Sidepath Intersection & Crossing Treatment Guide

MICHIGAN DEPARTMENT OF TRANSPORTATION

June 2018

Prepared by:

Toole Design Group

MDOT

Michigan Department of Transportation

Sidepath Intersection and Crossing Treatment Guide

Contract No. 2016-0274

June 28, 2018

Prepared for:

Josh Debruyn, AICP
Pedestrian and Bicycle Coordinator/Specialist
MDOT Michigan Department of Transportation

Prepared by:

Toole Design Group, LLC
212 3rd Ave N, Suite 476
Minneapolis, MN 55401

Contributors:

Hannah Pritchard, P.E. PTOE
Jesse Boudart, P.E.
Ashley Haire, Ph.D., P.E.
Rebecca Sanders, Ph.D.

Toole Design Group

Acknowledgements:

Steve Remias Ph.D., P.E.	Wayne State University
Rob Burchfield, P.E.	Toole Design Group
Bill Schultheiss, P.E.	Toole Design Group
Carissa McQuiston, P.E.	Nonmotorized Safety Engineer
Deb Alfonso	Supervisor Intermodal Services Unit
Jason Latham	Planning Manager, Southwest Region
Suzette Peplinski, P.E.	Traffic, Safety and Operations Engineer, Grand Region
Tom Pozolo P.E.	Operations Engineer, Oakland TSC Metro Region
Brian Pawlik	Bicycle and Pedestrian Planner, Southeast Michigan Council of Governments

Contents

Appendices

Introduction

Bicyclists and pedestrians are the most vulnerable users on the road, and designers face several choices when trying to meet the needs of all anticipated users of a transportation corridor. As interest in bicycling increases, more people are demanding greater physical separation between bikeways and vehicle lanes. This desire frequently results in the development of separated on-street bikeways or sidepaths, a type of shared use path located parallel to a roadway. The design of these bikeway types, while reflecting the desire for separation, should also consider the safety and comfort of bicyclists where the facility meets driveways and intersections.

Sidepaths are used throughout the state of Michigan to provide separated pedestrian and bicycle facilities for nonmotorized roadway users[1]. These facilities are often constructed adjacent to state or county roads and are generally implemented concurrently with roadway modifications (Exhibit 1). To improve the selection of the most appropriate bikeway in conjunction with proposed roadway projects, the Michigan Department of Transportation (MDOT) examined safety performance and interactions between motorists and bicyclists at intersections with sidepaths. This analysis sought to determine which features of sidepaths contributed to safety conditions for nonmotorized roadway users. Combined with national safety best practices, the following sidepath design guidance has been developed to maximize safety for vulnerable roadway users.

Purpose and outline

This Sidepath Intersection and Crossing Treatment Guide lays out a straightforward process and provides guidance for integrating high-quality bikeways into a proposed roadway project or as a stand-alone project. Efforts should be made to construct the optimal sidepath design. If this design cannot be achieved, then barriers to that design should be documented. Working through this design process can help designers identify techniques to improve bikeway comfort and safety for the "interested but concerned" bicyclist. This guide has been created to reflect the latest state-of-the-practice principles for designing optimal bicycle facilities, with a particular focus on sidepath design.

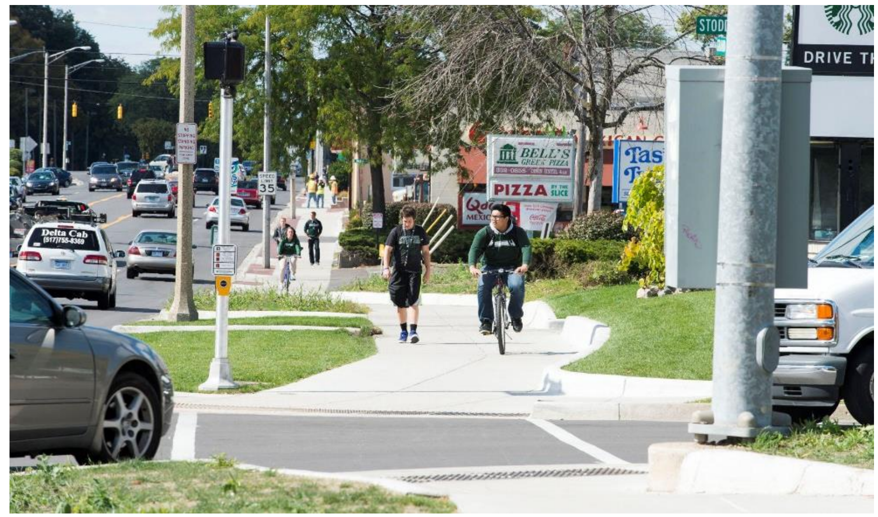


Exhibit 1: Example side path

The Sidepath Intersection and Crossing Treatment Guide is organized into the following major components:

- Bikeway selection
- Safety considerations for sidepaths
- Intersection treatment selection process

The following section gives guidance on selecting an appropriate bikeway for a given corridor based on the most recent AASHTO *Guide for the Development of Bicycle Facilities* and other research.

[1] The crash analysis and research for this project focused on bicyclists, not pedestrians. However, most of the treatments suggested here would also improve safety for pedestrians using sidepaths.

Bikeway selection

Highways and roadways across Michigan vary in width, capacity, and land use context, among other characteristics. Selecting an appropriate bikeway for these corridors should be based on bicycle user comfort thresholds, national best practices, available right-of-way, network characteristics, and adjacent land uses.

Bicycle design user

Bicycle design users can be classified into four categories (Exhibit 2):

- Experienced and Confident
- Casual and Somewhat Confident
- Interested but Concerned
- Not Interested

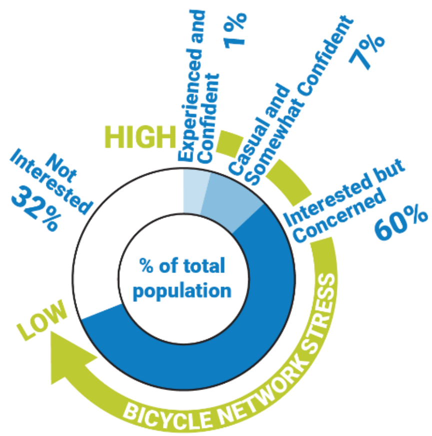


Exhibit 2: Bicycle users by percent of population

These categories are determined by the user's tolerance of traffic stress when riding a bicycle.[i] The Experienced and Confident design user is comfortable riding in mixed traffic and sharing lanes with motorists. Casual and Somewhat Confident bicyclists are comfortable riding on streets with automobiles, but prefer dedicated bicycle facilities, particularly when those facilities are separated from motor vehicle traffic. The Interested but Concerned design user would like to ride a bicycle but has reservations about mixing with motorists, preferring to ride in a bikeway completely separated from motor vehicle traffic.

The Interested but Concerned design user represents the majority of potential bicyclists in any community. Growth in bicycle ridership will come primarily from this group, and bicycle facilities should be planned and designed with the Interested but Concerned user in mind. Accordingly, low-stress bikeways that separate bicyclists from motorists, such as sidepaths, should be included in designs wherever possible. Intersection crossing treatments and other design details should be geared toward increasing safety while enhancing the comfort perceived by this design user.

Bikeway type selection

Selecting an appropriate bicycle facility for the Interested but Concerned design user can be performed using a chart indicating prevailing traffic volumes and vehicle speeds, as shown in Exhibit 3.

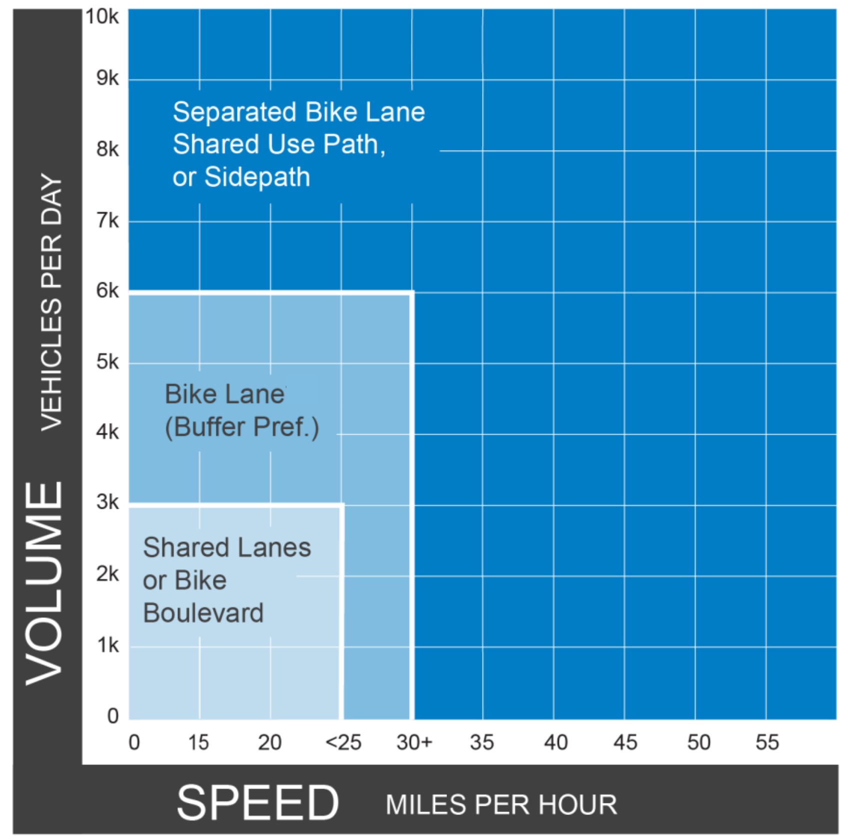


Exhibit 3: Facility selection for interested but concerned users

For the purposes of the Sidepath Intersection and Crossing Treatment Guide, the Interested but Concerned rider is the assumed design user for selecting bicycle facilities in a corridor and applying the intersection design treatments. Furthermore, the highways and roadways identified for bikeway improvements will likely exceed 6,000 Average Daily Traffic (ADT) and 30 mph. Therefore, selecting a sidepath will generally be appropriate for designers using this Sidepath Intersection and Crossing Treatment Guide.

One-way versus two-way operation

Selecting the appropriate bikeway configuration requires an assessment of many factors, including safety, overall connectivity, ease of access, public feedback, available right-of-way, curbside uses, intersection operations, ingress and egress at the termini, maintenance, and feasibility. The analysis should also consider benefits and trade-offs to people bicycling, walking, taking transit, and driving. The primary objectives for determining the appropriate configuration are the following:

- Minimize conflicts between all users – bicyclists, pedestrians, and motorists.
- Provide convenient access to destinations.
- Connect to the existing or planned roadway network in a direct and intuitive manner with special consideration for clear transitions between different bicycle facility types.

