SIDEPATH FACILITY SELECTION AND DESIGN

Project Report

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Project Structure & Research Team

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SIDEPATH FACILITY SELECTION AND DESIGN

This sidepath selection methodology addresses two issues related to bicycle travel: providing opportunities to those people who may wish to use a bicycle for transportation, and the safety of all those riding bicycles. Simply put, there are some people who will not choose to ride bicycles for transportation if only on-street facilities are provided. A subset of this group includes those who, while they must ride on whatever facility is provided (to get to jobs, schools, stores), are not comfortable riding in the roadway with motor vehicles. Providing sidepaths may increase the population of those who might choose to use bicycles and the mobility of those who must use bicycles. In addition to accommodating cyclists, the selection procedure must address bicycling safety concerns. This selection methodology addresses both the mobility and safety aspects of providing sidepaths.

The sidepath selection methodology is a step-by-step process for determining if a sidepath is an appropriate facility. It was developed as an expert system that addresses the need for a sidepath, design and operational considerations, and safety. If in any step it is determined a sidepath is not needed or appropriate, the analysis is stopped. Otherwise the user will proceed to the next step.

The sidepath selection procedure considers the following issues:

- level of accommodation for bicyclists on the adjacent roadway, paired with the potential bicycle travel demand along the roadway,
- potential safety of a sidepath facility;
- the presence of alternative routes,
- adequacy of right-of-way to accommodate a sidepath,
- access to probable destinations,

- appropriateness of sidepath length and the design of termini, and
- the level of comfort and safety the proposed sidepath would provide.

A more detailed explanation of these considerations follows:

Step 1: Evaluate the Bicycle Level of Service of the Adjacent Roadway.

The first step in determining if a sidepath facility is needed is to determine how well the available or potential on-street facilities accommodate bicyclists. FDOT's *Quality / Level of Service Handbook*[1] provides the approved Bicycle Level of Service methodology for making this determination.

In addition to the existing roadway Bicycle LOS, the potential demand for bicycle facilities should be considered when determining if a corridor is a candidate for a sidepath. The bicycling facilities provided should be related to the anticipated demand and user types for those facilities. In an urbanized area, a substantial number of bicyclists with varying experience can be expected to bicycle if given comfortable facilities. Long distance rural routes may attract more experienced cyclists who do not require as high a level of accommodation. Exhibit 1 provides guidance on when a sidepath may be appropriate given the roadway Bicycle LOS (supply) and the area type as defined in the *FDOT Quality / Level of Service Handbook*[2] (demand). This table is for general application and could be replaced with a more detailed supply vs. demand (benefit / cost) type methodology (such a methodology is the subject of an upcoming FDOT District 7 project). If land uses adjacent to a proposed project suggest special users groups (the presence of parks and schools would suggest children) these should be considered in addition to the general area type.

[1] *2002 Quality / Level of Service Handbook*, pg. 17-19, FDOT, Tallahassee, FL, 2002.

[2] *2002 Quality / Level of Service Handbook*, pg. 47-49, FDOT, Tallahassee, FL, 2002.

Exhibit 1 Sidepath based upon demand

		Roadway Bicycle Level of Service					
		A	B	C	D	E	F
Area Type	Urbanized	N	N	P	S	S	S
	Transitioning / Urban	N	N	N	P	S	S
	Rural Developed	N	N	N	P	S	S
	Rural Undeveloped	N	N	N	P	P	P

N – Not a prime candidate for a sidepath
P – Possible sidepath candidate
S – Sidepath Candidate

Step 2: Determine if a sidepath is a safe alternative to an on-street facility.

Prior to deciding to provide a sidepath facility, a designer should review the roadway environment to determine if the sidepath provides a safe alternative when compared to the on-street facility.

As the major effort of this project, the consultants performed an extensive evaluation of the crash rates for roadways with sidepath facilities. This evaluation yielded a predictive model to determine the relative safety of on-street versus off-street facilities for bicyclists. Twenty-one roadway sections throughout the state of Florida were analyzed to compare the crash rates of on-street bicyclists to those of the off-street bicyclists using the sidepaths (Exhibit 2). The geometric and operational conditions of each section were evaluated to determine what factors influenced the relative crash rates for the on- and off-street facilities.

