Shared Use Path – Roadway Intersections

Guidelines for Assigning Priority and Determining Traffic Control at Shared Use Path/Roadway Intersections

Pinellas County, FL

August 2014
Report

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Introduction

In Pinellas County and across the country, there is an increasing concern that the priority assigned to trail and roadway traffic at intersections and corresponding controls are not being implemented consistently or with due consideration of the intersection traffic conditions. This lack of a consistent methodology results in pathway and roadway users behaving unpredictably at intersections. This, in turn, can cause conflicts which may lead to crashes.

The *Manual on Uniform Traffic Control Device* (MUTCD*)* does not provide specific guidance on how to sign and stripe pathway/roadway intersections. The AASHTO *Guide for the Development of Bicycle Facilities*[1] states only that intersection striping should be placed as warranted by the MUTCD. Florida DOT design guidance[2] reiterates what is in the MUTCD. This lack of guidance contributes to the inconsistent and, in some cases, inappropriate, application of traffic control devices at these intersections, which, in turn, results in unpredictable and potentially dangerous behaviors on the part of motorists and path users.

The purpose of this project is to provide guidance for identifying specific traffic control packages that can be used at intersections of shared use paths with roadways with given traffic conditions. It primarily addresses midblock crossings of shared use paths with roadways. Each crossing will have its own set of geometric and operation parameters that must be addressed. Thus, this document should not be considered a standard. Engineering judgment is required when implementing these guidelines.

What does midblock mean?

This document refers frequently to midblock crossings. A midblock crossing is an intersection of a shared use path with a roadway that is located separate from a roadway/roadway intersection.

Methodology

This project is not a research project; rather the guidance developed for this project was based upon consensus from transportation professionals who work in Pinellas County. The process for developing the consensus involved the following steps:

1. Workshop with transportation professionals – The workshop was held October 3, 2013. Representatives from Pinellas County and FDOT participated. At this workshop, intersections of paths with roadways of varying volumes, speeds, and lanes were reviewed by the participants. For each intersection, the participants identified traffic control devices they felt would be appropriate given the traffic conditions.
2. Based upon the input received at the workshop, design guidance was developed for the identification traffic control devices to be used at path/roadway intersections. This guidance is in the form of three tables – one for low-volume roadways, one for medium-volume roadways, and one for high-volume roadways. The scenarios discussed at the workshop are highlighted on the tables.
3. The draft guidance was sent to workshop participants for their review and comment.

[1] AASHTO, *Guide for the Development of Bicycle Facilities,* AASHTO, Washington, D.C., 2012.
[2] FDOT, *Traffic Engineering Manual*, FDOT, Tallahassee, FL, 2013.

4. Met with stakeholders to review recommendations. At this meeting identify locations for field testing recommendations.
5. A field review was conducted to evaluate field testing locations and recommend changes to the draft technical memorandum describing results and proposed modifications to guidance.
6. Two additional tasks are yet to be completed:
    a. Meet to discuss field testing results and recommendations with stakeholders.
    b. Prepare draft final guidance report and submit.

DRAFT Path/Roadway Traffic Control Guidance

Determination of appropriate traffic control should be considered in three steps:

1. Should a grade separated crossing be provided?
   This decision should be based upon the volume of users on the path, types of users, and the character of the roadway being crossed. This guidance is not intended to address under what conditions a grade separated crossing should be provided.

2. Is a traffic signal warranted?
   If traffic volumes are not high enough to warrant a grade separation, then it should be determined if the roadway and path volumes are high enough to warrant a signal using the MUTCD signal warrants. For the pedestrian and school warrants, bicyclists may be counted as pedestrians. For vehicular warrants, only bicyclists can be considered.

3. What specific measures should be installed?
   The specific traffic control devices that should be installed at particular crossings will vary with the traffic and roadway conditions. The methodology should help determine who should be given priority at intersections and what devices, or combinations thereof, should be installed at the intersection.

The proposed crossing methodology is discussed in the following sections.

Grade Separated Crossings
Grade separated crossings are generally seen as the most desirable way to address conflicts between pathway and roadway users. Those provided along the Pinellas Trail are generally safe, convenient, and comfortable for all users.

In a case where a separate underpass or overpass is being considered, a quantitative method may be needed to justify a grade separated crossing. In 1984, FHWA developed warrants for grade separated crossings. According to these warrants, a grade separated crossing is justified if

- Hourly pedestrian volume >300 in four highest continuous hour periods (speed >40 mph) and inside urban area;

- Vehicle volume >10,000 during same period or ADT >35,000 (speed >40 mph) and inside an urban area; and,
- The crossing site is at least 183 m (600 ft) from nearest alternative safe crossing**.**

This warrant is graphically illustrated in Figure 1. If this warrant is met, a grade separated roadway crossing should be considered to accommodate the pathway users.

Figure 1 FHWA Axler Grade Separation Warrant

Signalized Crossings

The MUTCD provides warrants for the installation of traffic signals.[3] Any of the warrants described in the MUTCD can be used for pathway/roadway intersections. When using the vehicular warrants, however, only bicyclists should be considered as volume on the path. Alternatively, bicyclists can be counted as pedestrians for the application of the Pedestrian Volumes warrant.

The most common signal warrant used for the installation of traffic signals at pathway crossings is Warrant 4, Pedestrian Volumes, shown in Figure 2.

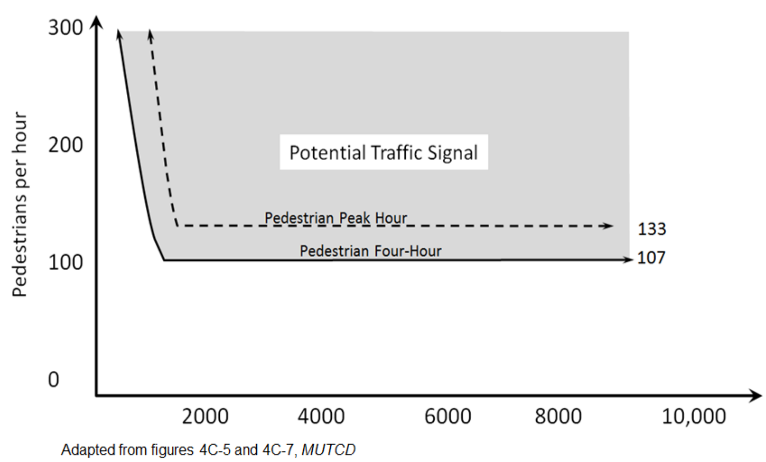

Figure 2 Pedestrian Signal Warrant

The MUTCD goes on to say that the Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 ft, unless the proposed traffic control signal will not restrict the progressive movement of [roadway] traffic.

[3] *Manual oN Uniform Traffic Control Devices*, Chapter 4C, FHWA, 2009.

