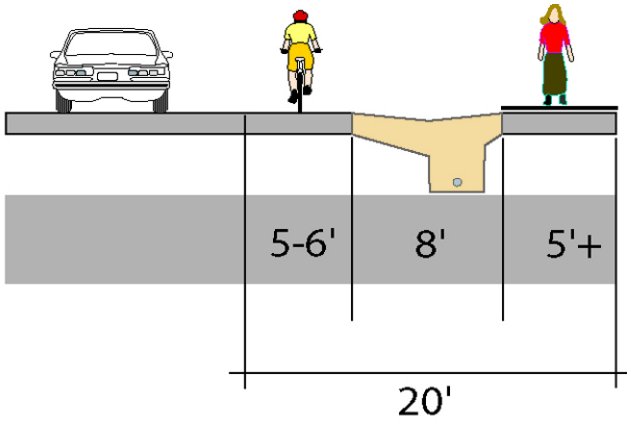


Figure 22. Aggregate Filter Strip

Swales

Swales (Figure 24 on page 131) are shallow, wide depressions adjacent to roadways and trails that collect stormwater runoff over vegetation to slowly settle sediments and particulate matter. The pollutants are filtered out, settled, or removed by plants, causing fewer pollutants to enter ecologically sensitive water bodies. For more information and further design guidelines for swales and other Green Street concepts, consult Metro's "Green Streets" guidebook.

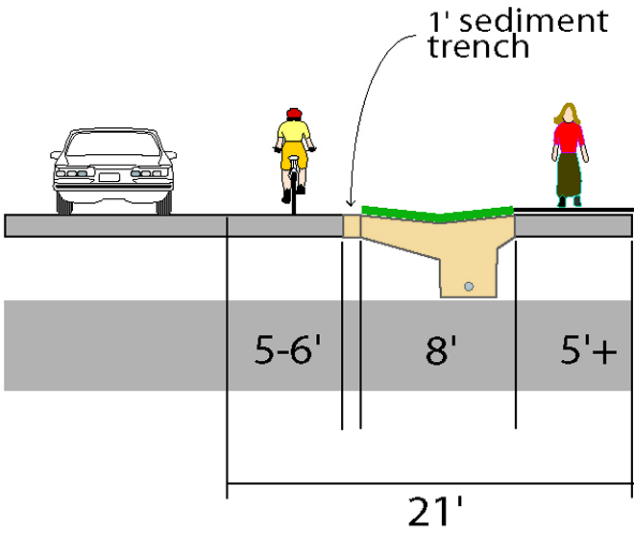


Figure 23. Grass Filter Strip

Bio-swale

Bio-Swale Guidelines *from Metro's "Green Streets"*	
Optimal length	200-250 ft
Slope of sides (optimal)	1-2%
Slope of sides (minimum, maximum)	1%, 6%
Optimal water depth	3 in
Optimal width	12 ft

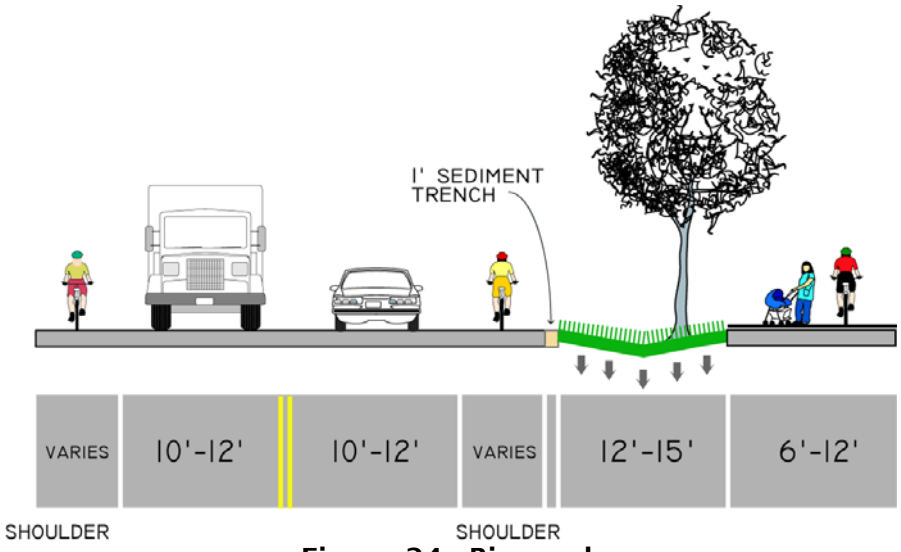


Figure 24. Bio-swale

Signing and Striping

On-Road Facilities

This section applies to those segments identified as community walkways and bikeways that exist as part of the roadway network. This includes bike lanes, bike routes, and sidewalks. Locations that have been identified as bicycle lanes will be striped and maintained by the city of Wilsonville. The bicycle lane striping should follow guidelines presented in this plan and supported by standards from the AASHTO Guide to Bicycle Facilities, the Oregon Bicycle and Pedestrian Plan, and the Manual on Uniform Traffic Control Devices (MUTCD).