Exhibit 2 Roadway sections analyzed in this study

Road Name	From	To	Length (miles)	County
US 19	McCormick Drive	Enterprise Rd	0.8	Pinellas
66th St N	Bryan Dairy Rd	118th Ave N	0.4	Pinellas
Alt US 19/ SR 595	Access Rd(South of 38th Ave)	Park St	0.5	Pinellas
66th St N	5th Ave N	10th St (Before 13th St)	0.3	Pinellas
Gulf Blvd	93rd Street	First Street	0.5	Pinellas
Tamiami Trail	Symmes Rd/ Emergency Signal	Beach Ave	0.25	Hillsborough
Cleveland St/SR 60	Highlands Ave	McMullen Booth Rd (Overpass)	4.139	Pinellas
Ulmerton Rd	Belcher Rd	Rose Tree Lane (Monterey Lake Apts)	0.2	Pinellas
W Hillsborough Ave	Tudor Dr	Sheldon Rd	0.5	Hillsborough
W Martin Luther King Blvd	Caraway Dr (West of Williams Rd)	Peak St (East of Hewitt St)	0.9	Hillsborough
66th St N	66th Ave	Park Blvd	0.5	Pinellas
S Missouri Ave	East Bay Dr	Court St (North of Rogers St)	3.0	Pinellas
East Bay Dr-Roosevelt Blvd	Seminole Blvd/Missouri Ave	Bolesta Rd	5.1	Pinellas
N Dale Mabry	W Cleveland St.	Nassua St/ Before I-275 Ramp	0.7	Hillsborough
S Pasedena Ave	Blind Pass Rd	Park St	0.71	Pinellas
Fowler Ave	Florida Ave	30th St/ Bruce B.Downs	1.8	Hillsborough
S Pasedena Ave1	Blind Pass Rd	Shore Drive S	0.99	Pinellas
Fowler Ave1	N Florida Ave	I-275 overpass	0.3	Hillsborough
Gulf Blvd	Corey Ave	93rd St	1.0	Pinellas
S Dixie Hwy	Ludlum Road/SW 67 Ave	SR 966/ SW 72 St	0.95	Dade
S Dixie Hwy	SR 966/ SW 72nd St	Maggiore St	2.05	Dade

Crash data were obtained from a variety of sources. Initially, it was thought that the FDOT crash database (CARS) would provide adequate data for this project. While there are limitations to the data in this database, the researchers felt that the data would at least be consistently limited across all the facilities. Initial modeling using this data found that sidepaths were inherently safer than roadways. Because this result is inconsistent with previously published research (submitted as the literature search for this project) on this subject, the researchers felt the limitations of the CARS dataset were more serious than anticipated. Upon a detailed review of the crashes obtained through the FDOT database, we identified two potential problems with the data which were impacting the accuracy of any analysis and, if not mitigated, would have led to erroneous conclusions. First, many of the crashes which were coded as having occurred on the roadway may, in fact, have been sidepath users who were entering the roadway or trying to cross an intersecting roadway. Second, crashes occurring along a sidepath may have been recorded as occurring on an intersecting roadway rather than on the roadway paralleling the sidepath, and thus not be represented in the subsequent analysis.

To determine if either or both of these two problems was occurring we obtained hard copy crash reports of the roadway / sidepath sections. This analysis entailed obtaining hard copies of the crash reports for crashes occurring on the State Road along which the sidepaths are located. Additionally, local law enforcement agencies were contacted and, working with those agencies, we obtained crash reports for all bicycle crashes occurring along the roadways that intersected the sidepath. The crash reports were individually reviewed to determine their relevance to the project analysis.

To develop crash rates, bicyclist exposure counts were performed for four hours on a weekday afternoon and four hours on a weekend morning. Data collection forms were developed and tested. Then, using Florida's network of FDOT and local Pedestrian and Bicycle Coordinators to supervise the field data collection effort, temporary employees and volunteers were used to actually count trail and roadway users on the twenty-one facilities.

Stepwise regression was used to develop a robust mathematical model (R^2 = 0.81) to predict the difference in crash rates between cyclists riding on a sidepath and cyclists riding on the roadway. This mathematical model is shown below:

$$\Delta = W_{sp}\left(6.311 - 0.465W_{sp}\right) + D\left(0.015S - 0.685\right) - 1.528\ln(L) - 17.555 \qquad \text{(Eq. 1)}$$

where:

Δ = predicted bicycle crash rate for a roadway – predicted bicycle crash rate for a sidepath
W_{sp} = width of the sidepath
D = effective distance between the sidepath and the roadway (buffer width + ½ sidepath width)
S = speed limit of the adjacent roadway
L = number of through lanes on the adjacent roadway

Below some of the impacts of the model form are discussed. The exhibits provided below are for specific (example) cases. They should not be used to analyze actual roadway scenarios (unless they meet the conditions specified).