This warrant requires actual roadway traffic volume and pedestrian (or bicycle) counts for the pathway and motor vehicle counts on the roadway. Additionally, to satisfy the pedestrian warrant the number of adequate gaps in the roadway traffic stream must be counted. Unfortunately, determining the demand for a potential midblock pathway crossing location is not something that can be done by counting the existing number of individuals crossing the roadway. Some method using a surrogate site, or perhaps latent demand, must be employed to estimate the number of users that would cross at a new signalized crossing.

Unsignalized Crossings

When a pathway/roadway intersection does not meet the warrants for a signal, unsignalized treatments should be considered. The following sections address three aspects concerning designating and designing unsignalized midblock path roadway crossings. First, we discuss geometric constraints which may make realigning the trail intersection to a near intersection a more appropriate crossing treatment than a designated midblock crossing. The next section discusses how to assign priority at a midblock path/roadway intersection. Then we provide guidance on the selection of traffic control devices for path/roadway intersections.

Roadway Geometric Constraints

Roadway geometrics are an important factor because they dictate if the midblock pathway crossing can be designed safely. Two primary factors need to be considered: sight distance and proximity to intersections.

The sight distances available to motorists and path users must be adequate to allow for a safe crossing. Sight distance provided for motorists should be at least equal to the stopping sight distance for the design speed of the roadway. For these values refer to *A Policy on the Geometric Design of Streets and Highways*.[4] While motorists are required to yield the right of way to pedestrians, pedestrians are more comfortable crossing the street when they have adequate sight distance for them to see far enough up the approach roadway to identify an adequate gap in traffic. Required gap lengths for path users to complete street crossings are discussed below. Vehicles should be assumed as traveling at the roadway's design speed.

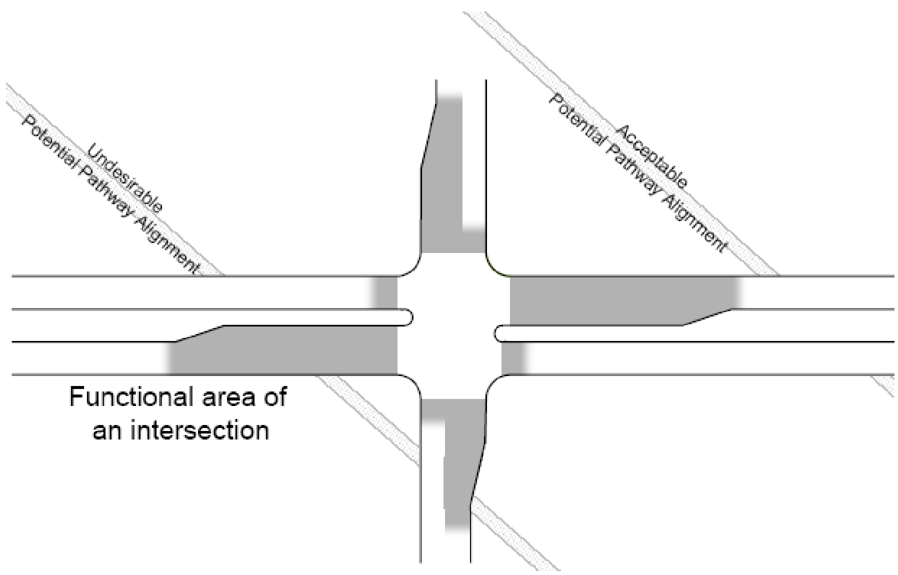

Figure 3 Functional Area of an Intersection

[4] AASHTO, *A Policy on the Geometric Design of Streets and Highways*, AASHTO, Washington, D.C., 2005.

The proximity to intersections is an important consideration because of the complexity of motor vehicle movements on the approach to intersections. Essentially, if it can be avoided, midblock pathway crossings should not be placed within the functional area of an intersection. The functional area of an intersection includes both the approaches to and departures from the intersection and the longitudinal limits of the auxiliary lanes (see Figure 3).[5] If a crossing within the functional area of an intersection is unavoidable, it is recommended that the crossing be moved to the intersection.

Assigning Priority at Unsignalized Pathway Crossings

If a midblock crossing is to be designated, the first step is to determine which facility, the path or the roadway, should receive priority at the crossing. Assigning priority to the "wrong" facility will result in unpredictable and often inappropriate path user and motorist behaviors. For unsignalized crossings, the MUTCD provides guidance for assigning priority at path roadway intersections. It states,

> *When placement of STOP or YIELD signs is considered, priority at a shared-use path/roadway intersection should be assigned with consideration of the following:*
>
> *A. Relative speeds of shared-use path and roadway users;*
> *B. Relative volumes of shared-use path and roadway traffic; and*
> *C. Relative importance of shared-use path and roadway.*
>
> *Speed should not be the sole factor used to determine priority, as it is sometimes appropriate to give priority to a high-volume shared-use path crossing a low-volume street, or to a regional shared-use path crossing a minor collector street.*
>
> *When priority is assigned, the least restrictive control that is appropriate should be placed on the lower priority approaches. STOP signs should not be used where YIELD signs would be acceptable.*[6]

It should not be a forgone conclusion that the roadway's speeds will be higher than the pathway's. On sidepath type facilities (where the path is within the right of way of a parallel street) the motorists on the roadways intersecting the path frequently are reducing speeds to negotiate the adjacent roadway/side street intersection. Additionally, consideration given to the roadway having higher speeds might be offset by the volume of the pathway being much higher than that of the roadway. A local roadway might also be considered a lower priority than a regional pathway (such as the Pinellas Trail). The Pinellas Trail (existing and proposed extension) has a higher volume than the local roadways it crosses. However, on future extensions, or on other trails, it may be a factor to consider when assigning priority.

For assigning priority at pathway intersections with two-lane roadways, we propose comparing the volumes and speeds of the Pinellas Trail and intersecting roadways to determine which facility should get priority. Figure 4 shows how this could be applied. Essentially the slope of each line has been adjusted to reflect the proportionate speeds of the intersecting facilities (a 20 mph design

[5] AASHTO, *A Policy on the Geometric Design of Streets and Highways*, AASHTO, Washington, D.C., 2005.
[6] FHWA, *Manual on Uniform Traffic Control Devices*, pg. 9B-2, FHWA, Washington, D.C., 2003.

speed was used for the Pinellas Trail). For instance, based upon Pinellas County Pinellas Trail user counts there are about 1,600 users per day on the Pinellas Trail. Therefore, if the trail intersects a roadway with a daily traffic of 900 vpd, and a speed limit of 30 mph, the trail would receive priority over the roadway. If, however, the roadway had a speed limit of 45 mph, the roadway would receive the priority.