Bike lanes and bike routes should also have additional on-road symbols where appropriate as established in the standards mentioned earlier. Signage is also an important part of the bicycle and pedestrian network. Figure 25 shows a number of different signs and markings, both on poles and on the roadway, that the City of Portland has adopted for their new bicycle signage program. The signs have been approved by ODOT, and are being installed around Portland. Signs such as these improve the clarity of travel while illustrating that destinations are really only a short ride away.

Wilsonville should also review the existing signage to ensure it is serving the intended purpose and that the signs are highly visible to bicyclists and pedestrians.

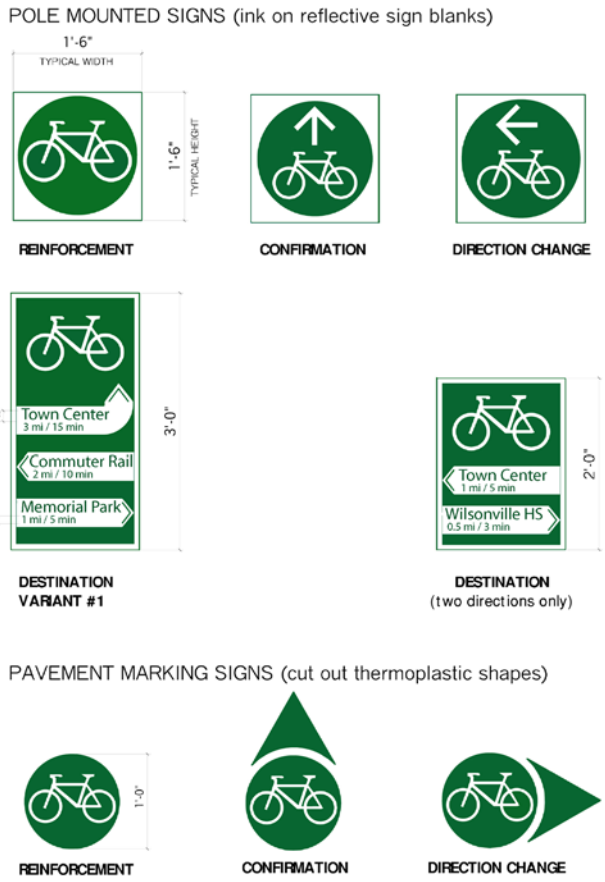


Figure 25. On-Road Facilities Signage

Separated Facilities

This section applies to those segments of community walkways and bikeways, local trails, and regional trails that are separated facilities from the current roadway system. Crossing features for all roadways include warning signs both for vehicles and trail users. The type, location, and other criteria are identified in the Manual for Uniform Traffic Control Devices (MUTCD). Adequate warning distance is based on vehicle speeds and line of sight. Signage should be highly visible; catching the attention of motorists accustomed to roadway signs may require additional alerting devices such as a flashing light, roadway striping or changes in pavement texture. Signing for trail users must include a standard stop sign and pavement marking, sometimes combined with other features such as bollards or a kink in the trail to slow bicyclists. Care must be taken not to place too many signs at crossings lest they overwhelm the user and lose their impact.

Directional signing may be useful for trail users and motorists alike. For motorists, a sign reading "Bicycle Trail Xing" along with a Wilsonville trail emblem or logo helps both warn and promote use of the trail itself. For trail users, directional signs and street names at crossings help direct people to their destinations.

The directional signing should impart a unique theme so trail users know which trail they are following and where it goes. The theme can be conveyed in a variety of ways: engraved stone, medallions, bollards, and mile markers. A central information installation at trailheads and major crossroads also helps users find their way and acknowledge the rules of the trail. (Figure 26) They are also useful for interpretive education about plant and animal life, ecosystems, and local history. Information regarding the various slopes of trails can also be incorporated into the trailhead to ensure that users do not get into trouble on a path that is beyond their capabilities.

A number of striping patterns have emerged over the years to delineate trail crossings. A median stripe on the trail approach will help to organize and warn trail users. The actual crosswalk striping is a matter of local and State preference, and may be accompanied by pavement treatments to help warn and slow motorists. The effectiveness of crosswalk striping is highly related to local customs and regulations. In communities where motorists do not typically yield to pedestrians in crosswalks, additional measures may be required.