On two-way streets, one-way bikeways on each side of the street are typically preferred over a two-way bikeway on one side of the street. However, in some situations one-way bikeways are not practical or desirable. For example, consider a corridor with one-way bikeways where it is challenging for bicyclists to cross from one side to the other. Faced with a wide roadway with heavy traffic volumes, high speeds, and infrequent crossings, a bicyclist may choose to ride against traffic on their current side of the street, rather than cross to access the one-way facility in the appropriate direction. In this case, larger network improvements, designated mid-block crossings, or traffic calming efforts may be needed to encourage bicyclists to ride with the direction of traffic. Right-of-way constraints or an imbalance in land uses may also lead to a decision to implement a two-way bikeway on one side of the street.

If one-way bicycle facilities are not practical or desirable, a two-way facility on one side of the roadway *can* be implemented safely. This guide provides recommendations for the design of intersections and crossings that will help reduce the crash risk associated with riding against traffic.

Sidepath research highlights

Fundamental safety research was conducted by Toole Design Group (TDG) and Wayne State University (WSU) to create a baseline for sidepath safety performance. This safety analysis provided contextual information to establish a basis for determining which corridor and intersection designs should be implemented, depending on roadway characteristics.

TDG and WSU conducted the safety analysis using data for six years of bicycle-related crashes occurring in Kent and Oakland counties on roadway facilities under several jurisdictions. Due to constraints in crash data report descriptions, sidepath crashes and sidewalk crashes were combined into one crash category. The five statistically significant trends found in the data were:

- Bicyclists riding against traffic are at higher risk than in other corridor forms.
- Bicyclists riding against traffic have a higher risk of crashes with right-turning vehicles.
- Bicyclists riding against traffic have a higher crash risk at commercial driveways and signalized intersections.
- Bicyclists riding through signalized intersections have a higher risk than at intersections with other types of traffic control.
- At signalized and unsignalized intersections, sidepath/sidewalk bicycle crashes tend to occur with left- or right-turning vehicles.

Appendix A contains details about each of these trends.

Crash risk reduction

When on sidepaths, bicyclists riding against traffic and riding through intersections are at the greatest risk for crashes. Several overarching principles can be applied to reduce bicyclist crash risk in both situations.

Bicyclists riding against traffic

Situations in which bicyclists ride against traffic may be unavoidable, especially when there is only enough right-of-way for a sidepath on one side of the street. When possible, constructing sidepaths on both sides of the street along with safe and lower-stress bicycle crossings of the main roadway can enable more bicyclists to ride with the direction of motor vehicle traffic.

Barring that arrangement, **providing signs to warn motorists of a bicycle contraflow conflict** may increase the likelihood that motorists will be attentive to bicyclists. Exhibit 4 shows an adaptation of the W10-2 railroad grade crossing warning sign used by the Colorado DOT to warn motorists of the presence of a parallel, two-way sidepath. Similarly, Exhibit 5 shows a sign used by the Virginia DOT, to warn pedestrians and bicyclists of turning vehicles. This sign could be posted facing contraflow bicycle traffic, to warn bicyclists of potential conflicts.

The intersection treatments described in the next section are also designed to increase motorist awareness at sidepaths.

Intersection risk reduction

There are several external resources available to identify treatments to minimize bicyclist crash risk at intersections, such as the Highway Safety Manual Clearinghouse[ii] and the BIKESAFE online guide[iii]. These resources can be useful for identifying strategies to reduce bicyclist crash risk through design.

Specific sidepath/sidewalk crash data evaluated as part of this MDOT project have revealed techniques to tailor crash reduction measures for existing infrastructure. Three primary risk-reduction strategies have been identified, which are described here in further detail.

Exhibit 4: Sidepath warning sign for motorists (CDOT)

Exhibit 5: Watch for turning vehicles sign for bicyclists (VDOT)

Establish priority

Roadway users yield to each other based on the roadway environment, rules of the road, and signs that reinforce these regulations. Safety for bicyclists on sidepaths may be improved by clarifying the right-of-way (ROW) at sidepath crossings with yield or stop signs for drivers, provided that warrant conditions are met. At driveways and unsignalized intersections, bicyclist movements can be reasonably prioritized over motorist movements from the driveway or side street that must yield to vehicles on the adjacent roadway.

The Michigan's Uniform Traffic Code (UTC) stipulates that drivers must yield to pedestrians in crosswalks and that pedestrians may not enter the path of a vehicle that is so close that a driver cannot yield. The majority of Michigan communities have adopted the UTC directly, by reference, or have their own ordinances that include similar guidance.[2] Furthermore, the Michigan Vehicle Code (MVC) indicates that bicyclists legally riding on a sidewalk or in a crosswalk are afforded the same rights and responsibilities as pedestrians.[3]

Despite this stipulation, automobiles often have de facto priority at driveways, unsignalized intersections, and signalized intersections. In addition to their larger size, existing designs such as free-flow movements and large corner radii encourage higher speeds and imply right-of-way.

Modifying the de facto priority of vehicle movements can be achieved through geometric changes that create additional visual cues reminding motorists to yield to bicyclists and pedestrians. Further, the sidepath crossing can be prioritized by installing corresponding traffic control signs. Other advanced bicycle and pedestrian warning and regulatory signs, such as those shown in Exhibits 5 through 7, could also be employed. However, these warning signs and markings should be installed in conjunction with other speed reduction methods to reinforce their validity. In communities that have not adopted the UTC, traffic control signs could be installed at crossings to define roadway user priority.

Sidepath ROW may also need to be prioritized in locations where a motorist's ability to see a sidepath user may be limited due to geometry or obstructions, as described in the *Manual on Uniform Traffic Control Devices* (MUTCD)[iv].

Signal phasing

At signalized intersections, prioritizing bicycle movements could be achieved by adjusting signal timing to provide an exclusive sidepath signal phase or a leading interval.

Volume thresholds for providing a separated bicycle phase or leading interval at a signalized intersection are provided in Table 1. These thresholds, based on the Massachusetts DOT *Separated Bike Lane Planning and Design Guide*[xi], should be considered when evaluating the need for a separate bicycle phase at a signalized intersection. A separate bicycle phase is typically provided using a bicycle signal. Bicycle signals are still a new tool in many areas, and designers are encouraged to review the FHWA Interim Approval of bicycle signals and work with the MDOT Signals Unit if pursuing this option.

Table 1: Protected signalization thresholds for sidepaths

Sidepath Protected Signalization Thresholds	Motor Vehicles per Hour Crossing Two-way Sidepath
Right-turn	100
Left-turn across one lane	50
Left-turn across two lanes	0

These volume-based signalization thresholds are intended to mitigate the safety risks identified with vehicles turning across the sidepath, while reducing the cost of building high-quality facilities in locations where conflicts are infrequent. Bicycle exposure to automobile traffic is a well-documented indicator of risk,[xi] so implementing protected signalization with these volume thresholds may reduce risk for a sidepath user at an intersection.

[2] In communities where the UTC or similar ordinance has not been adopted, bicyclists and motorist should mutually yield based on their time of arrival.
[3] See MVC 257.660c. The distinction between a sidepath and a sidewalk is unclear. Sidepaths are for use by pedestrians, and bicyclists are allowed on sidewalks in most places, so for the purposes of this discussion, it is assumed that a sidepath crossing is legally the same as a crosswalk.

Speed management

Intersection speed management is possible using a range of treatments from ROW clarification to vertical deflection. The 2016 FHWA document *Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts*[v] provides important guidance toward applying speed management principles. The guide indicates that raised intersections and raised crosswalks can be used on arterial streets. Using this guidance and associated design principles, treatments that minimize crash risk for bicyclists may also improve safety for motorists.

Implementing vertical deflection with a raised bicycle crossing is one method to manage vehicle speeds. The raised crossing requires motorists to "ramp up" to the sidepath. Exhibit 6 illustrates a raised crossing of a bikeway at a side street. **The vertical rise of the crossing can be constructed to attain a desired vehicle speed.** Lower motor vehicle speeds increase the likelihood that a motorist will yield to a bicyclist in the crossing.

At driveways, 5 mph may be an appropriate speed management target. At unsignalized intersections, 10-15 mph may be more appropriate to balance traffic flow while maintaining sidepath user safety. At signalized intersections, vertical deflection would typically be implemented across a low-volume minor approach or driveway. The prevailing motor vehicle speeds approaching the crossing should be considered in the construction of a raised crossing.

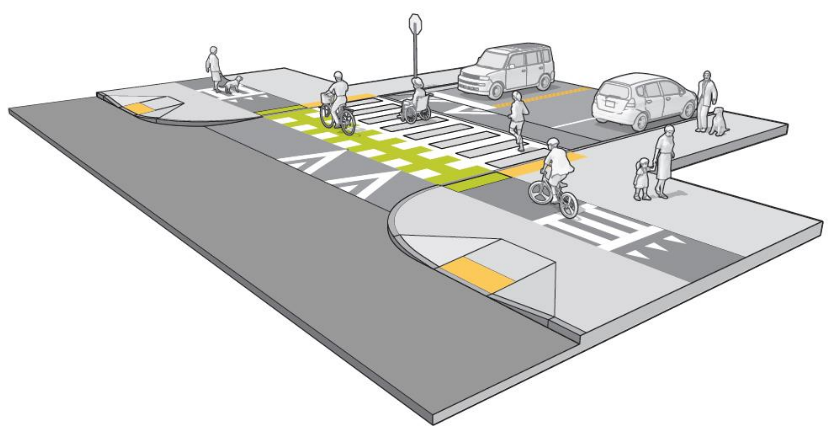


Exhibit 6: Raised crossing example

Horizontal treatments can also be used to manage motor vehicle speeds. In the safety analysis of sidepaths/sidewalks, many of the recorded crashes occurred between bicyclists and turning motor vehicles. One approach to mitigating these conflicts is to decrease curb radii, which are often designed to accommodate heavy vehicles. In some situations, heavy vehicle traffic volumes may be low enough that the need for large curb radii is reduced. In lieu of reconstructing intersection corners, smaller radii may be created using cost-effective plastic delineators or retrofitted truck aprons. Exhibit 7 illustrates a truck apron that discourages high-speed turns for passenger cars but still allows truck movements.