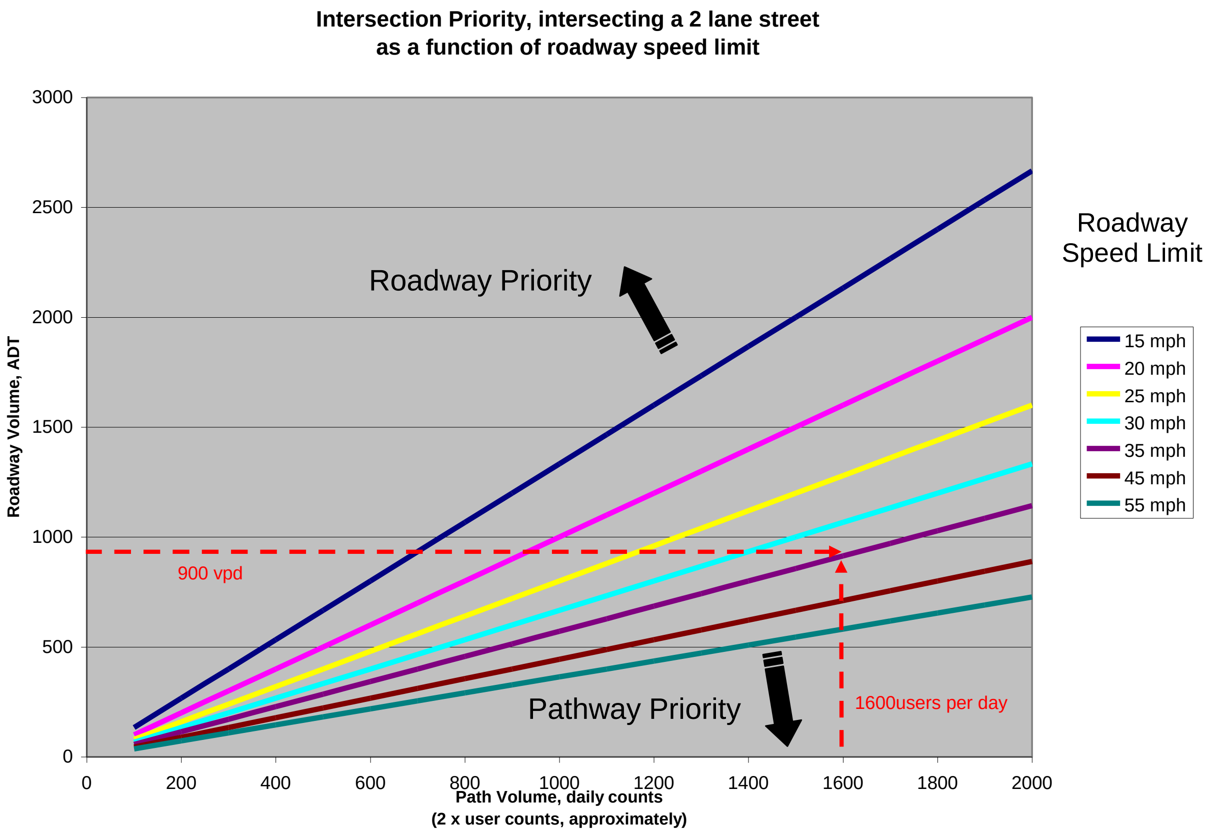

Figure 4 Proposed priority based upon facility speeds.

On four-lane roadways, the priority is automatically assigned to the roadway. This was done for a number of reasons. Multi-lane roadways are typically higher priority roadways; speeds are typically higher on multilane roadways; and with multiple lanes in each direction, there is a potential for multiple threat crashes.

The Apparent Paradox of Roadway Priority

There is an apparent paradox with assigning the priority to the roadway at a shared-use path crossing. For example, on a multi-lane roadway the priority would be assigned to the roadway. Therefore, the traffic control on the approaches to the intersections – signing, markings, flashing beacons – are all placed to ensure the <u>approaching</u> path users know that they are required to yield the right of way to the roadway users.

The conundrum becomes apparent when one realizes that a shared use path is a pedestrian facility (sidewalk) as well as a vehicular way. At every crossing of a shared use path and a roadway, there is a legal crosswalk, whether marked or not. According to Florida Statutes (Section 316.130(7)),

> *"…the driver of a vehicle shall yield the right-of-way, slowing down or stopping if need be to so yield, to a pedestrian crossing the roadway within a crosswalk when the pedestrian is upon the half of the roadway upon which the vehicle is traveling or when the pedestrian is approaching so closely from the opposite half of the roadway as to be in danger."*

Moreover, with regard to bicyclists, the law states (Section 316.2065(10)),

> *"A person propelling a vehicle by human power upon and along a sidewalk, or across a roadway upon and along a crosswalk, has all the rights and duties applicable to a pedestrian under the same circumstances."*

Consequently, when priority is assigned to the roadway, we are apparently requiring pathway users to yield to traffic **that is required by law to yield to pathway users**. In actuality, when we assign priority at an intersection we are requiring traffic approaching the intersection to yield to traffic on the other approaches. However, this assignment of priority does not exempt path users or motorists from their obligation to yield to users already within the intersection.[7] This conundrum is not merely academic – it underscores the importance of careful design and selection of traffic control at path roadway intersections. Improper or incomplete design, and/or maintenance of pathway/roadway intersections, have contributed and will continue to contribute to crashes, injuries and deaths.

Driveways

Shared use path crossings of driveways are a special case path /roadway intersection. How they are addressed is dependent upon the location of path with regard to parallel roadways. Where shared use paths that are along independent alignments (not adjacent to a roadway) cross driveways, priority should be assigned just as with any other path/roadway intersection. The relative speeds and volumes should be considered and priority set as described above.

If the path is parallel and relatively close to an adjacent roadway, there are two options for assigning priority. Ideally, at unsignalized crossings, the path would be realigned to cross the driveway far enough away from the roadway paralleling the path to act as an independent intersection. If this can be done, then priority should be determined using the relative speeds and volumes of the driveway and the path. If, however, the path must remain close to the parallel roadway, then the path should be given the same priority over entering driveways as the parallel roadway.

Appropriate Traffic Control for the Crossing

Once the priority has been assigned at the intersection, appropriate traffic control treatments must be selected. The traffic control used at pathway/roadway intersections must accomplish several objectives:

1. Make pathway users and roadway users aware of the crossing conflict;

[7] Section 316.121(1), F.S. and Section 316.130(8)

2. Make users understand their obligations with regard to yielding on the approach to the crossing; and,
3. Clarify the motorists' obligations to path users within the crosswalk itself.

The method for determining traffic control for pathway/roadway intersections described below addresses these three objectives.

The width of the roadway being crossed by the trail users and the motor vehicle volumes are the determining factors for making this decision. This methodology uses these factors in combination to stratify roadways by volume for application of different traffic control device packages.

For these guidelines, roadways are stratified into low-, medium-, and high-volume. The threshold volume for low- to medium-volume was determined using the amount of time a pedestrian can expect to wait for an adequate gap in traffic to cross the street. The medium- to high-volume threshold is based upon the midblock crossing study previously referenced.