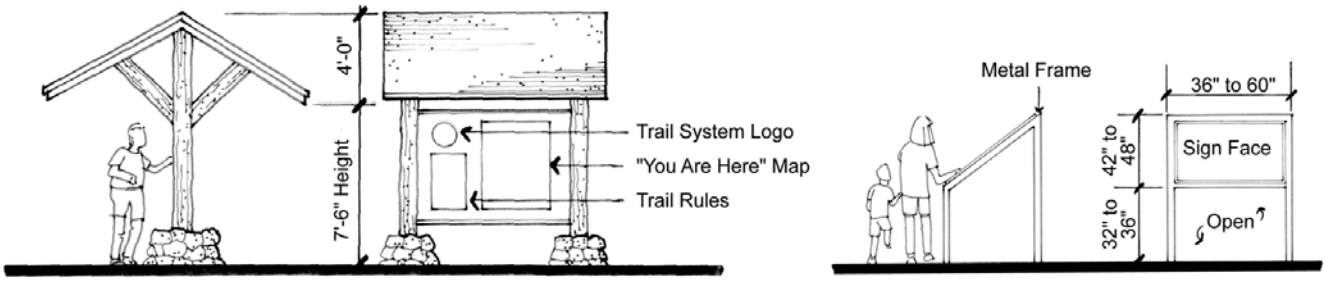


Figure 26. Trailhead Information Installation Examples

Wooden bollard with directional information

Inlaid medallions

Stone mileage marker

Amenities

There are a number of amenities that make a bicycle and pedestrian system inviting to the user. Below are some common amenities that make systems stand out.

Interpretive Installations

Interpretive installations and signs can enhance the users experience by providing information about the history of Wilsonville. Installations can also discuss local ecology, environmental concerns, and other educational information.

Water Fountains and Bicycle Parking

Water fountains provide water for people (and pets, in some cases) and bicycle racks allow recreational users to safely park their bikes if they wish to stop along the way, particularly at parks and other desirable destinations.

Pedestrian-Scale Lighting and Furniture

Pedestrian-scale lighting improves safety and enables the facility to be used year-round. It also enhances the aesthetic of the trail. Lighting fixtures should be consistent with other light fixtures in the city, possibly emulating a historic theme. Lighting fixtures should be designed to reduce or eliminate light pollution onto neighboring properties.

Providing benches at key rest areas and other appropriate locations, as well as viewpoints encourages people of all ages to use the trail by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

Maps and Signage

A comprehensive signing system makes a bicycle and pedestrian system stand out. Informational kiosks with maps at trailheads and other pedestrian generators can provide enough information for someone to use the network with little introduction - perfect for areas with high out-of-area visitation rates as well as the local citizens.

Art Installations

Local artists can be commissioned to provide art for the trail system, making it uniquely distinct. Many trail art installations are functional as well as aesthetic, as they may provide places to sit and play on.

Safety On and Around the Trail

Creating a safe trail environment goes beyond design and law enforcement and should involve the entire community. The most effective and most visible deterrent to illegal activity on trails in Wilsonville will be the presence of legitimate trail users. Getting as many "eyes on the corridor" as possible is a key deterrent to undesirable activity. There are several components to accomplishing this as outlined below:

Provide Good Access to Trails

Access ranges from providing conveniently located trailheads along the trail, to encouraging the construction of sidewalks to accommodate access from private developments adjacent to the trail. Access points should be inviting and signed so as to welcome the public onto the trail.

Good Visibility from Adjacent Neighbors

Neighbors adjacent to the trail can potentially provide 24-hour surveillance of the trail and can become Wilsonville's biggest ally. Though some screening and setback of the trail is needed for privacy of adjacent neighbors, blocking the trail completely from neighborhood view should be discouraged. This eliminates the potential of neighbor's "eyes on the trail," and could result in a "tunnel effect" on the trail.

High Level of Maintenance

A well-maintained trail sends a message that the community cares about the public space. This message alone will discourage undesirable activity along the trail.

Programmed Events

Community events along the trails will help increase public awareness and thereby attract more people to use the trail. Neighbors and residents, as well as a newly created Friends of Wilsonville Trails group, can help organize numerous public events along the trail which will increase support for the trail. Events might include a day-long trail clean-up or a series of short interpretive walks led by long-time residents or a park naturalist. Friends of the Trails can also generate public support for future funding applications.

Community Projects

The support generated by community groups could be further capitalized by involving neighbors and friends of the trail in a community project. Ideas for community projects include volunteer planting events, art projects, interpretive research projects, or even bridge building events. These community projects are the strongest means of creating a sense of ownership along the trail that is perhaps the strongest single deterrent to undesirable activity along the trail.

Adopt-a-Trail Program

Nearby businesses, community institutions, and residential neighbors often see the benefit of their involvement in the trail development and maintenance. Businesses and developers may view the trail as an integral piece of their site planning and be willing to take on some level of responsibility for the trail. Creation of an adopt-a-trail program should be explored to capitalize on this opportunity and build civic pride.