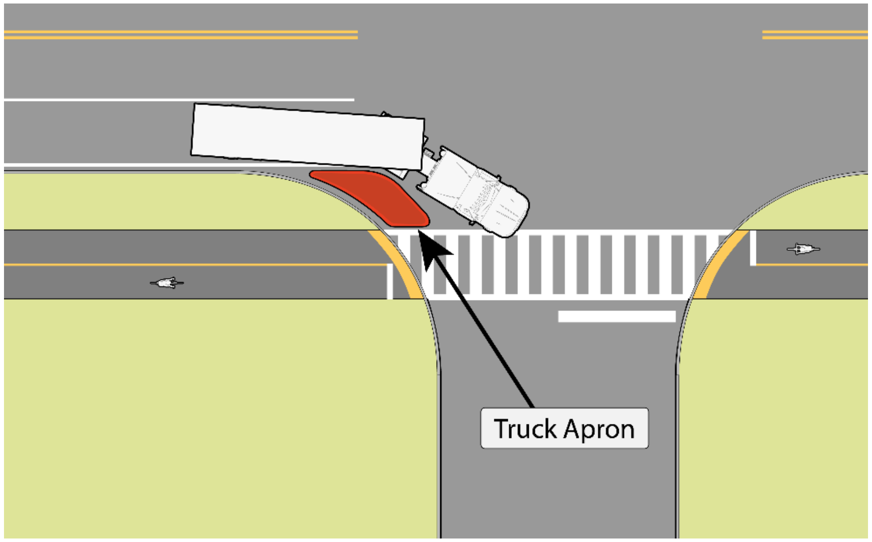


Exhibit 7: Truck apron example design treatment

Signs and markings

A simple method to increase motorist awareness of the presence of bicyclists is to deploy appropriate signs and pavement markings. These items should be thoughtfully placed in the landscape strip, center median, or other logical locations near the sidepath intersection or crossing. Exhibit 8 illustrates regulatory signs to encourage motorist yielding. Similarly, Exhibit 9 shows warning signs to increase motorist awareness of bicyclists, traffic control devices, or physical features associated with sidepaths. Exhibit 10 illustrates signs which should be used to denote one-way sidepaths and alert bicyclists to proper riding behavior. Exhibit 11 provides several signs and markings to instruct bicyclists on positioning or actions to be taken to be detected at signalized intersections. See MDOT's Traffic Sign Design, Placement, and Application Guidelines for more information on how to properly design and locate signs.[vi]

Exhibit 12 illustrates yield pavement markings (shark's teeth) and dashed white lines designating the bicycle crossing (elephant's feet) which can be used to provide visual cues and decrease the crash risk to a vulnerable user. [vii,viii]

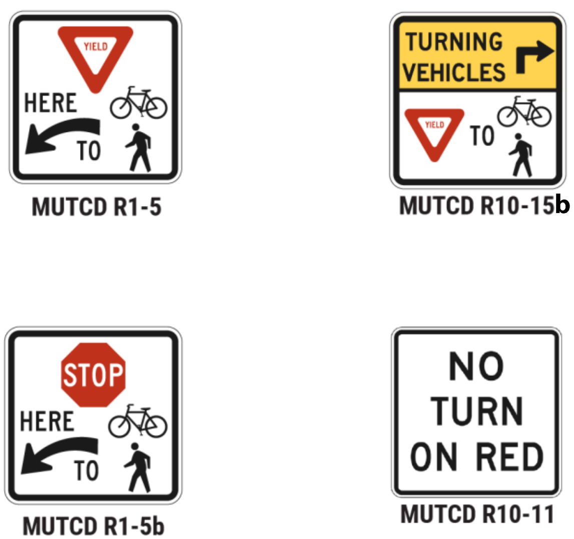


Exhibit 8: Regulatory signs to encourage motorist yielding

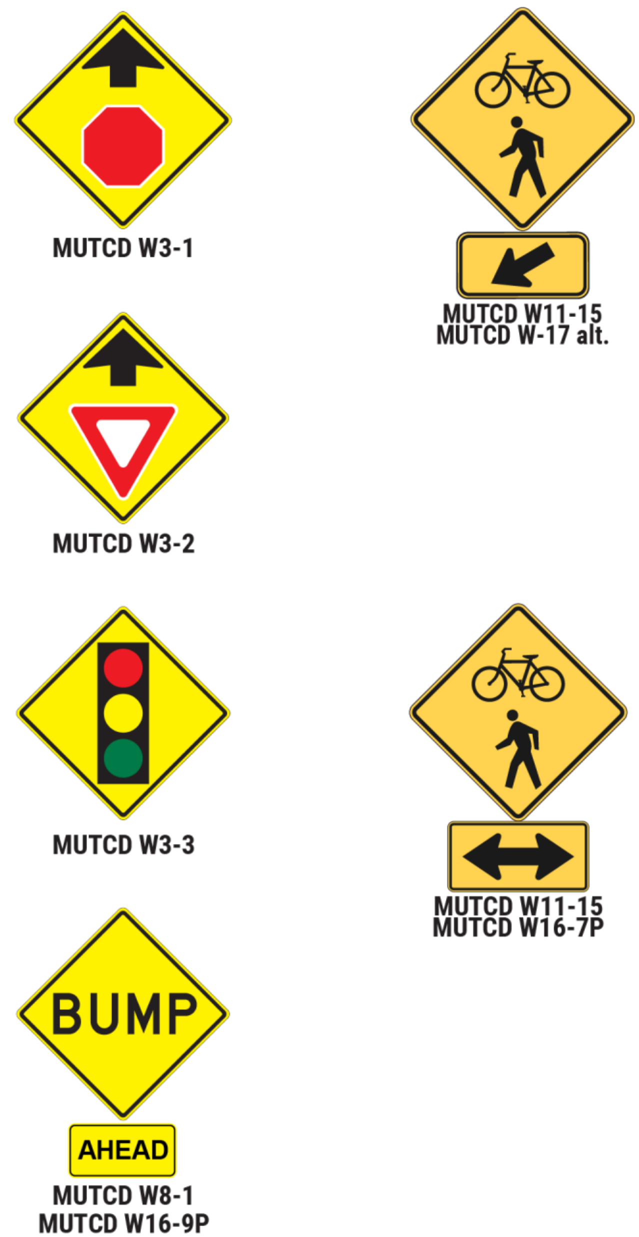


Exhibit 9: Applicable warning signs for sidepaths

MUTCD R5-1b

MUTCD R9-3c

Exhibit 10: Signs for one-way bikeways

MUTCD R9-5

MUTCD R10-24

MUTCD R10-10b

MUTCD 9C-7

MUTCD R10-22

FHWA EXPERIMENT

Exhibit 11: Signs and markings for bicyclists at signals

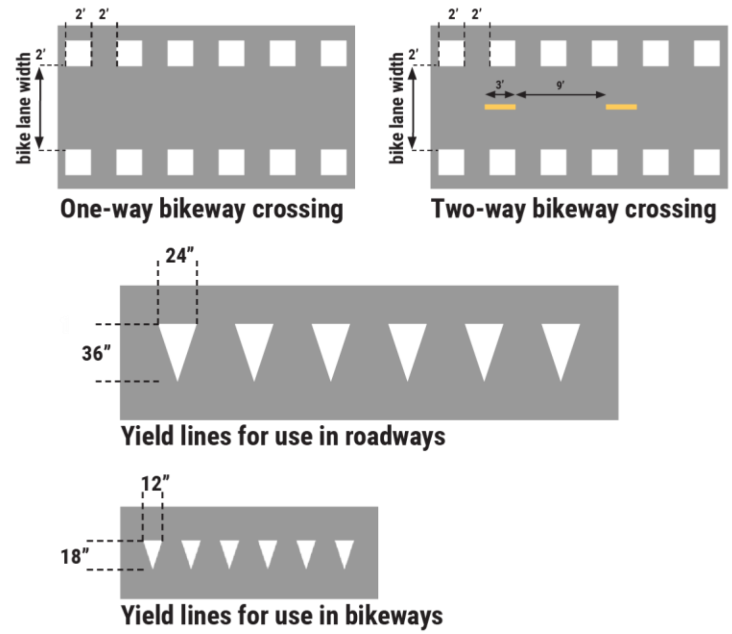


Exhibit 12: Crossing and yield markings for sidepath crossings

Crossing geometry

Modifying roadway geometry is another way to increase bicyclist visibility at various intersection forms. In particular, increasing the offset distance between the sidepath crossing and the primary roadway modifies the timing and positioning at which a turning motorist will see or encounter a bicyclist. One key design consideration is to offset the sidepath 6 to 16.5 feet[4] from the curb line of the parallel roadway, as shown in Exhibit 13.

With offset geometry, a motorist turning from the parallel roadway more directly faces a bicyclist in the crossing, rather than conventional designs that position a bicyclist closer to the travel lanes and in the motorist's blind spot. This offset distance also creates space for a right-turning motorist to yield and wait for a through-moving bicyclist.[ix, x, xi, xii]

Modifying the turning radius from the primary roadway induces motorists to decrease their speed through the turn, which allows them more time to scan the sidepath for bicyclists. Coupled with warning signs and pavement markings, modifying roadway geometry can be effective in reducing crash risk for pedestrians and bicyclists.

Providing sufficient approach clear space for motorists to see bicyclists at intersections is also an appropriate method to increase visibility. Obstructions should be removed from this clear space, such as trees, large poles, etc. The length of the clear space should increase with higher roadway and turning movement speeds.

Offset crossings can also be raised. As noted earlier, raised crossings are not only effective speed management tools, but they also elevate the position of sidepath users, which increases user visibility.

For motorists exiting a driveway or side street onto the primary roadway, this offset sidepath geometry effectively separates the yielding actions by encouraging motorists to yield to the sidepath and then pull forward to yield to traffic on the primary roadway. A larger setback also allows drivers to yield to motor vehicle traffic without blocking the sidepath crossing. In this configuration, the motorist has additional time to first look for sidepath users, and then clear the sidepath to focus on merging into the primary roadway.