Low- to Medium-Volume Threshold. Low-volume roadways are those on which a path user could expect to obtain an adequate gap to cross the street safely within 10 seconds of arriving at the pathway/roadway intersection. The 90 percentile delay time was used to determine the upper threshold for this roadway volume range; that is, 90 percent of the path users would be able to begin crossing in a safe gap within 10 seconds of arriving at the intersection.

To calculate the required gaps, several assumptions about the users and the roadways were required. The lengths of adequate gaps were calculated assuming 12-foot lanes, a startup time of 2 seconds, and a crossing speed of 2.8 ft/sec.[8] Table 1 below shows the gap lengths for different numbers of lanes. For roadways with a minimum 6-foot median, a pedestrian can select an adequate gap to cross one direction of traffic, cross to the median, wait for an adequate gap to cross the opposite direction of traffic, and cross to the far side of the roadway. For roadways without a minimum 6-foot median, the pathway user must select a gap that is adequate to cross the entire roadway.

Table 1. Required Gap for a to Cross

Number of lanes	Gap length (sec)
1	6.29
2	10.57
3	14.86

Gap length is the time interval from when the rear of the first vehicle passes the observer to when the front of the second vehicle passes the observer and represents the time when the lane is clear of vehicles. Average gap length was calculated using the number of vehicles per hour per lane, a speed of 44 ft/sec (30 mi/h), and a vehicle length of 20 ft. Thus

Average gap length (sec) = 3600 seconds/vehicles per hour – 20 feet/speed

[8] This 2.8 ft per second speed was recommended in comments to an early draft of the methodology. It was discussed at the January meeting and adopted for this revision.

where

3600/vehicles per hour	=	number of seconds from when the front of the first vehicle passes a waiting pathway user to when the front of the second vehicle passes the pathway user
20/speed	=	the length of time for a vehicle to travel its own length

Gap lengths were assumed to be normally distributed, with a mean of the average gap length and a standard deviation of 0.37 times the average gap length. That is, vehicles were assumed to pass the midblock crossing location randomly rather than in platoons.

Using the NORMDIST function in Microsoft Excel, it is possible to calculate the proportion of gaps that are of any specified minimum duration for any traffic volume. Figure 5 shows gap lengths for 200 (top line), 400 (middle line), and 600 (bottom line) vehicles per hour in one lane. With 200 vph, nearly 96 percent of gaps are a minimum of 6.29 seconds (the gap length required to cross one lane of traffic). As traffic volumes increase, average gap lengths are shorter and fewer gaps will meet the same specified duration. Figure 5 also shows that with 400 vph, about 76 percent of gaps are a minimum of 6.29 seconds. With 600 vph, only 36 percent of gaps are a minimum of 6.29 seconds.

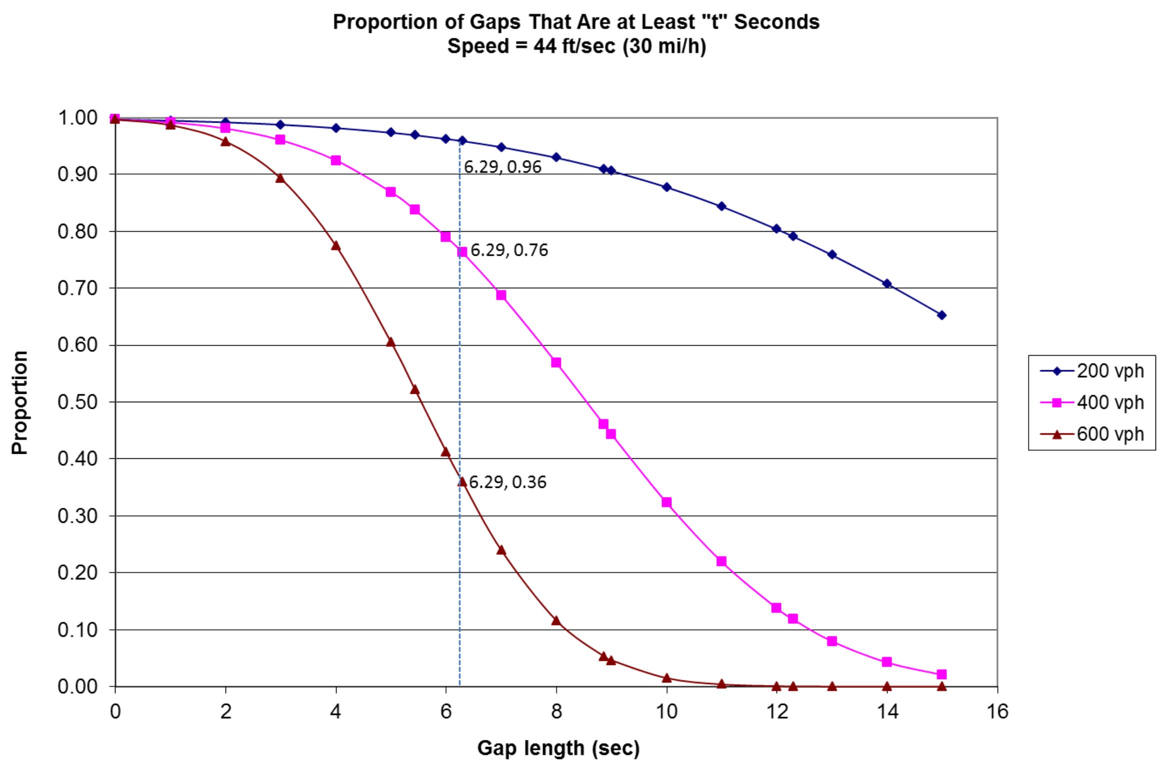

Figure 5 Sample Probability curves for Gap Lengths

As can be seen, as traffic volumes increase, crossing opportunities (i.e., adequate gaps) become fewer. As a result, the probability that a path user will find an adequate gap to cross within a reasonable time period (such as 10 seconds or 30 seconds) diminishes. Figure 6 shows the probabilities of finding an adequate gap (i.e., 6.29 sec) within 10 seconds for different volumes on a one-lane crossing. For example, with 475 vph, there is a 90 percent probability that a pathway

user will experience a delay no longer than 10 seconds (that is, find an adequate gap within 10 seconds). At 800 vph, this probability drops to 20 percent.

Vehicles in one lane were also assumed to pass the observer independently of vehicles in another lane. Thus, the probability of encountering a 10-second gap in two lanes is simply the probability of a 10-second gap in Lane 1 times the probability of a 10-second gap in Lane 2.
P(2 lanes) = P (Lane 1) X P (Lane 2). With this assumption in mind, the same reasoning can be extended to crossings involving 2-lanes, 3-lanes, and wider roadways.