Trail Watch Program

Partnering with local and county law enforcement, a trail watch program would provide an opportunity for local residents to become actively involved in crime prevention along the trails in Wilsonville. Similar to Neighborhood Watch programs, residents are brought together to get to know their neighbors, and are educated on how to recognize and report suspicious activity.

Table 15 on page 136 summarizes some of the key safety issues and recommended strategies for addressing the concerns of Wilsonville residents.

Property Owner Safety and Security

Successful trails provide pleasant, safe environments for trail users while creating a wonderful amenity for adjacent property owners. While property owners often express concern over safety and security issues when a trail is proposed, experience in the Portland Metro region has shown that a well-designed trail enhances property values and safety, and coupled with implementation of the safety recommendations in Table 15, creates a positive situation for the city, trail users, and the adjacent property owners. It is important to involve property owners in trail planning and design, ensure their concerns are heard and addressed, and involve them in an on-going monitoring of trail activities and maintenance.

Table 15. Safety Recommendations

Safety Issue	Recommended Improvements
Privacy of adjacent property owners This was one of the biggest concerns expressed by residents to the City of Wilsonville. Concern is that the trail will bring people into areas that have for decades been quasi-private. Trail users will be able to peer into people's backyards and homes.	1. Encourage the use of neighborhood friendly fencing and also planting of landscape buffers. 2. Clearly mark trail access points. 3. Post trail rules that encourage respect for private property. 4. Strategically place lighting. 5. Consider strategic placement of surveillance cameras to protect property owners' privacy and discourage trespassing.
Litter and Dumping	1. Post trail rules encouraging pack it in pack it out etiquette. 2. Place garbage receptacles at trailheads. 3. Provide good visual access to the trail. 4. Strategically-placed lighting, utilizing light shields to minimize unwanted light in adjacent homes. 5. Manage vegetation within the right-of-way to allow good visual surveillance of the trail from adjacent properties and from roadway/ trail intersections. 6. Encourage local residents to report incidents as soon as they occur. 7. Remove dumpsites as soon as possible. 8. Encourage use of yard debris recycling service.
Trespassing Trespassing through people's backyards and onto boat docks was a concern expressed by some members of the public.	1. Clearly distinguish public trail right-of-way from private property through the use of vegetative buffers and the use of good neighbor type fencing. 2. Post trail rules that encourage respect for private property.
Crime Undesirable transient activity should be handled following these recommendations as well.	1. Manage vegetation so that corridor can be visually surveyed from adjacent streets and residences. 2. Select shrubs that grow below three feet in height and trees that branch out greater than six feet in height. 3. Place lights strategically and as necessary. 4. Place benches and other trail amenities at locations with good visual surveillance and high activity. 5. Provide mileage markers at quarter-mile increments and clear directional signage for orientation. 6. Create a "Trail Watch Program" involving local residents. 7. Proactive law enforcement. Use trail corridors for bicycle patrol training.
Intersection Safety Roadway and trail crossings present a potential safety concern between trail users and cars. See Roadway Crossings on page 137 for more information.	1. Require all trail users to stop at public roadway intersections through posting of stop signs. 2. Provide cross walk striping and trail crossing warning signs for vehicle drivers. Put Wilsonville Trail logo on warning signs. 3. Manage vegetation at intersections to allow visual access at crossings.
Local On-Street Parking	1. Post local residential streets as parking for local residents only to discourage trail user parking. Place "no outlet" and "no parking" signs prior to trail access points.
Trailhead Safety	1. Clearly identify trailhead access areas. 2. Provide sufficient lighting and visibility around trailhead. 3. Provide a Public Safety telephone to provide access to communication.
Vandalism	1. Select benches, bollards, signage and other site amenities that are durable, low maintenance and vandal resistant. 2. Respond through removal or replacement in rapid manner. 3. Keep a photo record of all vandalism and turn over to local law enforcement. 4. Encourage local residents to report vandalism. 5. Create a trail watch program; maintain good surveillance of the corridor. 6. Involve neighbors in trail projects to build a sense of ownership. 7. Place amenities (benches, etc.) in well used and highly visible areas.

Roadway Crossings

The most basic crossing type is an unmarked, unsignalized crossing, at which a bicyclist or pedestrian waits for a gap in traffic to cross. The lack of markings or signals at most crossings can be very intimidating for bicyclists and pedestrians, and may be challenging enough to discourage people from choosing those modes of transport. However, in most cases, roadway crossings can be properly designed at-grade to a reasonable degree of safety and meet existing traffic and safety standards.

Grade separated crossings are recommended in certain situations, which are discussed further in the study when examining I-5 and potential crossing opportunities. The conversion of existing at-grade crossings to grade-separated crossings is a difficult and expensive undertaking and should be considered where other traffic control measures have failed, where the natural topography lends itself to a grade-separated crossing, or where persistent safety issues exist.