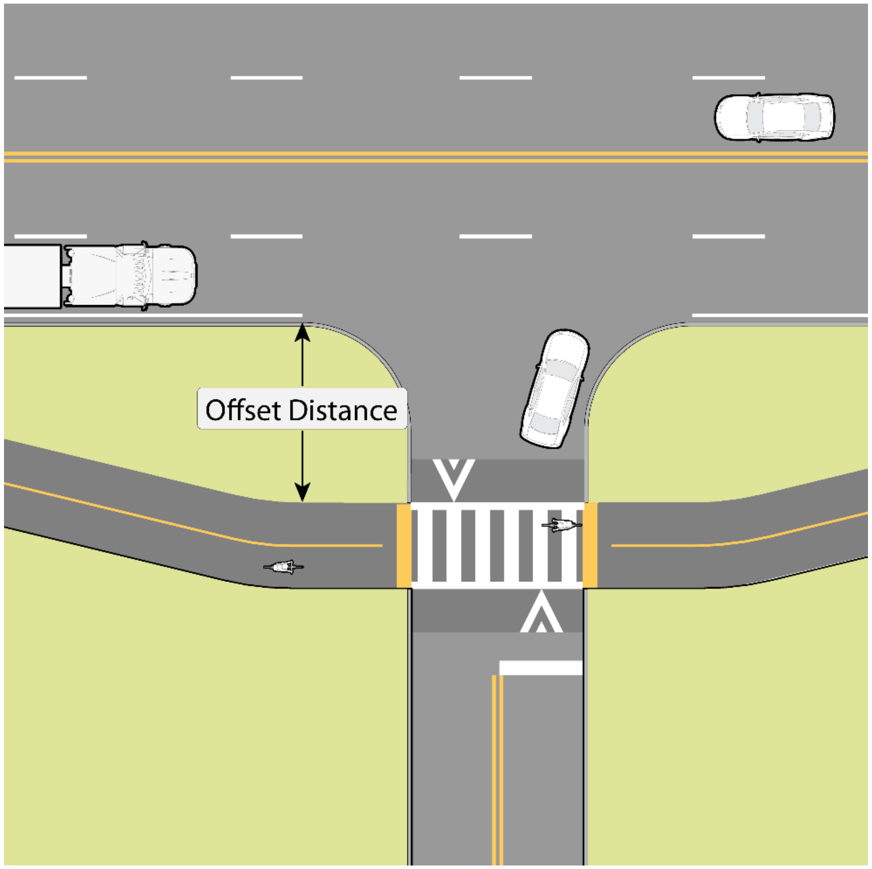


Exhibit 13: Offset sidepath crossing geometry

[4] An offset of up to 24 feet may be appropriate for roadways with traffic speeds of 55 mph or greater.

Bikeway width and intersection treatment selection process

Identifying design parameters and constraints and incorporating supportive design elements for sidepaths along roadways in Michigan has been outlined in a step-by-step process, illustrated in Exhibit 14.

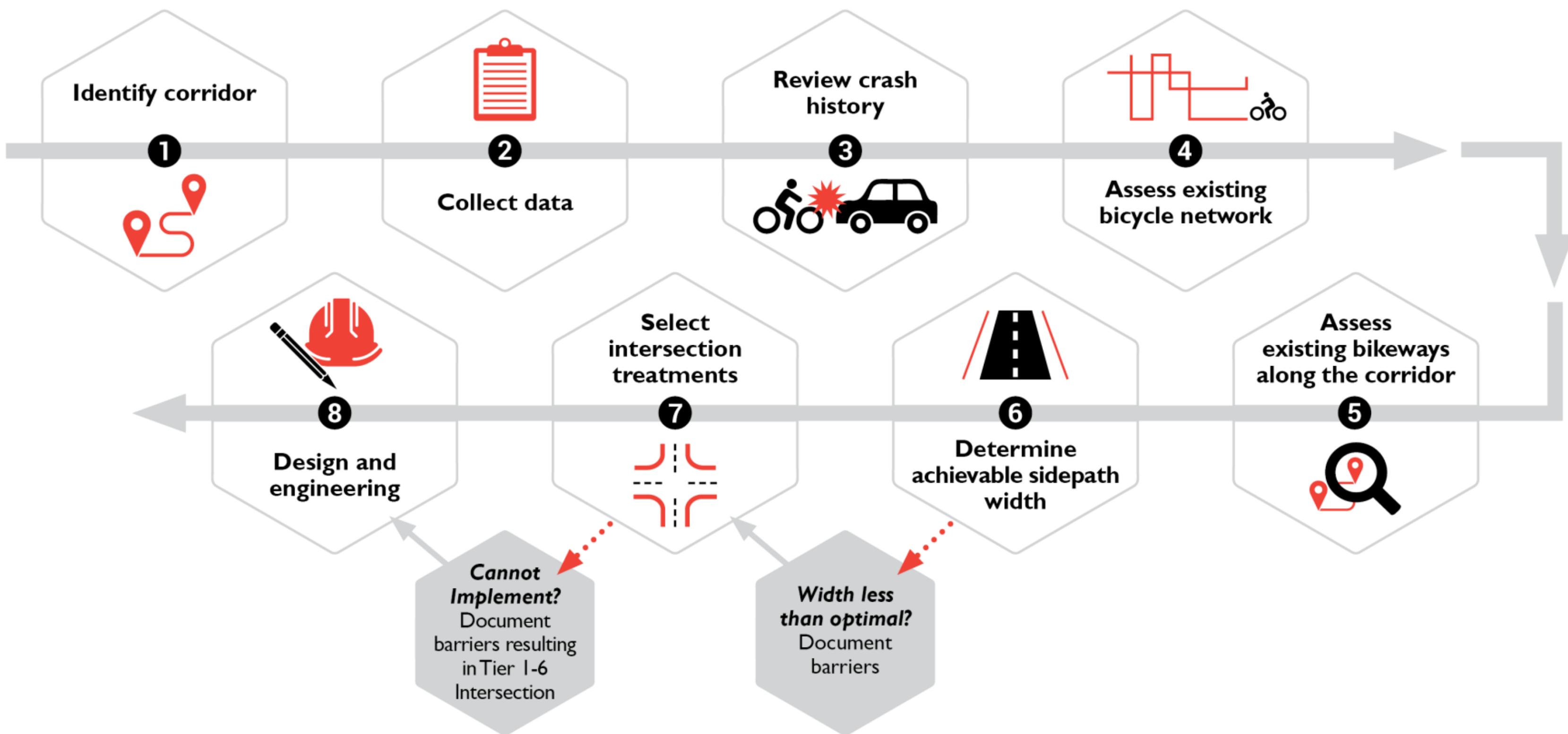


Exhibit 14: Sidepath design process

Step 1: Identify corridor

The first step in the sidepath design process is to identify the corridor and project limits. Typically, roadway projects are undertaken to address vehicle capacity or pavement condition and a sidepath is considered an additional feature. The type of construction undertaken influences the extent to which the corridor design can accommodate optimal sidepath design parameters.

Three primary types of projects allow for incorporation of sidepaths:

A) New construction
B) Reconstruction/expansion projects
C) Construction projects within existing ROW

These project types provide different opportunities for creating a sidepath or enhancing existing sidepath conditions on a given corridor. New construction and reconstruction projects may provide the greatest opportunity for incorporating sidepaths according to best practices. In an unconstrained corridor, ROW acquisition can include the area needed for an optimal sidepath design. In constrained corridors or in construction projects that maintain the existing ROW, the ability to implement an optimal facility may be compromised, or require adjustments to other roadway design elements to accommodate the optimal sidepath design.

Step 2: Collect data

Following identification of the corridor, limits, and project type, the existing conditions can be inventoried and evaluated for design opportunities. Collecting these data will help in understanding the modifications that can be implemented on a corridor-wide basis.

The following data need to be collected on a corridor-wide basis to establish existing conditions:

- Crash data – identify contextual crash risk issues
- ROW – widths and location of limits
- Vehicle lanes – quantity and widths
- Center turn lane – presence and width
- Landscape strip or street buffer – presence and width
- Sidepath/sidewalk – presence and width
- Bicycle lane – presence and width
- On-street parking – presence and width

These corridor dimensions and data must be known and understood so that potential improvements can be assessed in subsequent facility selection steps. The following data can be used to evaluate intersections and/or driveways as available:

- Traffic signal timing
- Geometric data
  - Presence of a turn lane
  - Turning radii of corners intersecting the potential sidepath
- Traffic information
  - Vehicle counts (and heavy vehicle percentage)
  - Pedestrian counts
  - Bicycle counts

The availability of pedestrian and bicycle count data may be limited. In locations where this data is not available, consider the use of an online tracking system, such as the Strava Global Heatmap[5], for additional information on bicycle and pedestrian activity in the area.

Step 3: Review crash history

Performing a basic safety analysis may identify potential high crash risk areas. These locations can then be addressed in the subsequent corridor and intersection treatment design phase.

It should be noted that a lack of crashes along a corridor does not mean that a crash risk is not present. Many bicyclists avoid riding on corridors that feel unsafe or uncomfortable, leading to low exposure for crashes.

In addition, not all crashes involving bicyclists are reported. It may be necessary to engage other stakeholders, such as bicycle advocacy groups or local agencies, to identify any under-reported crashes or near-misses for bicyclists along the corridor.

[5] https://labs.strava.com/heatmap/

Step 4: Assess existing bicycle network

Providing connections between the sidepath and existing bikeways in the immediate vicinity of the selected corridor will improve the effectiveness of the overall bicycling network in the area. The proposed project extents may not necessarily complete an entire connection, but due to the infrequency of roadway projects, filling the gaps present in each project area will result in an overall enhanced bicycle network. Inventorying the surrounding bicycle network is important to determining whether network-wide bicycle improvements can be made. Furthermore, this inventory may provide insight on whether two-way or one-way bikeways should be implemented for optimal network connectivity. Consult any available local bicycle plans to see if other neighboring jurisdictions have plans to connect to the project corridor in the future. If sidepaths cannot be added to both sides of the roadway, this assessment will help to determine the most convenient side for improvements, so that network connectivity is maximized.

Step 5: Assess existing bikeways along the corridor

The roadway may already include a wide shoulder or on-street bikeway. To determine if these on-street bikeways should be replaced by or supplemented with a sidepath, consult Exhibit 3 or the most recent AASHTO *Guide for the Development of Bicycle Facilities*.

The proposed project corridor could also include a pre-existing sidepath on one side of the roadway. However, due to the increased crash risk when bicyclists ride against traffic, the proposed project may be an opportunity to encourage bicyclists to ride with traffic by adding a sidepath on the opposite side of the roadway. Installing bicycle facilities on both sides of the roadway is recommended, even if the facilities are two-way. For roadways that have more than one lane in each direction, installing sidepaths on both sides of the roadway is strongly recommended.

Step 6: Determine achievable sidepath width

While the safety analysis performed for this project did not find a relationship between sidepath/buffer width and crash risk for bicyclists, the optimal sidepath design includes paths that are wide enough to support the expected volume of users on both sides of the roadway with a comfortable buffer between the path and the road.

The shared use path chapter of the AASHTO *Guide for the Development of Bicycle Facilities* provides guidance on the preferred width of two-way sidepaths. [xiii] The guide recommends a 10-foot width, with an 8-foot minimum allowed for limited distances in some constrained locations such as adjacent to bridge abutments. The guide also recommends a street buffer width of 6 feet, with a 2-foot minimum allowed for limited distances in some constrained locations. Consult the AASHTO Guide for more specific information on the use of these minimums.

Two-way sidepath widths may require up to 14 feet to accommodate high volumes of bicycle and pedestrian traffic. The Shared Use Path Level of Service Calculator is helpful in determining if a width beyond 10 feet is necessary.[xiv] Locations with more than 100 total users (bicyclists and pedestrians) in the peak hour can benefit greatly from wider pathway widths. Consult the information collected in Steps 4 and 5 to evaluate the potential for a high volume of bicycle or pedestrian traffic on the sidepath.