The number of acceptable gaps in traffic is also influenced by the speed of the vehicles on the roadway. Because a faster car takes less time to cross a point, for a given flow rate, higher speed vehicles actually increase the number of (theoretically) acceptable gaps in a traffic stream. Because this is a method for estimating the number of gaps, a conservative speed of 30 mph was chosen as the assumed speed for developing this methodology. If the user wishes to confirm the actual number of gaps, a pedestrian gap study could be performed.

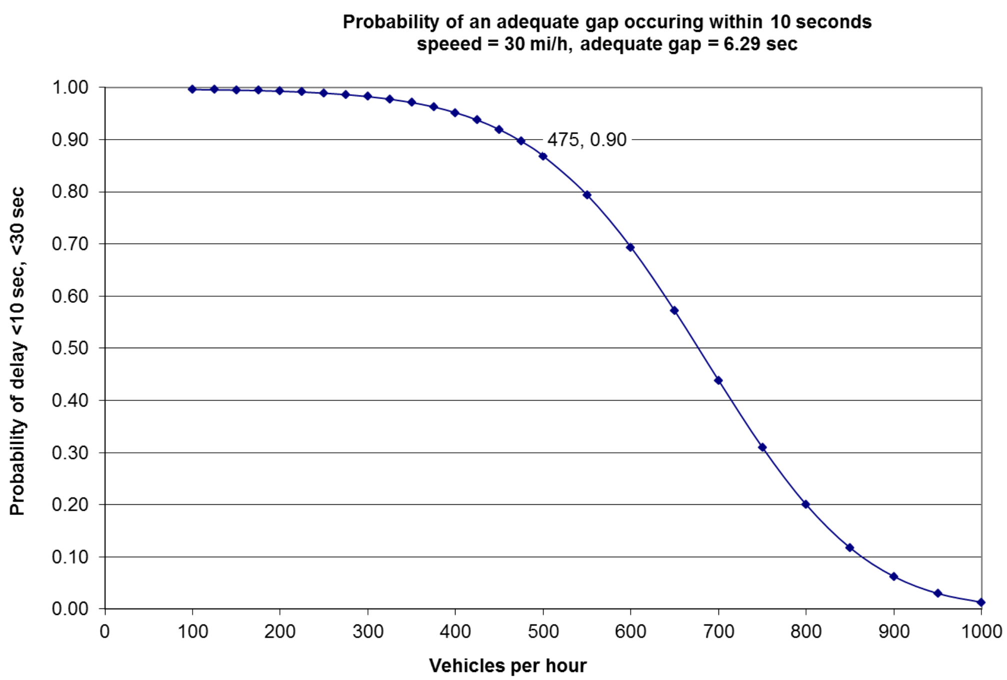

Figure 6 Probability of a Pedestrian Getting an Adequate Gap

Based upon the above calculations, a low volume road is assumed to be a road where a pedestrian would not have to wait more than 10 seconds to encounter an adequate gap for crossing the street. This equates to approximately 4,500 vpd.[9]

Medium- to High-Volume Threshold. The medium- to high-volume threshold was chosen as 12,000 vpd. This volume was chosen as based upon a recent FHWA report[10] which concluded,

[9] Assumes K=0.097 and d=0.55.
[10] Zegeer, Charles V., J. Richard Stewart, Herman F. Huang, Peter A. Lagerwey, John Feaganes, and B.J. Campbell. *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations – Final Report and Recommended Guidelines*. Report No. FHWA-HRT-04-100. Federal Highway Administration, McLean, VA, February 2005.

> "Marked crosswalks alone (i.e., without traffic-calming treatments, traffic signals with pedestrian signals when warranted, or other substantial improvement) are not recommended at uncontrolled crossing locations on multilane roads (i.e., four or more lanes) where traffic volume exceeds approximately 12,000…"

The referenced study distinguishes between roadways with and without medians, raising the threshold to 15,000 vpd for roadways with raised medians. To minimize the volume categories in the crossing guidelines, we chose to not differentiate between roadways with refuges and those without with regard to this guideline. Consequently, we have decided to use 12,000 vpd as the minimum value for high-volume roadways.

The calculated and final threshold volumes are provided in Table 2. The hourly volume of 1,150 vph shown in Table 2 represents the application of an assumed daily peak-to-daily factor (k factor) of 0.097 and directional (d) factor of 0.55. These thresholds pertain to an undivided roadway or a divided roadway with less than 6 ft of raised median. For a divided roadway with a minimum 6-foot raised median, these thresholds pertain to each direction of traffic. The Guidelines Total Traffic Volume column of Table 2 contains generalized values based upon the calculated volumes.

Table 2. Volume Thresholds for Pathway User Delay for Various Roadway Crossings

	Calculated Volume Thresholds, vplph (vph for crossing)			Guidelines Total Traffic Volume for Lanes Crossed , vph
	1 lane	2 lane	3 lane	
Low volume (delay <=10 sec)	< 475	< 230 (< 460)	< 139 (< 417)	< 475
Medium volume	475-1,150	343-575 (460 – 1,150)	139-384 (417 - 816)	475 to 1,150
High-volume	>1,150	> 575 (>1,150)	> 384 (>1,150)	>1,150

vplph = vehicles per lane per hour
vph = vehicles per hour

The above table has been simplified for the actual crossing guidelines application. In the application, one would determine the volume of traffic in the lanes being crossed and use Table 3 to determine which table in the traffic control matrices to use. The proposed traffic control matrices are provided later in the "Crossing Treatments Matrices" section of this document.

Table 3. Volume Thresholds for the Crossing Treatments Guidelines

Traffic Volume in Lanes Being Crossed	
< 4,500 vpd	Table 5
4,500 – 12,000 vpd	Table 6
>12,000 vpd	Table 7

vpd = vehicles per day

A summary of the treatments selected for each intersection is provided below.

Crossing Treatment Matrices

Three tiers of traffic control device packages were identified for these guidelines: static signs, activated signs, and hybrid beacons. The components of each of these packages are provided in the table below:

Table 4. Traffic Control Devices Tiers

	Traffic Control Devices Tier		
Traffic Control Device	Static Signs	Activated Signs	Hybrid Beacon
Marked Crosswalks	✓	✓	✓
Trail Xing Sign (W11-15) w/ Arrow (W16-7p)[2] 	✓	✓	✓
Advance Stop Lines[5]	✓	✓	✓
Trail Xing Sign (advance) and TRAIL XING Pavement Marking	✓	✓	✓
Stop Here to Ped Signs (R1-5)[3,4] 	✓	✓	✓
RRFB crossing: Ped Xing Signs (W11-2) with rapid rectangular flashing beacons, and supplemental striping		✓	
Pedestrian Hybrid Beacon[7]			✓

The matrices on the following pages present packages of traffic control devices recommended for specific roadway conditions. While providing guidance, there are sometimes field conditions which make the strict adherence to any typical signing and marking scheme impractical. Therefore, when applied at new locations, each location should be reviewed in the field to ensure the proposed treatments are appropriate.