Roadway crossings should comply with the Association of American State Highway and Transportation Officials (AASHTO) Guide for the Development of Bikeway Facilities and "A Policy on the Geometric Design of Highways and Streets" (Green Book), Oregon Department of Transportation (ODOT), and Manual of Uniform Traffic Control Devices (MUTCD) standards.

Evaluation of roadway crossings involves analysis of vehicular and trail user traffic patterns, including speeds, street width, traffic volumes (average daily traffic, peak hour traffic), line of sight, and trail user profile (age distribution, destinations). This study identifies the most appropriate crossing options given available information, which must be verified and/or refined through the actual engineering and construction document stage.

Crossing Prototypes

This study is based on established standards,[6] published technical reports,[7] and the experiences from cities around the country.[8] The Wilsonville crossings will fit into one of five basic categories:

- Type 1: Marked/Unsignalized
- Type 1+: Marked/Enhanced
- Type 2: Route Users to Existing Intersection
- Type 3: Signalized/Controlled
- Type 4: Grade-separated crossings

Type 1: Marked/Unsignalized Crossings

A Marked/Unsignalized crossing (Type 1) consists of a crosswalk, signing, and often no other devices to slow or stop traffic. The approach to designing crossings at midblock locations depends on an evaluation of vehicular traffic, line of sight, trail traffic, use patterns, vehicle speed, road type and width, and other safety issues such as the proximity of schools. The following thresholds recommend where Unsignalized crossings may be acceptable:

- Maximum traffic volumes:
  9,000-15,000 Average Daily Traffic (ADT)
  up to 15,000 ADT on two-lane roads, preferably with a median.
  up to 12,000 ADT on four-lane roads with median.
- Maximum travel speed:

35 mi/h

- Minimum line of sight:

25 mi/h zone: 155 feet
35 mi/h zone: 250 feet
45 mi/h zone: 360 feet

This includes the majority of streets and crossings in Wilsonville with their current traffic volumes. For example, Rogue Lane and Memorial Drive, or Boones Ferry Road and 5th Street.

Marked mid-block crossings should be installed under special circumstances.

6. MUTCD, AASHTO Guide for the Development of Bicycle Facilities, Oregon Pedestrian and Bicycle Guide.
7. Federal Highway Administration (FHWA) Report, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations."
8. In particular, the recommendations in this report are based in part on experiences in cities like Portland (OR), Seattle (WA), Tucson (AZ), and Sacramento (CA), among others.

If well designed, crossings of multi-lane higher volume arterials over 15,000 ADT may be unsignalized with features combining some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges, advance stop bars with appropriate signage, and/or active warning devices like flashing beacons or in-pavement flashers. These are referred to as Type 1 Enhanced (Type 1+).

Type I crossing

On roadways with low to moderate volumes of traffic (< 10,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety. This type of roadway feature is currently not allowed within Wilsonville. It is recommended that the possibility of allowing raised crosswalks be explored further. This might be appropriate at the crossing of Lancelot Lane and Camelot Lane, where the trail for the park at Merryfield begins.

Raised crosswalk

The crosswalks are raised 75 mm above the roadway pavement, similar to speed humps, to an elevation that matches the adjacent sidewalk. The top of the crosswalk is flat and typically made of asphalt, patterned concrete, or brick pavers. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles, and ADA requirements for a continuous, smooth, vibration-free surface. Tactile treatments are recommended at the sidewalk/street boundary so that visually impaired pedestrians can identify the edge of the street. Costs can range from $5,000 to $20,000 per crosswalk, depending on the width of the street, the drainage improvements affected, and the materials used for construction.

A flashing yellow beacon – such as on Wilsonville Road at Landover – may be used, preferably one that is activated by the bicyclist or pedestrian, rather than operating continuously. This equipment, while slightly more expensive, will help keep motorists alert. The costs will range between $5000 and $15,000 depending on the need for poles with arms and overhead mounted signals.

Type 2: Route Users to Existing Intersection

Crossings within 250 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes. For this option to be effective, barriers and signing may be needed to direct trail users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with the ADA. In many cases, such as on most community trails parallel to roadways, crossings are simply part of the existing intersection and are not a significant problem for trail users.