Table 2 shows optimal sidepath dimensions. If the optimal facility cannot be constructed, the factors inhibiting the corridor's optimal sidepath design should be documented. Documenting the issues that compromise the optimal design will help planners and engineers identify ways to implement bikeways of a comfortable width.

Table 2: Optimal sidepath dimensions

Two-Way Facility	One-Way Facility
≥10-foot shared-use path	7-foot bikeway and 5-foot sidewalk
≥ 6-foot street buffer	≥ 6-foot street buffer

MDOT Michigan Department of Transportation

Given an unlimited amount of ROW, incorporating this optimal sidepath width into any new construction or reconstruction project is relatively straightforward. However, implementing a sidepath can be more challenging in situations where there are physical constraints and/or competing ROW needs.

Accommodating the optimal sidepath width dimensions may be achieved by narrowing other roadway facilities such as vehicle lanes, parking stalls, raised center medians or striped median spaces, or by expanding the ROW of the corridor. Prioritization of these competing design features depends on the context of the roadway and the needs of the community. Including a street buffer of 6 feet or more also allows for more straightforward incorporation of offset crossings. If the optimal sidepath cannot be accommodated, documenting the reasons that the optimal sidepath dimensions cannot be implemented may simultaneously help the designer overcome design barriers.

Step 7: Select intersection treatments

The following section describes the tiered rating system for bikeways. The treatments described earlier in this document have been combined to define the tiers. Because the most crucial safety locations along sidepaths are points where sidepath users must interact with motorists, the tiered rating system focuses on the design of these locations, consisting of intersection and driveway crossings.

An optimal Tier 1 facility should be the goal in sidepath intersection design, but may not be possible on all corridors. If the top-tier treatments cannot be included, documentation should be prepared describing why lower-tier facilities need to be implemented. Design components for Tier 1 unsignalized and signalized driveway and intersection variants are provided in Tables 4 through 8 and Exhibits 15 through 18.

Intersection treatment selection process

The process to select appropriate intersection treatments for the proposed project corridor begins with trying to accommodate the top tier (Tier 1) facility within the proposed ROW at most intersections. The intersection type (signalized, unsignalized, or driveway) is used to select corresponding treatments to achieve a Tier 1 facility.

The Tier 1 treatments are intended to mitigate the risk associated with a sidepath crossing. **An intersection receives a lower-tier score when one design element is removed from the overall design.** For example, if sidepath users do not have a dedicated signal phase but the intersection design includes all other design elements, including signs, offset distance, etc., then the intersection treatment will be rated as Tier 2. **Each subsequent removal of a design element will result in moving the overall design down a tier noting less accommodation.** Also, each removal of a design element needs to be addressed when documenting why the facility rating drops to Tier 3 and below.

Constructing a Tier 1 facility (and subsequent Tier 2 through 6 facilities) may be done by modifying the approach geometry and/or control to the intersection. Expanding the ROW may be needed in certain circumstances to provide sufficient offset distance. If the Tier 1 or 2 facility cannot easily fit within the available ROW, the barriers to implementation should be documented. Describing why the optimal intersection facility cannot be installed will provide a process for trying to overcome design barriers on future projects.

Driveway treatment thresholds

Three types of driveways, based on usage, have been defined. Some of the design elements have been omitted from low-usage and medium-usage driveway types because lower motor vehicle volume, and therefore lower risk to sidepath users, is anticipated. The vehicular volume thresholds for low-, medium-, and high-usage driveways are presented in Table 3.

Table 3: Driveway type thresholds

Driveway Usage Classification	Motor Vehicles per Hour Crossing Two-way Sidepath
Low	<10
Medium	10-50
High	>50

These thresholds have been established to represent varying degrees of risk to bicyclists proceeding through the driveway uninterrupted (i.e., their speed can be maintained without a potential stop). For example, low-usage driveways may represent a single-family home or standalone business. In this scenario, constructing a raised crossing, modifying curbs, and offsetting the sidepath from the primary roadway may not be contextually appropriate or cost-effective. Medium-usage driveways could represent a small subdivision or strip mall development. Similarly, curb work and changes to offset the path from the primary roadway may not be cost-effective. However, due to higher motor vehicle usage compared to lower-usage driveways, a raised crossing could provide a good balance between cost and potential safety benefit for sidepath users. High-usage driveways should be treated the same as unsignalized intersections with named streets.

Differentiating driveway types by usage allows the designer to achieve a Tier I driveway crossing in the absence of more intensive, but potentially cost-prohibitive, designs. Engineering judgment should be used to determine if additional design elements beyond those listed are needed for the low- and medium-usage driveway classifications.

Note: As of June 2018, the use of the R10-15b as portrayed in Exhibits 15, 16, and 17 is not consistent with the current MUTCD standards. This sign is currently only suggested for use at signalized intersections, and will require FHWA approval.

Table 4: Tier I facility – driveway intersection (low usage)

Treatment	*Intersection Treatment Category*		
	Crossing Priority	Speed Reduction	Sidepath User Visibility
Motorist Stop/Yield signs - bicyclists have priority through intersection	⬢		
Signs - sidepath user warning signs are provided for motorists			⬢
Striping - white pavement markings are provided for the intersection crossing			⬢

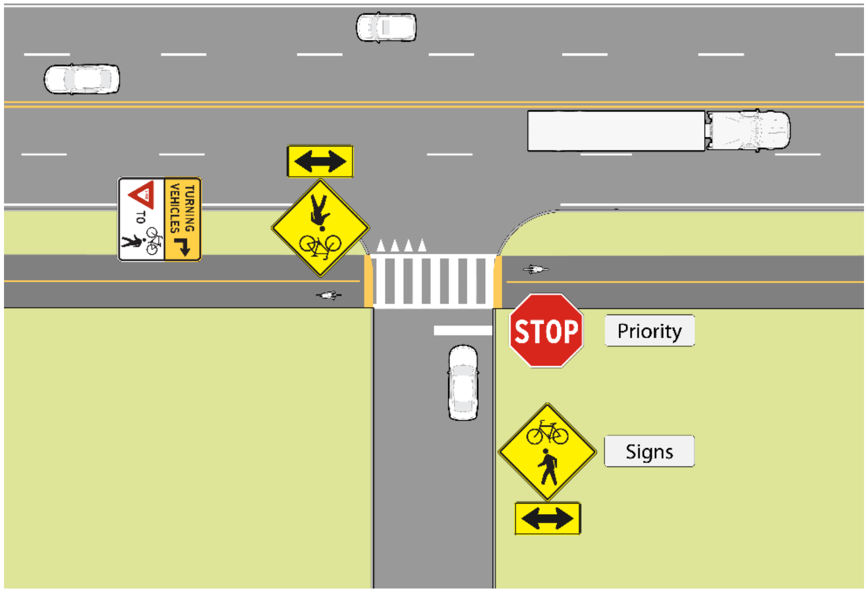


Exhibit 15: Tier I facility - driveway intersection (low usage) treatment

Table 5: Tier I facility – driveway intersection (medium usage)

Treatment	*Intersection Treatment Category* Crossing Priority	Speed Reduction	Sidepath User Visibility
Motorist Stop/Yield signs - bicyclists have priority through intersection	⬢		
Raised crossing - motorists ramp up to sidepath by at least 6 inches and crossing hump is designed for 10 mph		⬢	⬢
Signs - sidepath user warning signs are provided for motorists			⬢
Striping - white pavement markings are provided for the intersection crossing			⬢

Table 6: Tier I facility – unsignalized intersection / high usage driveway

Treatment	*Intersection Treatment Category* Crossing Priority	Speed Reduction	Sidepath User Visibility
Motorist Stop/Yield signs - bicyclists have priority through intersection	⬢		
Raised crossing - motorists ramp up to sidepath by at least 6 inches and crossing hump is designed for 10 mph		⬢	⬢
Curb radii - exiting and entering intersection curb radius is 0-15 feet		⬢	
Offset distance - edge of sidepath is offset 6-16.5 feet from the travel lane across full length of crossing		⬢	⬢
Signs - sidepath user warning signs are provided for motorists			⬢
Striping - white pavement markings are provided for the intersection crossing			⬢

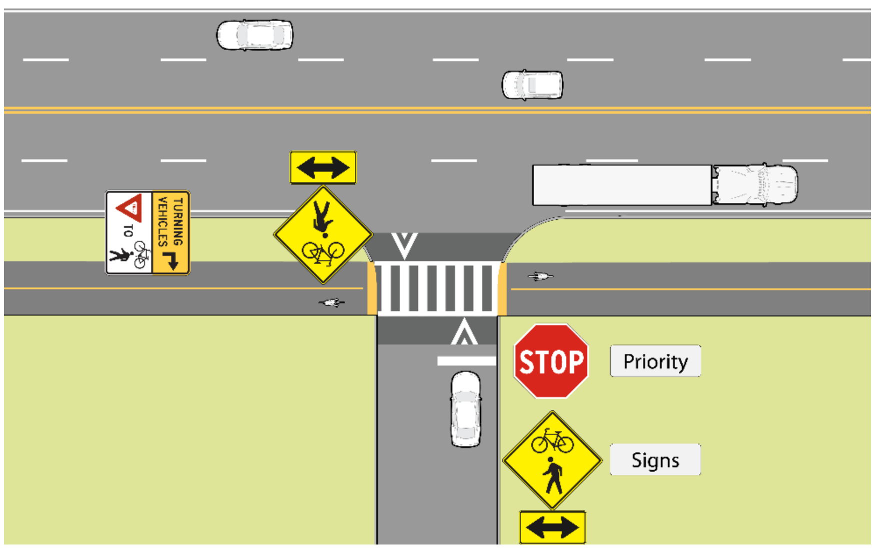


Exhibit 16: Tier I driveway intersection (medium usage) treatment

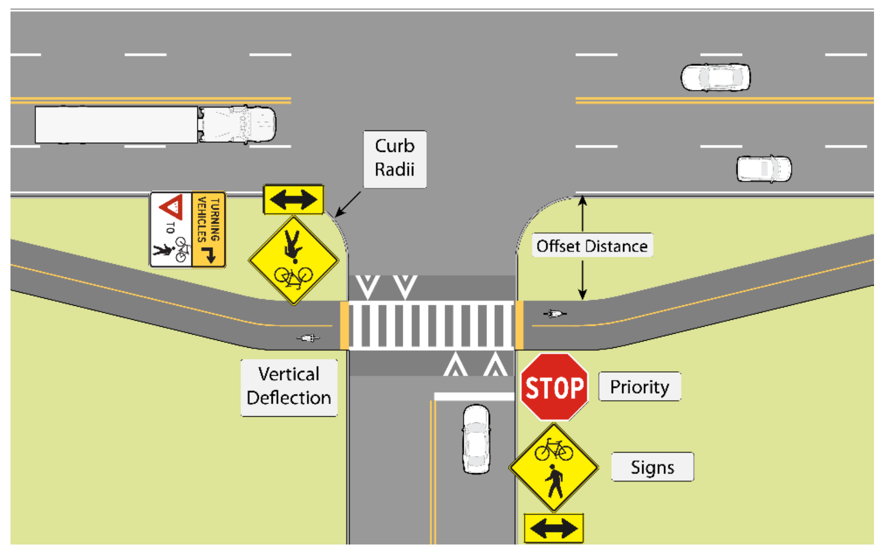


Exhibit 17: Tier I unsignalized intersection / high usage driveway treatment

Table 7: Tier I facility – signalized intersection

Treatment	*Intersection Treatment Category* Crossing Priority	Speed Reduction	Sidepath User Visibility
Dedicated bicycle signal phase or leading interval - based on vehicle volume thresholds	⬢		⬢
Raised crossing - motorists ramp up to sidepath by at least 6 inches and crossing hump is designed for 10 mph		⬢	⬢
Curb radii - exiting and entering intersection curb radius is 0-15 feet		⬢	
Offset distance - edge of sidepath is offset 6-16.5 feet from the travel lane across full length of crossing		⬢	⬢
Signs - sidepath user warning signs are provided for motorists	⬢		⬢
Striping - white pavement markings are provided for the intersection crossing			⬢