If sight distance is limited, additional traffic control may be appropriate.

Additional traffic control may be appropriate in areas where expected path users are predominately school children or individuals with mobility impairments.

The matrices assume that the roadway is given priority. If the pathway is to be given priority, then STOP or YIELD signs as appropriate should be installed on the roadway along with the applicable pavement markings (stop lines or yield markings).

The following general notes apply to the crossing treatment matrices:

General Notes for Applying the Crossing Treatment Methodology Matrices

1. Volumes in the title cells assume a daily to peak hour volume factor of 0.97.

2. Each column in the table represents a package of traffic control devices recommended for the specific crossing condition.

3. The designation of "YES" for the median assumes there is potential for installing a raised median at the crossing location and that one will be installed. Raised medians that can be used as refuges (6 feet wide minimum for pedestrians, greater than 8 feet recommended for shared use paths) will allow for less restrictive motor vehicle traffic controls to be used in conjunction with the midblock crossings.

4. On roadways with two-way left turn lanes, refuge islands should be installed at crossing locations.

5. On multi-lane roadways with medians on the approach, crossing signs should be placed in the medians as well as on the side of the roadway.

6. When advance stop lines are used on the approach roadways they should be used in conjunction with solid lane lines extending back the stopping sight distance from stop lines. This is to enable law enforcement officers to determine when a motorist fails to yield when he could have done so.

7. On six-lane, undivided roadways, strong consideration should be given to providing a grade-separated crossing of the roadway for pedestrians/trail users. Until such time as this can be achieved, aggressive channelization should be used to divert pedestrians/trail users to the nearest safe crossing.

8. This guidance assumes that lighting will be considered and provided where needed for crossings that are used at night.

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	Table 5: Roadway Volume less than 475 vehicles per hour, vph (4,500 vehicles per day[1], vpd)												
	Lanes	2 lanes						4 lanes					
	Median	No			Yes			No			Yes		
	Speed	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph
Taffic Control Devises Package	Static Signs	✓	✓	✓	✓	✓		✓			✓	✓	
	Rectangular Rapid Flashing Beacon						✓		✓	✓			✓
	Hybrid Beacon												

	Table 6 : Roadway Volume > than 475[1] vph (4,500 vpd) and < than 1,150 vph (12,000vpd)																		
	Lanes	2 lanes						4 lanes						6 lanes					
	Median	No			Yes			No			Yes			No			Yes		
	Speed	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph
Taffic Control Devises Package	Static Signs	✓	✓		✓	✓					✓								
	Rectangular Rapid Flashing Beacon			✓			✓	✓	✓	✓		✓	✓				✓	✓	
	Hybrid Beacon													✓	✓	✓			✓

	Table 7 : Roadway Volume > than 1,150 vph (12,000vpd)																		
	Lanes	2 lanes						4 lanes						6 lanes					
	Median	No			Yes			No			*Yes*			No			Yes		
	Speed	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph	≤ 30 mph	35–40 mph	≥ 45 mph
Taffic Control Devises Package	Static Signs	✓	✓		✓	✓					✓								
	Rectangular Rapid Flashing Beacon			✓			✓	✓				✓	✓						
	Hybrid Beacon								✓	✓				✓	✓	✓	✓	✓	✓

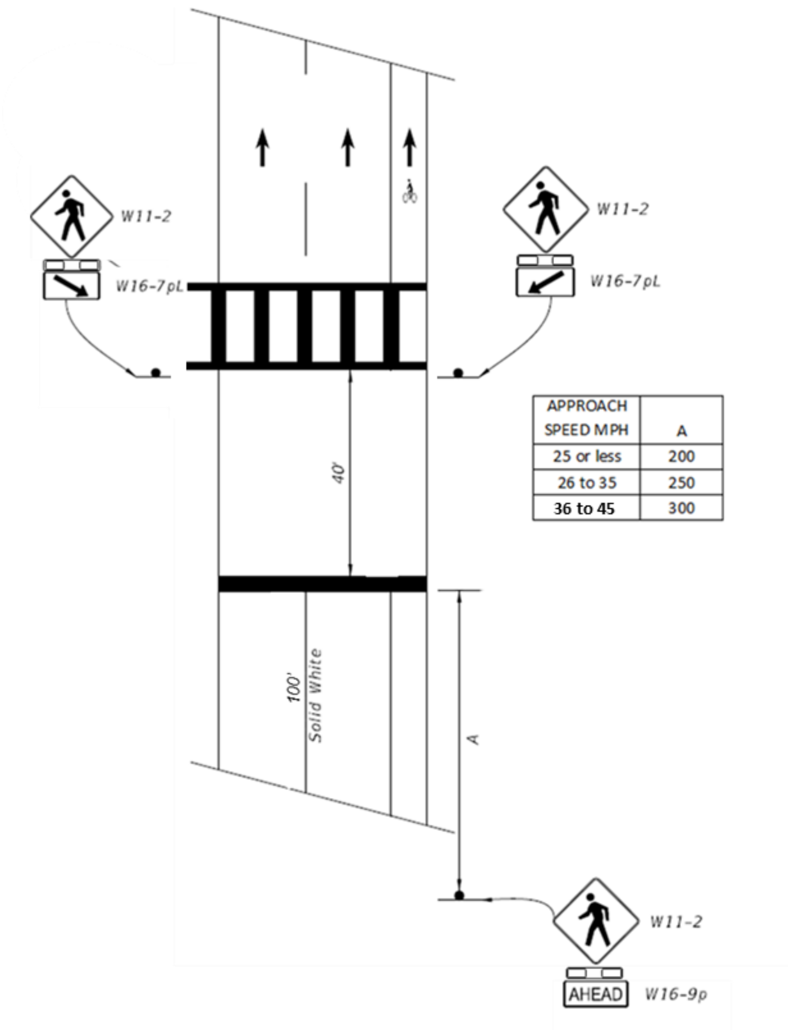
Sprinkle

Rapid Rectangular Flashing Beacon (RRFB) Crossing Treatment

The RRFB (Figure 7) treatment is a combination of signing, markings and pedestrian activated strobe and feedback devices. Signing for the RRFB includes advance warning signs (W11-2) with AHEAD supplemental plaques (W16-9p), and YIELD HERE TO PEDS signs (R1-5). Pavement markings include solid white lane lines (on divided multi-lane roads); the length of these lines is dependent upon the design stopping sight distance for the roadway. The pedestrian activated treatments are W11-2 signs with built in rectangular rapid flashing beacons. Additionally, pedestrian visible strobes inform pedestrians of when the crossing is activated. Signs should instruct pedestrians to wait for motorists to yield before crossing the road. This may be supplemented with an audible message.

TRAIL XING (Figure 8) pavement messages should be placed on the pavement in advance of the crossing. W11-15 signs may be used in place of W11-2 signs.