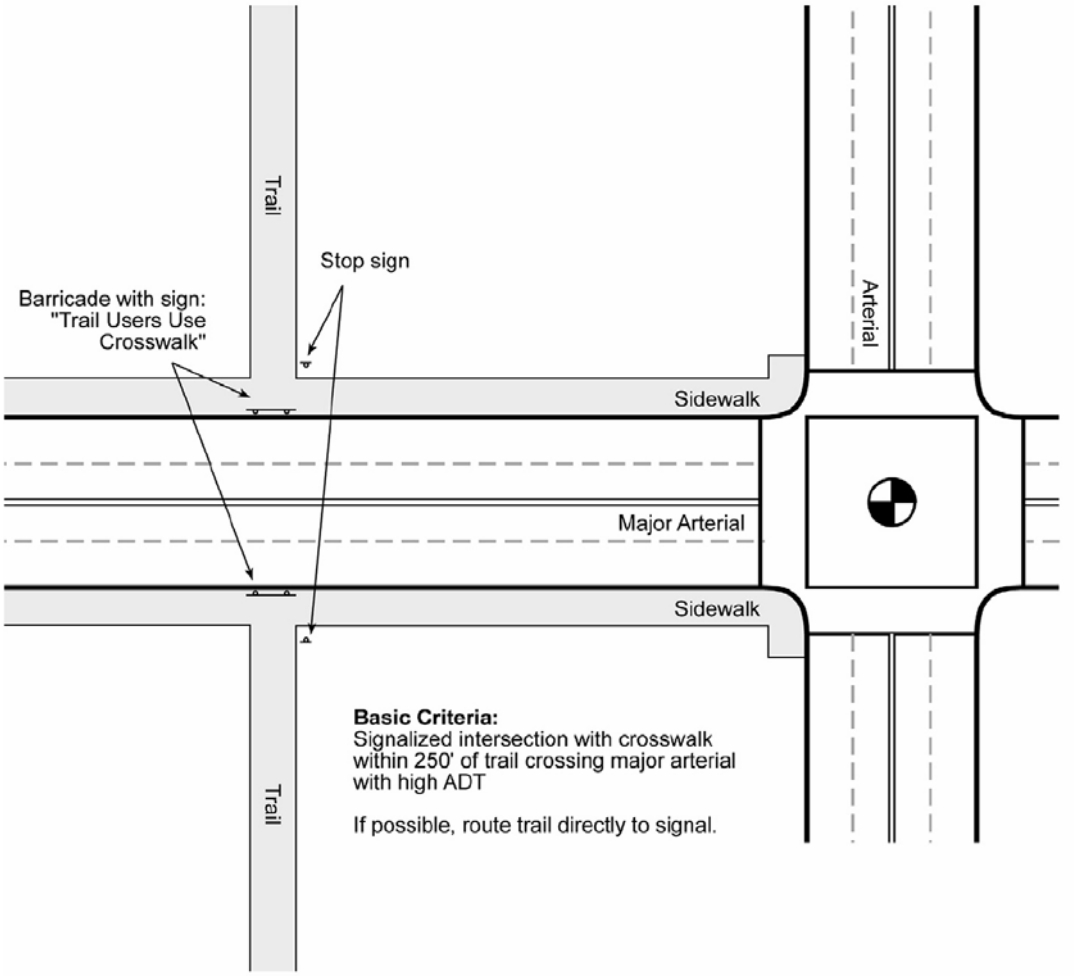


Figure 27. Type 2 Roadway Crossing Treatment

Type 3: Signalized/Controlled Crossings

Type 3 crossing

New signalized crossings may be recommended for crossings that meet pedestrian, school, or modified warrants, are located more than 250 feet from an existing signalized intersection and where 85th percentile travel speeds are 40 mi/h and above and/or ADT exceeds 15,000 vehicles. Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity, and safety.

Signals are normally activated by push buttons, but also may be triggered by motion detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street. The signals may rest on flashing yellow or green for motorists when not activated, and should be supplemented by standard advanced warning signs. Typical costs for a signalized crossing range from $150,000 to $250,000. However, there are additional signal choices, such as "half-signals," that are discussed later in the study.

A good example of this type of signal is the pedestrian-activated crossing signal at the entrance to Wood Middle School. Along with the standard crossing signal,

the crossing also has lighted pedestrian crossing signs as well as in-pavement flashers.

Type 4: Grade-Separated Crossings

Type 4 Grade-Separated Undercrossing

Grade-separated crossings may be needed where ADT exceeds 25,000 vehicles, and 85th percentile speeds exceed 45 mi/h. Safety is a major concern with both overcrossings and undercrossings. In both cases, trail users may be temporarily out of sight from public view and may have poor visibility themselves. Undercrossings, like parking garages, have the reputation of being places where crimes occur. Most crime on trails, however, appears to have more in common with the general crime rate of the community and the overall usage of the trail than any specific design feature.

Type 4 Grade-Separated Overcrossing

Design and operation measures are available which can address user concerns. For example, an undercrossing can be designed to be spacious, well lit, equipped with emergency cell phones at each end and completely visible for its entire length prior to entering.

Other potential problems with undercrossings include conflicts with utilities, drainage, flood control, and maintenance requirements. Overcrossings pose potential concerns about visual impact and functional appeal.