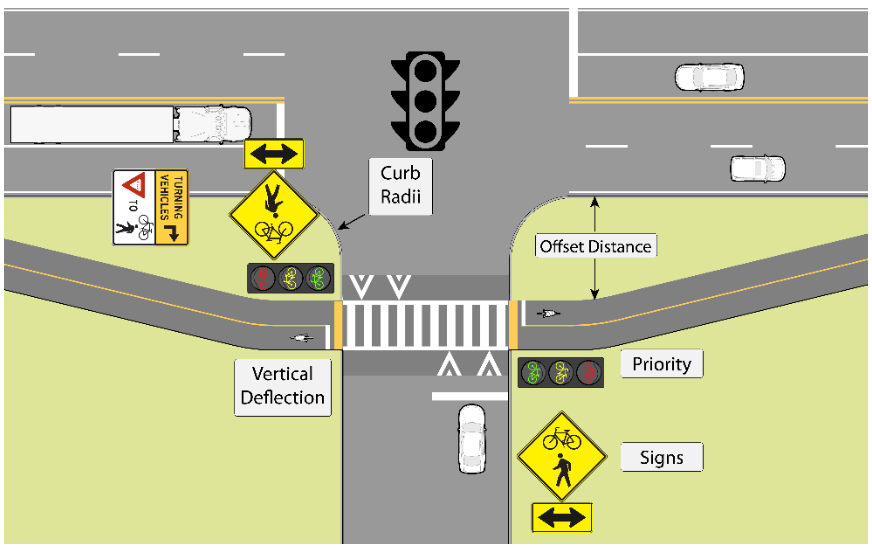


Exhibit 18: Tier I signalized intersection treatment

Step 8: Design and engineering

After the intersection sidepath treatments are chosen based on the highest rating possible, the bicycle facilities can be fully designed. With a rigorous design process, crash risk can be reduced for bicyclists traveling on a sidepath. For the Interested but Concerned bicyclist, an available route is only as strong as the "weakest link." Systematic improvements to sidepath crossings and intersections will result in a safer, low-stress facility that can maximize bicyclist use in the corridor.

Conclusion

This Sidepath Intersection and Crossing Treatment Guide has illustrated techniques to mediate general crash trends discovered during the safety analysis. Strong safety performance of sidepaths/sidewalks can guide the recommended design of sidepaths and associated intersection treatments. The described design process is intended to provide the designer with sufficient information to create an optimal sidepath design. However, no guide can anticipate every context or design situation, and engineering judgment should always be used when considering non-motorized facilities.

References

[i] Jennifer Dill and Nathan McNeil, "Four types of Cyclists? Examining a typology to better understand bicycling behavior and potential," Transportation Research Board, 92nd Annual Meeting, 2012.

[ii] United States Department of Transportation. Highway Safety Manual Clearinghouse. Published 2010, accessed 2017.

[iii] United States Department of Transportation. BIKESAFE. www.pedbikesafe.org/bikesafe. Accessed 2017.

[iv] Federal Highway Administration. Manual on Uniform Traffic Control Devices. Washington DC. US Department of Transportation. 2009 Edition.

[v] Federal Highway Administration. Achieving Multimodal Networks: Applying Design Flexibility and Reducing Conflicts. US Department of Transportation. 2016.

[vi] Michigan Department of Transportation. Traffic and Safety Design Division. Traffic Sign Design, Placement, and Application Guidelines. March 2017.

[vii] Michigan Department of Transportation. Bureau of Highway Development Standard Plan. Pavement Marking Standards PAVE-945-C. Approved 2015.

[viii] Jensen, S. U. (2008). Safety effects of blue cycle crossings: A before-after study. Accident Analysis and Prevention, 40(2), 742-750.

[ix] CROW. *Design Manual for Bicycle Traffic.* 2006.

[x] Florida Department of Transportation. *Sidepath Facility Selection and Design.* 2005.

[xi] Massachusetts Department of Transportation. Separated Bike Lane Planning and Design Guide. 2015.

[xii] Madsen, T. and Lahrmann, H. Comparison of Five Bicycle Facility Designs in Signalized Intersections Using Traffic Conflict Studies. Elsevior. Transport Research Part F 46 pp 438-450. 2017.

[xiii] American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities.* 2012.

[xiv]FHWA. Shared-use path Level of Service – A User's Guide. FHWA-HRT-05-138. 2006.

Appendix A: Sidepath research highlights

As part of this project, TDG and WSU conducted a safety analysis with six years of bicycle-related crashes occurring in Kent and Oakland counties on MDOT roadway facilities. First, a high-level summary of crashes was produced to establish the context of existing safety conditions. Table 1 presents the crashes occurring in the roadway and in sidepath/sidewalk facilities. Due to constraints in crash data report descriptions, sidepath crashes and sidewalk crashes were combined into one crash category.

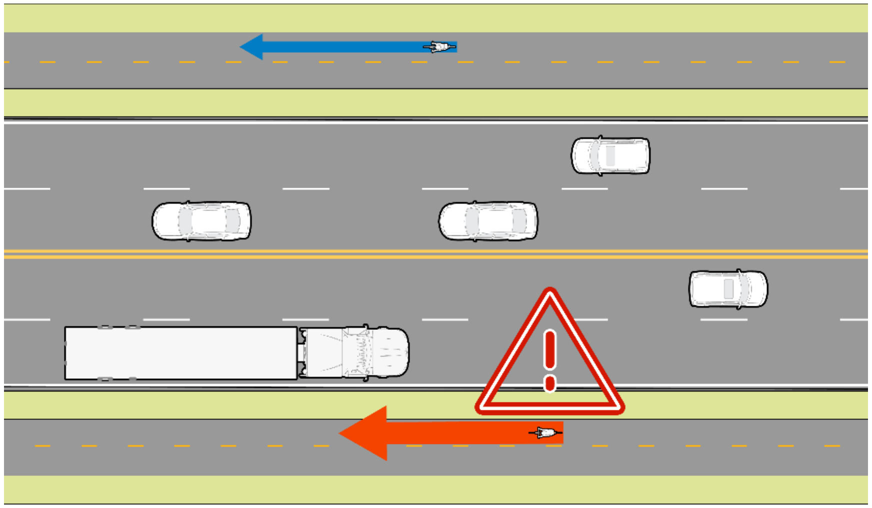
Table A-1 ***Crash Location and Severity (Kent and Oakland County Data)***

Facility	Count	%	Locaction	Count	%	Severity	Count	%
Roadway	806	35.8%	Intersection	379	47.0%	Fatal	7	1.8%
						A - incapacitating injury	43	11.3%
						B - nonincapacitating injury	153	40.4%
						C - possible injury	116	30.6%
						No Injury	60	15.8%
			Non-Intersection	331	41.1%	Fatal	9	2.7%
						A - incapacitating injury	37	11.2%
						B - nonincapacitating injury	111	33.5%
						C - possible injury	118	35.6%
						No Injury	56	16.9%
			Drive	95	11.8%	Fatal	0	0.0%
						A - incapacitating injury	9	9.5%
						B - nonincapacitating injury	29	30.5%
						C - possible injury	43	45.3%
						No Injury	14	14.7%
Sidepath/Sidewalk	1366	60.6%	Intersection	1128	82.6%	Fatal	4	0.4%
						A - incapacitating injury	52	4.6%
						B - nonincapacitating injury	403	35.7%
						C - possible injury	459	40.7%
						No Injury	210	18.6%
			Non-Intersection	31	2.3%	Fatal	1	3.2%
						A - incapacitating injury	2	6.5%
						B - nonincapacitating injury	10	32.3%
						C - possible injury	13	41.9%
						No Injury	5	16.1%
			Drive	207	15.2%	Fatal	0	0.0%
						A - incapacitating injury	10	4.8%
						B - nonincapacitating injury	70	33.8%
						C - possible injury	95	45.9%
						No Injury	32	15.5%

While Table 1 indicates that there are more crashes classified as occurring on a sidepath/sidewalk, crashes occurring on the roadway tend to be more severe. More crash trends have been identified in the detailed crash analysis report titled "Sidepath Application Criteria Development for Bicycle Use." (i)

The crash data were further parsed to examine several key characteristics important to the design and operation of sidepaths. Findings from the analysis of crash trends as they relate to design and operations are as follows:

Crash Trend #1: Bicyclists riding against traffic are at higher risk than those riding with traffic



Crash Trend 1 illustrates that bicyclists traveling against traffic comprise a greater proportion of sidepath/sidewalk crashes (64.8 percent).