The Rapid Rectangular Flashing Beacon is the subject of an Interim Approval from FHWA.



APPROACH SPEED MPH	A
25 or less	200
26 to 35	250
36 to 45	300

Figure 7 Rapid Rectangular Flashing Beacon Installation

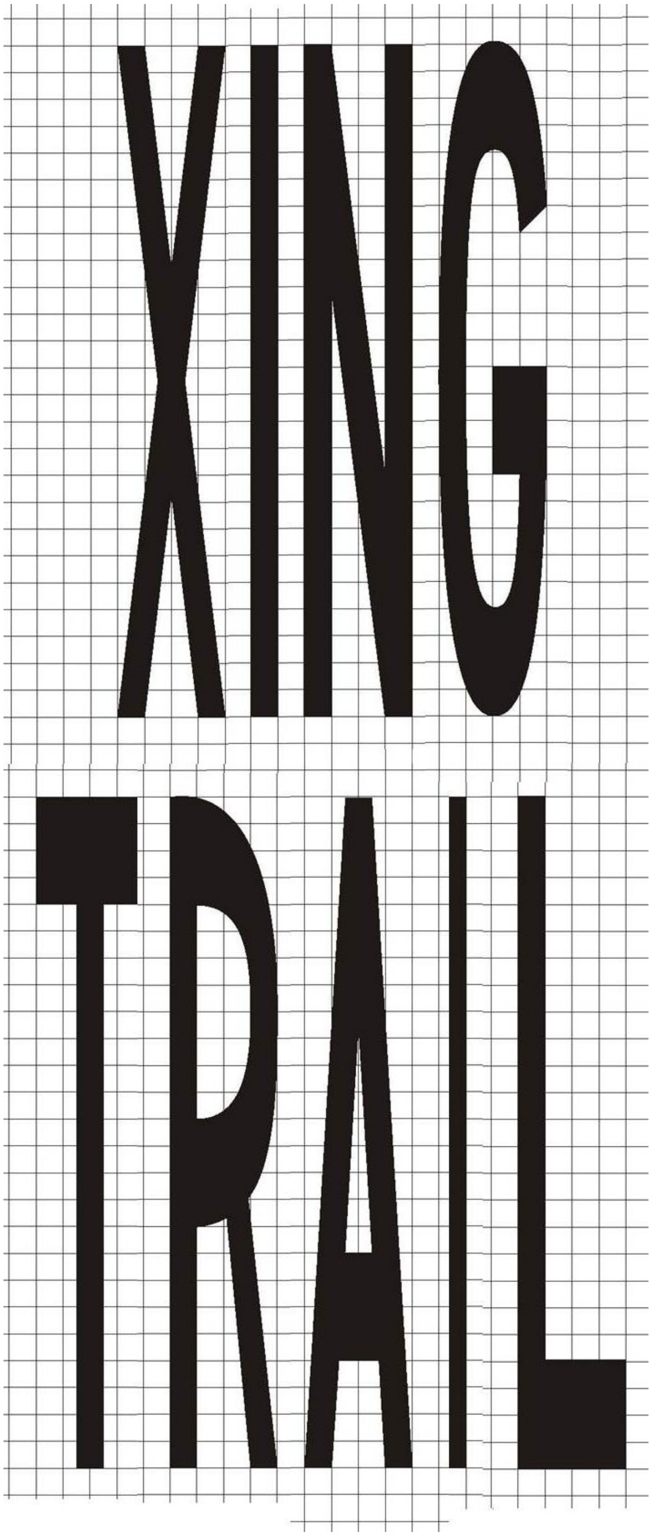


Figure 8 TRAIL XING Pavement Marking

Shared Use Paths Crossings of Side Streets at Intersections
Where a shared use path crosses a side street within the functional area of an intersection, the path should be brought to the intersection and cross the side street within the crosswalk.

Intersections of side streets and paths parallel to a roadway are to be given the same priority as the parallel roadway. Installing STOP or YIELD signs at these locations is not an effective method of slowing or stopping path users at side streets and driveways. If path users perceive the signs as overly restrictive, they will not comply with them. Furthermore, motorists may yield to path users and wave them through in conflict with the sign priority at the intersection. The overuse of these signs may decrease their effectiveness at locations where compliance with STOP or YIELD signs is critical to the path users' safety.

Where possible, reduce the speeds of shared use path users on the sidepath. Users of intersections must be able to perceive conflicts at intersections, understand their obligations to yield or stop, and be able to fulfill their obligations to yield. Slowing drivers and path users down on the approach to intersections can provide more time for users to perceive and understand their obligations. Traffic calming features are beyond the scope of this document. However, slowing the path user on the approach to the intersection will also support these fundamental concepts.

Horizontal deflection, either through a series of low design speed curves or a chicane, on the approach to an intersection is an effective technique in reducing bicycle speeds on the approach to intersections. Examples of these geometric design techniques are provided in Figures 9 and 10.