Signals and Signal Warrants

Full Signalized Crossings

The federal government has provided guidance to determine where traffic control signals should be considered for installation. The Pedestrian Volume signal warrant from the Manual on Uniform Traffic Control Devices (MUTCD) is intended for the application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. For signal warrant analysis, a location with a wide median, even if the median width is greater than nine meters (30 feet), should be considered as one intersection.

Warrant 4, Pedestrian Volume

Support:

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that both of the following criteria are met:

A.The pedestrian volume crossing the major street at an intersection or midblock location during an average day is 100 or more for each of any 4 hours or 190 or more during any 1 hour;

B.There are fewer than 60 gaps per hour in the traffic stream of adequate length to allow pedestrians to cross during the same period when the pedestrian volume criterion is satisfied. Where there is a divided street having a median of sufficient width for pedestrians to wait, the requirement applies separately to each direction of vehicular travel.

At non-intersection crossings, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (100 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings if a traffic control signal is justified by both this signal warrant and a traffic engineering study.

The criterion for the pedestrian volume crossing the major roadway may be reduced as much as 50 percent if the average crossing speed of pedestrians is less than 1.2 m/sec (4 ft/sec).

Warrants for the application of Traffic Control Devices (TCD) are a series of guidelines - not absolute values - that should be used in evaluating a situation. The satisfaction of a warrant is not proof that a TCD is needed, and failure to fully satisfy any specific warrant does not guarantee that the device could not serve a useful purpose. The application of warrants is effective only when combined with sound engineering judgment.

Warrant 5, School Crossing, is a second signal warrant that has applications in Wilsonville. Many of the community connectors in the Wilsonville system serve to connect the local schools, with several of these routes serving as the primary commuting routes for children. Furthermore, cities like Sacramento have modified their usage projections by upwardly accounting for youth, disabled, and elderly populations through the Equivalent Adult Units factors (see the chart at right) at intersections that are deemed to present special circumstances:

- 40 pedestrians cross during a one-hour period or 25 cross per hour for four consecutive hours using the Equivalent Adult Units system.[9]
- Fewer than five gaps in traffic during the peak five minute period.[10]

Equivalent Adult Units

Type	Factor
Child	2
Senior	1.5
Disabled	2

9. Use of a system of Equivalent Adult Units is recommended in order to recognize intersections that require special attention due to the presence of seniors or children, even if they don't meet the volume requirement. These two groups are disproportionately represented in collision and fatality statistics.
10. Average number of gaps per five-minute period = total usable gap time in seconds divided by pedestrian crossing rate at four feet per second, multiplied by 12.

Warrant 5, School Crossing

Support:

The School Crossing signal warrant is intended for the application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal.

Standard:

The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the children are using the crossing is less than the number of minutes in the same period (see Section 7A.03[6]) and there are a minimum of 20 students during the highest crossing hour.

Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.

The School Crossing signal shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 90 m (300 ft), unless the proposed traffic control signal will not restrict the progressive movement of traffic.

Guidance:

If this warrant is met and a traffic control signal is justified by an engineering study, then:

A.If at an intersection, the traffic control signal should be traffic-actuated and should include pedestrian detectors.

B.If at a nonintersection crossing, the traffic control signal should be pedestrian-actuated, parking and other sight obstructions should be prohibited for at least 30 m (110 ft) in advance of and at least 6.1 m (20 ft) beyond the crosswalk, and the installation should include suitable standard signs and pavement markings.

C.Furthermore, if installed within a signal system, the traffic control signal should be coordinated.

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6. "Alternate gaps and blockades are inherent in the traffic stream and are different at each crossing location. For safety, students need to wait for a gap in traffic that is of sufficient duration to permit reasonably safe crossing. When the delay between the occurrence of adequate gaps becomes excessive, students might become impatient and endanger themselves by attempting to cross the street during an inadequate gap."

Half Signalized Crossings

In situations where there are few "crossable" gaps and where vehicles do not stop for pedestrians waiting to cross (or because of multiple lanes, it is unsafe to cross in front of a stopped vehicle), there are a number of innovative pedestrian traffic signals that do not operate as full signals that might be installed. Many of these models have been used successfully for years overseas, and their use in the United States has increased dramatically over the last decade.

Pelican

A Pelican (**Pe**destrian **Li**ght **C**ontrol **A**ctivated crossi**n**g) signal incorporates a standard red-yellow-green signal light that rests in green for vehicular traffic until a pedestrian wishes to cross and presses the button. The signal then changes to yellow, then red, while Walk is shown to the pedestrian. The signal can be installed as either a one-stage or two-stage signal, depending on the characteristics of the street. In a two-stage crossing, the pedestrian crosses first to a median island and is then channelized along the median to a second signalized crossing point. At that point, the pedestrian then activates a second crossing button and another crossing signal changes to red for the traffic while the pedestrian is given a Walk signal. The two crossings only delay the pedestrian minimally and allow the signal operation to fit into the arterial synchronization, thus reducing the potential for stops, delays, accidents, and air quality environmental issues. A Pelican crossing is quite effective in providing a pedestrian crossing at midblock locations when the technique can be accommodated into the roadway design.