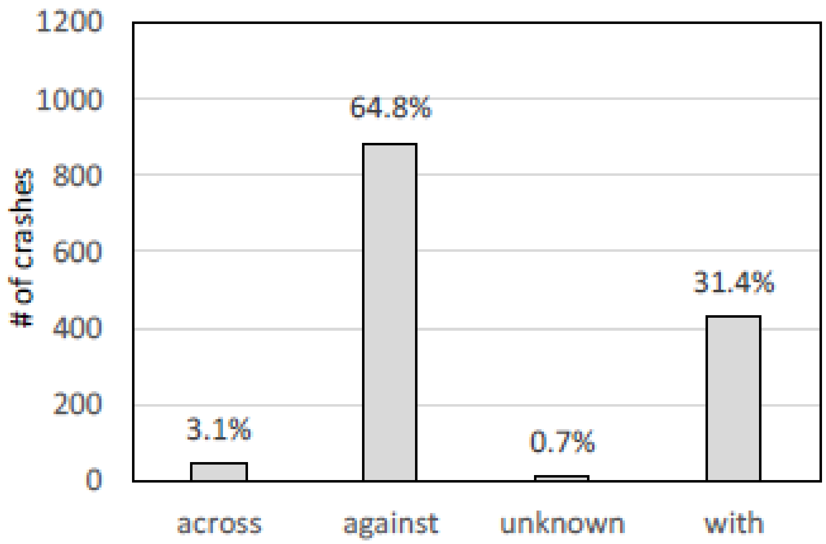
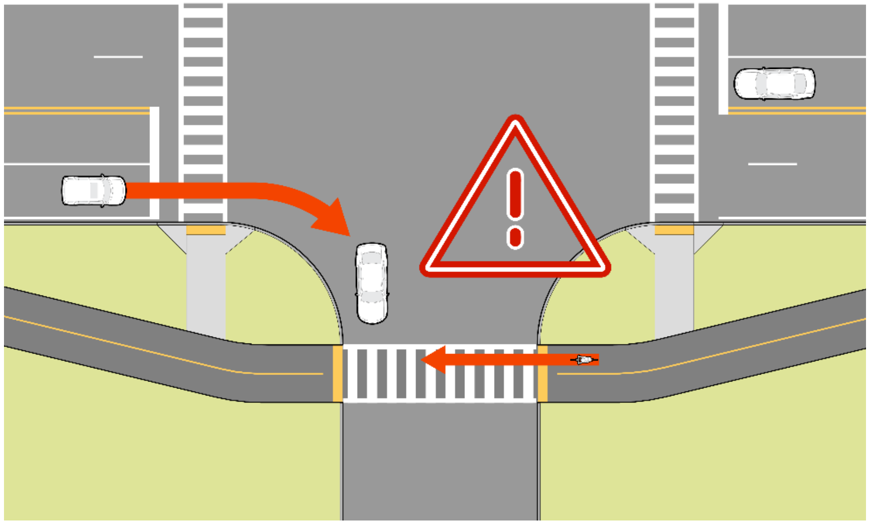


Exhibit A-1 Sidepath/Sidewalk Crashes by Bicyclist Direction

There are several roadway characteristics that may contribute to a bicyclist's decision to ride in the opposite direction to traffic on the sidepath. Because many intersecting roadways have multiple vehicular travel lanes, crossings are challenging. Also, with low pedestrian activity and sidepaths that are typically 8 feet wide, bicycling in the opposite direction to traffic is not geometrically discouraged.

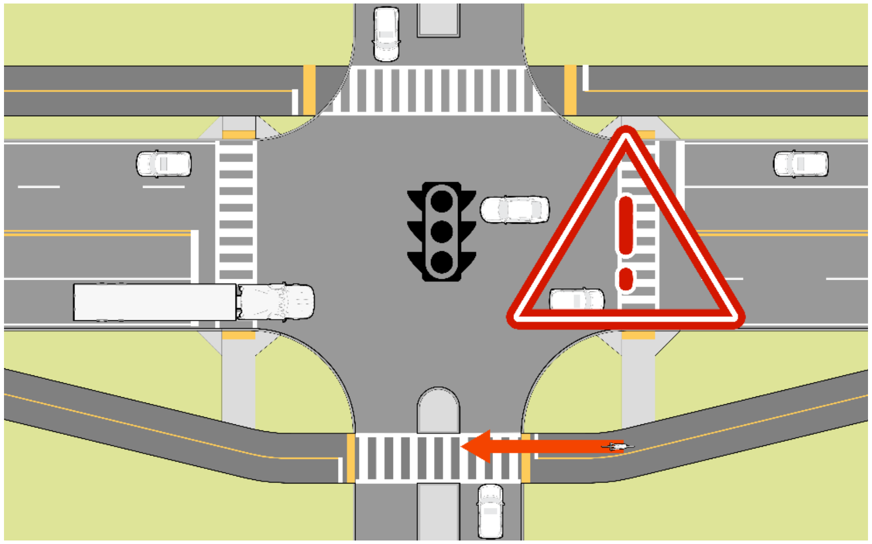
One explanation for the increased crash rate is that drivers may not expect bicyclists traveling in the opposite direction.

Crash Trend #2: Bicyclists riding against traffic have a higher risk of crash with right-turning vehicles



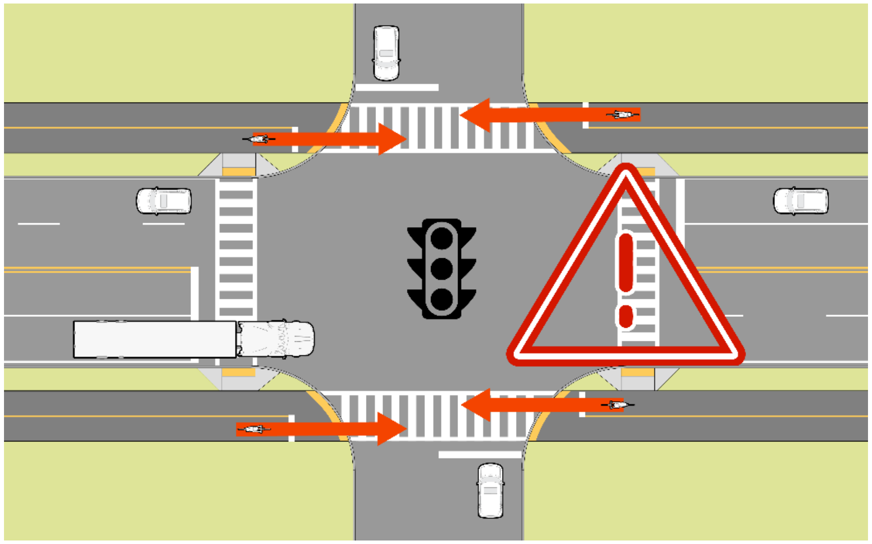
Of sidepath/sidewalk bicyclist crashes, 34 percent involved right-turning vehicles and bicyclists traveling against traffic. The next largest bicycle/vehicle crash types by direction are: right-turning vehicles and bicyclists traveling with traffic (10 percent), and vehicles traveling straight and bicyclists traveling against traffic (angle crash – 8 percent).

Crash Trend #3: Bicyclists riding against traffic have a higher crash risk at commercial driveways and signalized intersections



72 percent of sidepath/sidewalk crashes **at commercial driveways** involved bicyclists traveling against traffic. 64 percent of sidepath/sidewalk crashes at **signalized intersections** involved bicyclists traveling against traffic.

Crash Trend #4: Bicyclists riding through signalized intersections have a higher risk than at intersections with other types of traffic control

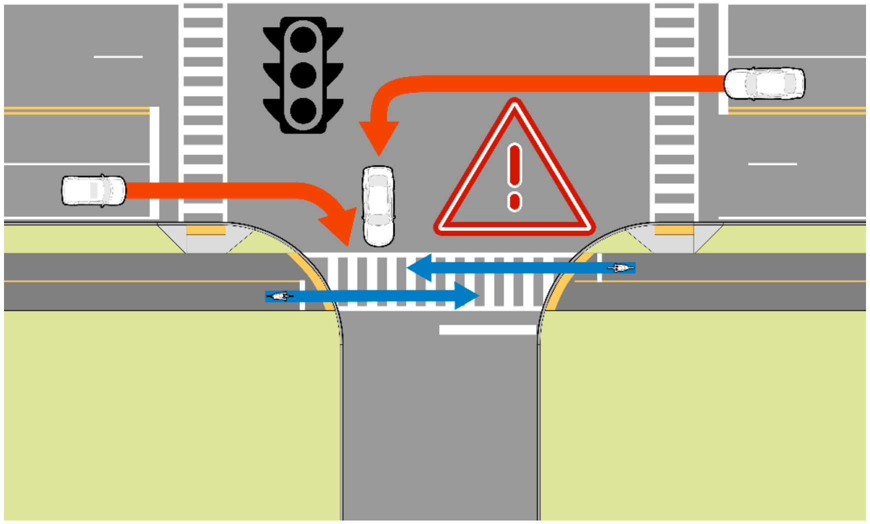


Intersection crash statistics illustrate that 51 percent of sidepath/sidewalk bicycle crashes occur at signalized intersections. Of the 51 percent of crashes, 61 percent involve right-turning vehicles and 15 percent involve left-turning vehicles.

By comparison, 31 percent and 10 percent of all intersection-related sidepath/sidewalk bicycle crashes occur at unsignalized intersections and driveways, respectively.

In most cases, signalized intersections can be assumed to have greater traffic volumes for all modes than unsignalized intersections, based on the necessity of the traffic signal. Higher traffic volumes at signalized intersections – the greater exposure inherent in these contexts – can increase the crash risk between a bicycle and motor vehicle.

Crash Trend #5: At signalized and unsignalized intersections, sidepath/sidewalk bicycle crashes tend to occur with left- or right-turning vehicles.



The majority, or 68 percent, of sidepath/sidewalk crashes at signalized intersections occur with right- or left-turning vehicles. At unsignalized intersections, 59 percent of sidepath/sidewalk crashes occur with right- or left-turning vehicles. Other crash types based on motor vehicle movement at signalized and unsignalized intersections comprise less than 10 percent (e.g., vehicles going straight, stopped, etc.).

[i] Sidepath Application Criteria Development for Bicycle Use. Wayne State University. Aug. 11, 2017.

Appendix B: Sidepath intersection and crossing design worksheet

As part of this project, TDG developed a fillable worksheet for use by practitioners when applying the steps recommended in the guide. The three page worksheet follows.

MDOT
Michigan Department of Transportation

SIDEPATH INTERSECTION AND CROSSING DESIGN WORKSHEET

This worksheet is intended to guide designers in the application of the Sidepath Intersection and Crossing Treatment Guide. Complete this worksheet as early in the design process as possible to ensure the incorporation of the highest quality sidepath design.

Step 1 : Identify Corridor

Define the project type:

- ☐ New construction
- ☐ Reconstruction / expansion
- ☐ Construction within the existing right-of-way
- ☐ Other, describe:

Briefly describe the project that includes the sidepath being evaluated (e.g. project limits, construction timeline, planning process):

Step 2 : Collect Data

Recommended corridor and intersection data are listed below, check all that were reviewed:

- ☐ 10 years of data for crashes involving bicyclists & pedestrians
- ☐ Right-of-way width & limits
- ☐ Corridor AADT
- ☐ Number and width of through lanes, turn lanes
- ☐ Presence/width of existing sidewalk/sidepath
- ☐ Presence/width of existing on-street bicycle lane
- ☐ Presence/width of on-street parking
- ☐ Intersection turning radii
- ☐ Signal timing information
- ☐ Intersection TMCs
- ☐ Pedestrian volumes
- ☐ Bicycle volumes
- ☐ Other, describe:

If any of the above were not reviewed, please explain:

Step 3 : Review Crash History

Date range of crash data reviewed:

Are there any patterns to non-motorized crashes along the corridor or at a given intersection (e.g. multiple crashes at the same location, crashes involving the same direction of travel or turning movement)?