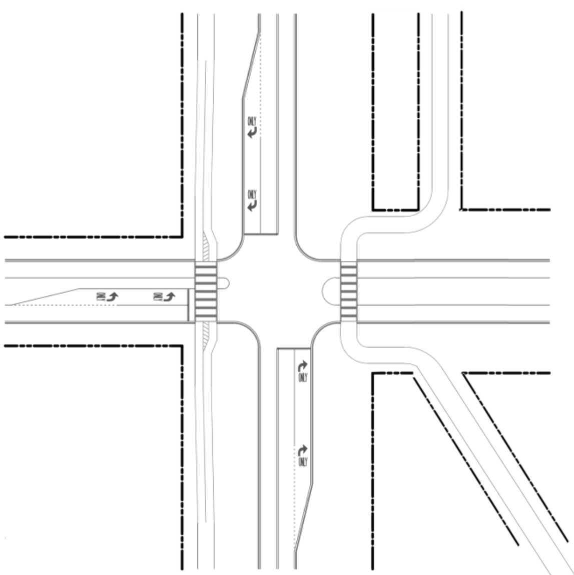


Figure 9 Geometric Design to Slow Bicyclists on Intersection Approaches

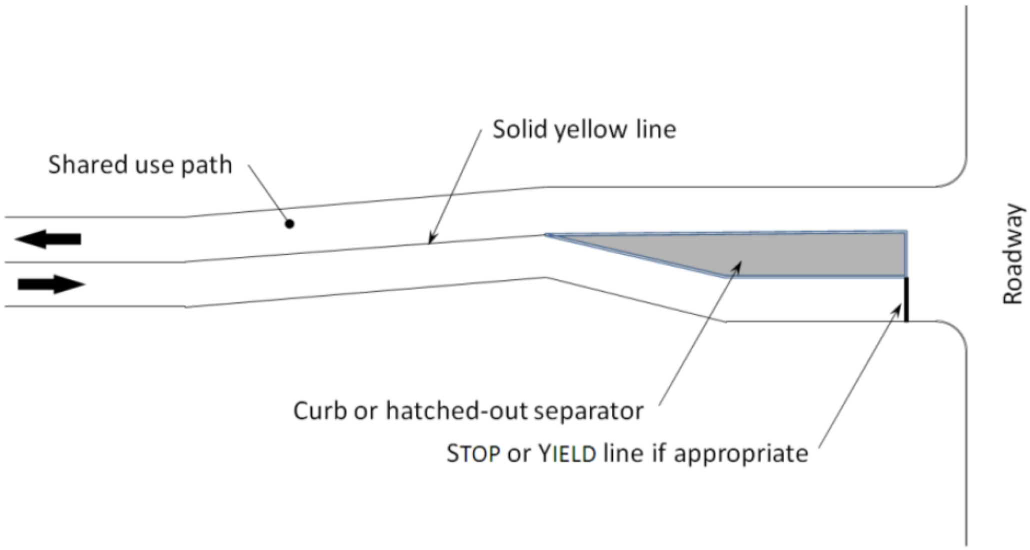


Figure 10 Chicane on Approach to Intersection

Additionally, motor vehicle speeds should be reduced at conflicts points. This can be accomplished by designing for the smallest design vehicle likely to commonly turn at the drive or intersection (AASHTO *A Policy on the Geometric Design of Streets and Highways*).

Sight lines should be kept clear to ensure that motorists approaching the conflict can clearly see the path users and so that path users can see approaching motorists. This requires limiting parking and landscaping around the conflict points. Sight distances are to be calculated for stopping sight distance.

At signalized intersections, consider installing blank-out signs, to be activated by path users (i.e., push buttons or loops) to alert motorists of their presence. NO RIGHT ON RED blank-out signs would be appropriate for the near side street approach. YIELD TO PEDS IN CROSSWALK signs would be appropriate for the adjacent right-turn, through-right, and opposing left-turn movements.

Pathway Approaches to Crossings

Pathways should be considered roads for the purposes of intersection design. A solid yellow centerline stripe should be placed on all pathway approaches to path/road intersections. This centerline stripe should extend 133 feet (stopping sight distance for a bicyclist per AASHTO) back from the intersection. STOP or YIELD signs and applicable markings (stop lines or yield markings) should be applied to the path surface.

At all new crossings, slight reverse curves of the path (or kinks) on the approaches to intersections should be considered. These offsets are to alert path users to the upcoming intersections and to act as path "calming" to reduce the speeds of path users through the intersections.

Bollards should be used sparingly and only if they are needed to prevent motor vehicle access. On new paths only odd numbers of bollards should be used. This helps define a "center" of the path and gives users a definitive reference for riding on the right. Even numbers of bollards can cause confusion as to which side of the bollards a path user should ride. Where bollards are used they should be striped as obstructions as described in the MUTCD. Striping around central

bollards, those separating path users traveling in opposite directions, should be yellow. Supplemental bollards separating users traveling in the same direction should be white.

Where an intersection is not clearly visible to an approaching bicyclist or where the traffic control is not visible for a sufficient distance to permit the bicyclist to respond to the traffic control, an Intersection Warning (W2-1), Stop Ahead (W3-1), Yield Ahead (W3-2), or Signal Ahead (W3-3) sign should be used on the path approach to the intersection.

Existing Trail Approaches

It is likely that the basic existing Pinellas Trail approach configurations – separated bikes and pedestrians, two bollards per approach - will be maintained at many locations. As these sections undergo maintenance the striping should be modified to better represent the desired operations for the approach and departure movements.

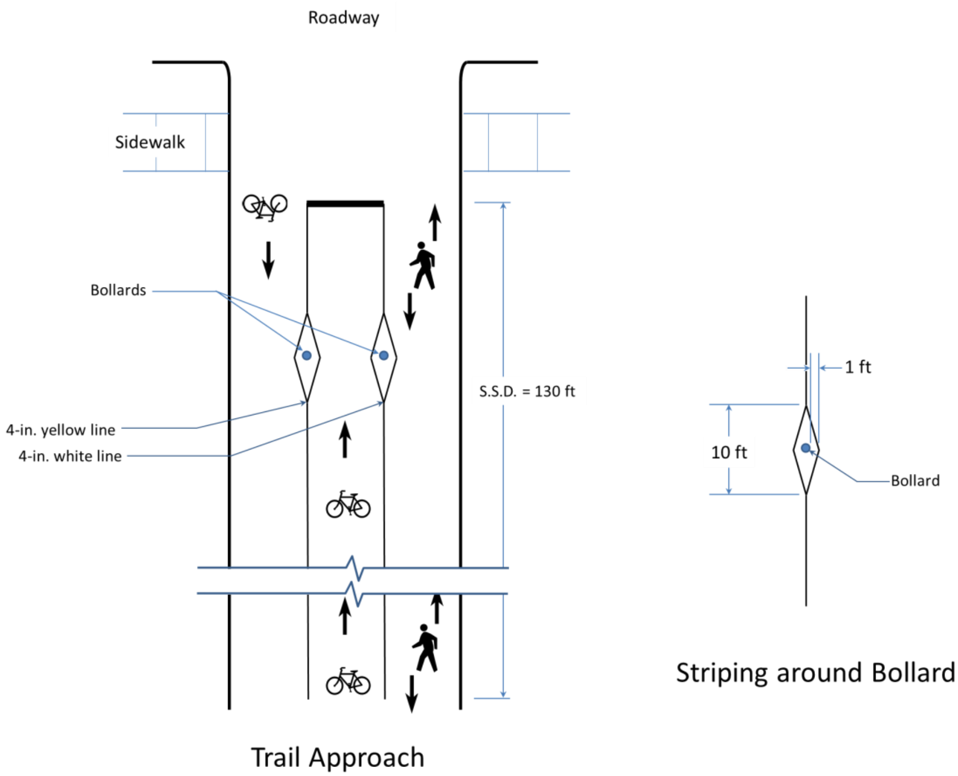


Figure 11 Approach Striping for Two-Bollard Approaches

The striping on the approach to the bollards should be modified to be consistent with Figure 11. The stripe between opposing bike flows should be yellow to indicate that bikes on the opposite side of the stripe are traveling in the opposite direction. The bicycle and directional symbols on the path should be placed in advance of the bollards for approaching bicyclists. The line separating the pedestrians from the bicyclists should be white as it essentially represents an edgeline for the (non-motorized) vehicular way of the path. Again, directional arrows should be placed on the approach side of the bollards. The solid lines on the approach to the intersections should be of a length approximating the stopping sight distance (S.S.D.) for bicyclists. Striping around the bollards should provide 1 foot clear to bicyclists and pedestrians. Stop lines should be placed for bicyclists approaching the roadway intersection.