Pelican signal in Tucson, AZ

Puffin signal

Puffin

A Puffin (**P**edestrian **U**ser **F**riendly **In**telligent) crossing signal is an updated version of a Pelican crossing. The signal consists of traffic and pedestrian signals with push-button signals and infrared or pressure mat detectors. After a pedestrian pushes the button, a detector verifies the presence of the pedestrian at the curbside. This helps eliminate false signal calls associated with people who push the button and then decide not to cross. When the pedestrian is given the Walk signal, a separate motion detector extends the Walk interval (if needed) to ensure that slower pedestrians have time to cross safely. Conversely, the signal can also detect when the intersection is clear of pedestrians and return the green signal to vehicles, reducing vehicle delay at the light. Puffin signals are designed to be crossed in a single movement by the pedestrian, unlike the Pelican signal, which can be designed to cross in either one or two stages.

Hawk

A Hawk (**H**igh-Intensity **A**ctivated Cross**w**al**k**) signal is a combination of a beacon flasher and traffic control signaling technique for marked crossings. The beacon signal consists of a traffic signal head with a red-yellow-red lens. The unit is normally off until activated by a pedestrian. When pedestrians wish to cross the street, they press a button and the signal begins with a flashing yellow indication to warn approaching drivers. The flashing yellow is then followed by a solid yellow, advising the drivers to prepare to stop. The signal is then changed to a solid red, at which time the pedestrian is shown a Walk indicator. The beacon signal then converts to an alternating flashing red, allowing the drivers to proceed after stopping at the crosswalk, while the pedestrian is shown the flashing don't walk signal.

Hawk signal

Pedestrian Control Features

Countdown Signals

Pedestrian countdown signal

According to the MUTCD, "Pedestrian Signal Heads provide special types of traffic signal indications exclusively intended for controlling pedestrian traffic. These signal indications consist of the illuminated symbols of a WALKING PERSON (symbolizing WALK) and an UPRAISED HAND (symbolizing DONT WALK)." An advanced type of pedestrian signal head being installed in Wilsonville contains a countdown signal, in addition to the WALK/DON'T WALK symbol. The countdown signal displays the number of seconds remaining for the individual to complete their crossing.

Leading Pedestrian Interval (LPI)

Including LPI at signalized crossings provides pedestrians with a three- to four-second head start into the intersection before parallel traffic is released by the green light. LPI's ensure that pedestrians are well into the intersection and visible to turning vehicles prior to vehicles entering the crosswalk.

Summary of At-Grade Recommendations

In summary, Table 16 provides guidance on how to implement at-grade roadway crossings in Wilsonville.

Table 16. Summary of Trail-Roadway Intersection Recommendations[11]

Roadway Type (Number of Travel Lanes and Median Type)	Vehicle ADT ≤ 9,000			Vehicle ADT > 9,000 to 12,000			Vehicle ADT > 12,000 to 15,000			Vehicle ADT > 15,000		
	Speed Limit**											
	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h	≤ 30 mi/h	35 mi/h	40 mi/h
2 Lanes	1	1	1/1+	1	1	1/1+	1	1	1+/3	1	1/1+	1+/3
3 Lanes	1	1	1/1+	1	1/1+	1/1+	1/1+	1/1+	1+/3	1/1+	1+/3	1+/3
Multi-Lane (4 or more lanes) with raised median***	1	1	1/1+	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3
Multi-Lane (4 or more lanes) without raised median	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3

*General Notes: Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone will not make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. These are general recomendations; good engineering judgment should be used in individual cases for deciding which treatment to use.

For each trail-roadway crossing, an engineering study is needed to determine the proper location. For each engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites.

**Where the speed limit exceeds 40 mi/h (64.4 km/h), marked crosswalks alone should not be used at unsignalized locations.

***The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and AASHTO guidelines. A two-way center turn lane is not considered a median.

1= Type 1 Crossings. Ladder-style crosswalks with appropriate signage should be used.

1/1+ = With the higher volumes and speeds, enhanced treatments should be used, including marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

1+/3 = Carefully analyze signal warrants using a combination of Warrant 2 or 5 (depending on school presence) and EAU factoring. Make sure to project usage based on future potential demand. Consider Pelican, Puffin, or Hawk signals in lieu of full signals. For those intersections not meeting warrants or where engineering judgment or cost recommends against signalization, implement Type 1 enhanced crosswalk markings with marked ladder style crosswalks, median refuge, flashing beacons, and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

11. This table is based on information contained in the U.S. Department of Transportation Federal Highway Administration Study, " Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations," February 2002.