Were there any fatalities? ☐ Yes ◯ No

If yes, describe any crash factors that this design project could address:

Step 4 : Assess Existing Bicycle Network

Describe the local or regional bicycle plans that were reviewed:

Is the corridor included explicitly in any of these plans? ☐ Yes ◯ No ◯ N/A

If a local or regional bicycle plan was not available are there any nearby land uses or destinations that may attract bicycle users to the corridor (e.g. schools, parks, or retail districts)?

Step 5 : Assess Existing Bikeways Along The Corridor

How would a bicyclist use the corridor under current conditions? Check all that apply.

- ☐ Existing sidepath at least 8 feet wide
- ☐ Existing sidewalk less than 8 feet wide*
  (Unless bicycle use on sidewalks is specifically prohibited by local ordinance.)
- ☐ Marked on-street bikeway (with or without buffer / protection)
- ☐ Wide shoulder at least 4 feet wide
- ☐ Shared lane with marking (e.g. sharrow)
- ☐ Shared lane with no marking
- ☐ Other, describe:

If an existing sidewalk or sidepath is present, is it present on both sides? ☐ Yes ◯ No

SIDEPATH INTERSECTION AND CROSSING DESIGN WORKSHEET

Step 6 : Determine Achievable Sidepath Width

What type of sidepath is included in the design? ☐ one-way ◯ two-way

Does the sidepath design meet the optimal width dimensions described in the sidepath intersection and crossing safety guide? ☐ yes ◯ no

If not, describe the barriers to meeting the optimal design:

Step 7 : Select Intersection Treatments

A Grade A facility includes each of the five following treatments. Check the boxes for each treatment included at corridor intersections.

☐ Crossing priority, describe:

☐ Vertical deflection of at least 6 inches
☐ Horizontal deflection of at least 6 feet
☐ Curb radii no larger than 15 feet
☐ Signage, describe: Click or tap here to enter text.

Based on the treatments incorporated in the design, assign a letter grade to the facility

☐ 5 = A ◯ 4 = B ◯ 3 = C ◯ 2 = D ◯ 0-1 = F

If any treatments were not included, describe the barriers to meeting the optimal design:

Step 8 : Design & Engineering

Include this worksheet in the project documentation.

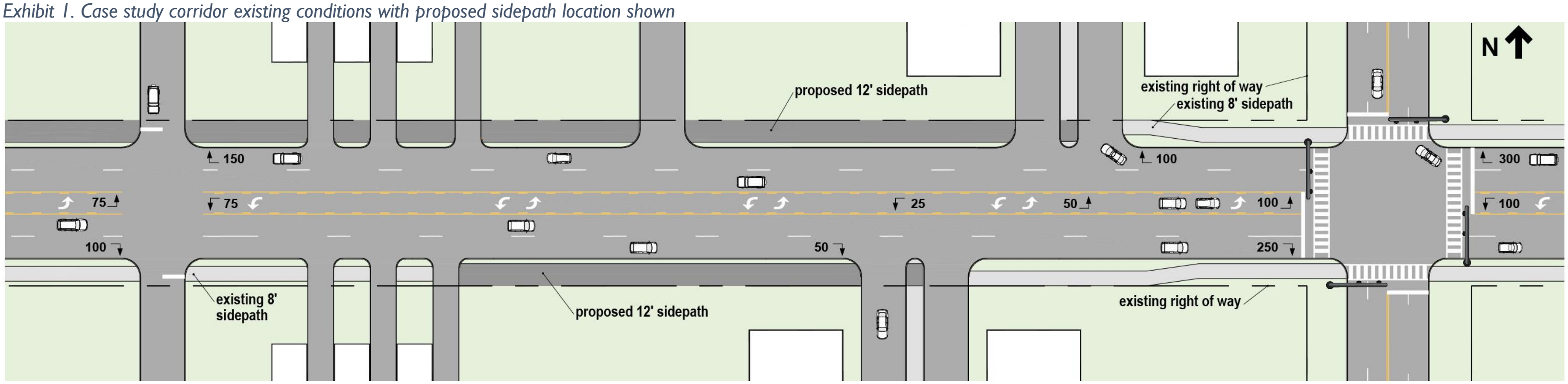
Appendix C: Case study

This case study applies the Sidepath Intersection and Crossing Treatment Guide methodology to a hypothetical corridor in Michigan. The following information is available for the corridor:

- Funding is for construction within the existing ROW.
- The existing right-of-way width is 90 feet, with two through-lanes and a continuous center left-turn lane. All lanes are 12 feet wide. There is no shoulder or on-street bike lane.
- The corridor has a mix of commercial and residential land uses.
- There is one signalized intersection and one unsignalized intersection along the corridor.
- Grades along the corridor are generally flat. The southbound approach to the signalized intersection is slightly downhill.
- Corridor Average Annual Daily Traffic (AADT) is 45,000 vehicles per day.
- Corridor posted speed limit is 50 mph.
- Heavy vehicle percentages are around two percent, and some businesses receive deliveries by large truck.
- There are two commercial driveways serving multiple businesses, one subdivision entrance, and several individual residential driveways on the corridor. The commercial driveways serve, among other destinations, a grocery store and multiple restaurants/coffee shops with drive-through windows.
- An 8-foot sidepath already exists along some segments of the corridor and its pavement is in good condition, but it is not continuous.
- The buffer between the 8-foot sidepath and the street varies from 3 feet to 7 feet in width.
- The corridor is not currently shown on any local bicycle plans; however, it is the only bicycle-accessible route across a river for 2 miles in either direction.
- Pedestrian and bicycle volume data are not available, but the designer saw a handful of pedestrians and at least one bicyclist on a recent field visit. Strava data showed light usage.
- There have been four bicycle-involved crashes on the corridor in the last 10 years, including one fatality at the unsignalized intersection. The bicyclist was riding against traffic on the existing 8-foot sidepath on the south side of the roadway and was struck by a right-turning motorist.

Exhibit 1 illustrates the extents of the corridor, known turn volumes, and other characteristics.

Exhibit 1. Case study corridor existing conditions with proposed sidepath location shown



Steps 1 – 5: Data collection and background information

Using the Sidepath Intersection and Crossing Treatment Guide, the available data is reviewed and observations are documented on the provided worksheet. Because there are already sidepaths on either side for portions of the high-traffic corridor and the corridor provides a necessary connection for bicyclists, providing a continuous sidepath on both sides should be considered. The ROW is sufficient to incorporate at least the minimum-width sidepath and buffer on both sides of the roadway.

Because there is no bicycle volume information, a crash rate cannot be calculated. However, the occurrence of a bicycle-involved fatality suggests that safety treatments at the unsignalized intersection should be as robust as possible.

Step 6: Determine achievable sidepath width

The existing 90 feet of right-of-way width is divided into 60 feet of curb-to-curb roadway width and 15 feet behind the curb on both sides. The existing sidepath width meets the minimum requirements (8-foot path with 2-foot buffer), but not the recommended dimensions (10-foot path with 6-foot buffer). However, because the pavement is in good condition, and the budget for this project is limited, the existing segments are to remain as-is.

In the areas where a new sidepath will be added, a 12-foot sidepath could be considered if volumes are expected to be high. However, this design would leave only 3 feet for the buffer - less than the recommended 6 feet. Roadway lane widths were reviewed, but given the motor vehicle volumes and speeds, no additional space is available. A compromise between width and buffer space is sought, and a 10-foot path with 5-foot buffer is designed.

Step 7: Select intersection treatments

Unsignalized intersection treatment

Due to the recent fatality at the unsignalized intersection, every effort is made to incorporate Tier A treatments.

The intersection currently has relatively large curb radii that can be reduced to 15 feet to minimize turning speeds. Traffic volume data indicate that there are not many trucks making this movement, so moving the curb to reduce the radius is feasible, and a truck apron is not deemed necessary.

In this case, achieving the desired offset distance happens to include the purchase of ROW from businesses on the corners of the intersection. The agency responsible for developing the plans engages these stakeholders early and often, and is able to reach an agreement to make the purchase and achieve an 8-foot offset. The project timeline is delayed by a few months as a result. The intersection receives a Tier A rating.

Signalized intersection treatment

At the signalized intersection, traffic volumes are high enough to apply intersection design treatments adhering to the motor vehicle thresholds shown in Table 1. The eastbound and westbound right-turn volumes exceed the 100-vehicle threshold for a protected signal phase. However, capacity at the intersection is limited, and a traffic operations study found that a fully-protected phase for the sidepath in every cycle is not feasible. A 7-second leading interval is included in the design, with the option to add detection and a fully-protected phase if field results after installation suggest that the leading interval is not sufficient.

Plastic delineators are selected to decrease the effective turning radius of passenger vehicles, while still allowing for turning movements of large trucks. The agency developing the plans happens to own both roadways at this intersection, as well as the necessary ROW to achieve a 6-foot sidepath offset.

A review of the approach grades and drainage on the southbound approach determined that integrating vertical deflection was not feasible without significant reconstruction of the drainage system. Omitting the vertical deflection on this approach, but incorporating all other treatments, results in a Tier B rating for this intersection.

Driveway intersection treatments

Although driveway volumes are not available, traffic volumes can be estimated from land uses. The driveways along the corridor can be divided into low-, medium-, and high-volume crossings based on the land uses served and the thresholds provided in Table 3. The single-family residential driveways are assumed to have fewer than 10 crossings per day. The subdivision entrance serves a neighborhood of 30 homes, and is assumed to have more than 50 crossings per day. The commercial driveways are assumed to fall into the high-volume category, based on the number of businesses and the presence of the drive-through operations.

Low-volume driveway treatments

Tier A facilities are feasible for these low-volume locations without complications. Public engagement with the homeowners may be needed to ensure bicyclist priority at the crossings.

Medium-volume driveway treatments

None of the driveways on the corridor meet the criteria for medium-volume driveways.

High-volume driveway treatments

Constructability of vertical deflection at the subdivision entrance will not be an issue. However, it is a new concept for motorists in the area. Public engagement during project development to fully explain and get buy-in on the design may be needed.

At the two commercial driveways, constructability of vertical deflection and the sidepath offset is not problematic. However, the grocery store owner is concerned about trucks accessing their store. The store receives deliveries from 53-foot trucks once or twice per day. In this case, a truck apron is used to achieve a 15-foot curb radius for passenger cars, and provide a larger, 40-foot radius for trucks when needed.

All driveways receive a Tier A rating.

Overall project score

Because bicyclist comfort is based on the weakest link in their trip, the overall Tier for the corridor is a Tier B, based on the signalized intersection treatments.