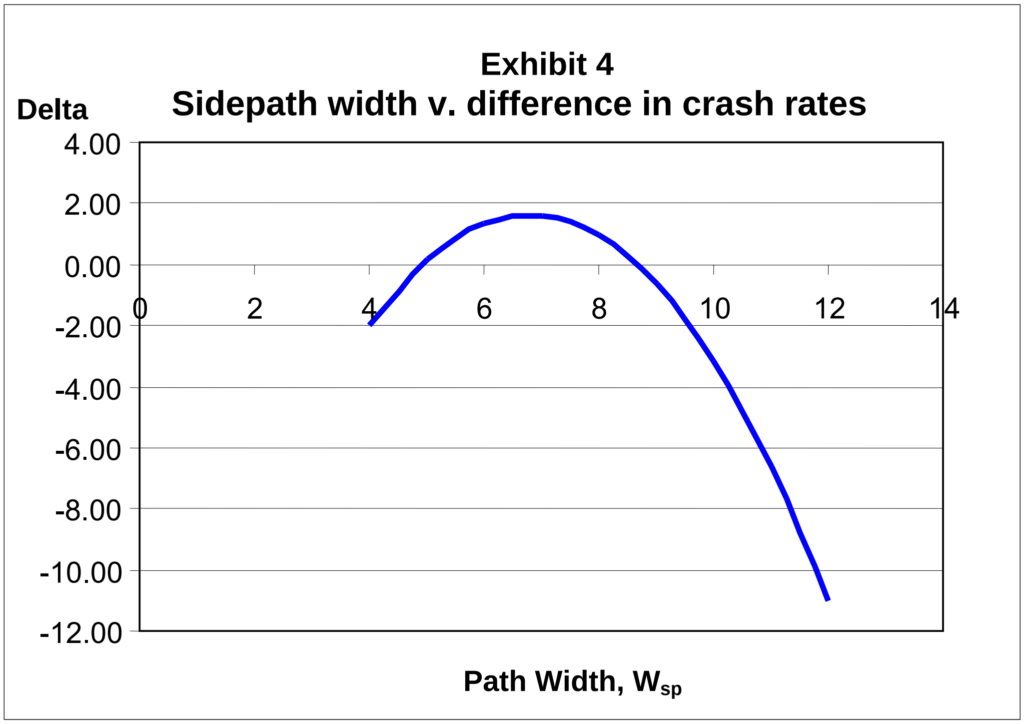
As can be seen from the definition of Δ (delta), a positive result from the model predicts that the sidepath would have a lower crash rate than the roadway for bicyclists.

Exhibit 3 Model Coefficients and Statistics

Model Terms	Coefficients	T-statistics
W_{sp}	6.311	6.026
W_{sp}^2	-0.465	-6.326
D*S	0.015	2.845
D	-0.685	-2.838
Ln(L)	-1.528	-2.442
Constant	-17.555	-4.726
Model Correlation (R^2)	0.81	

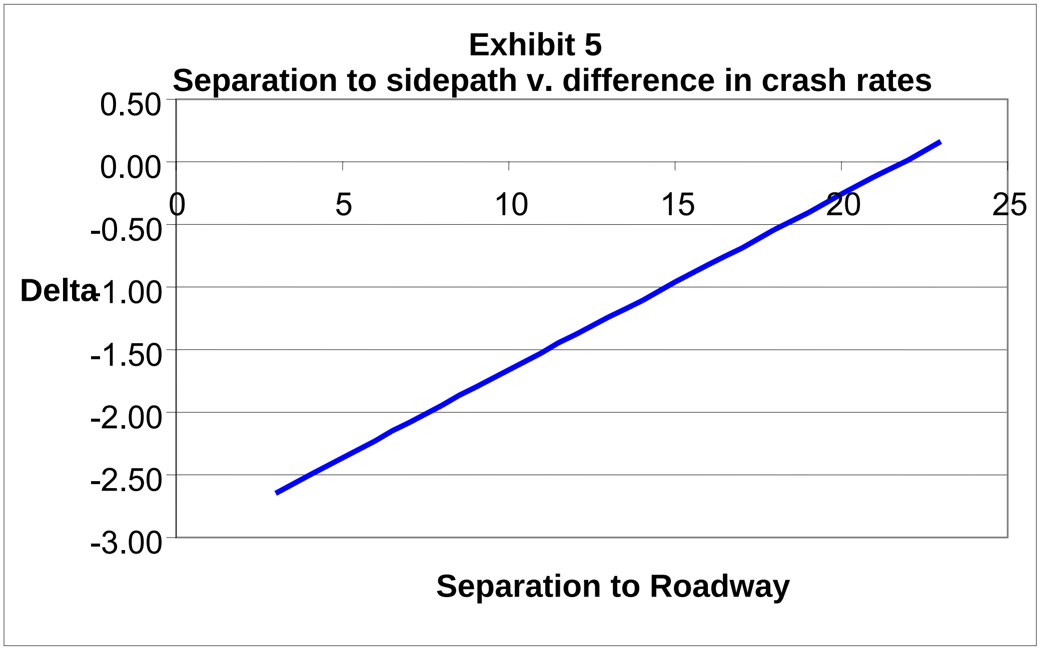
Effect of Path Width

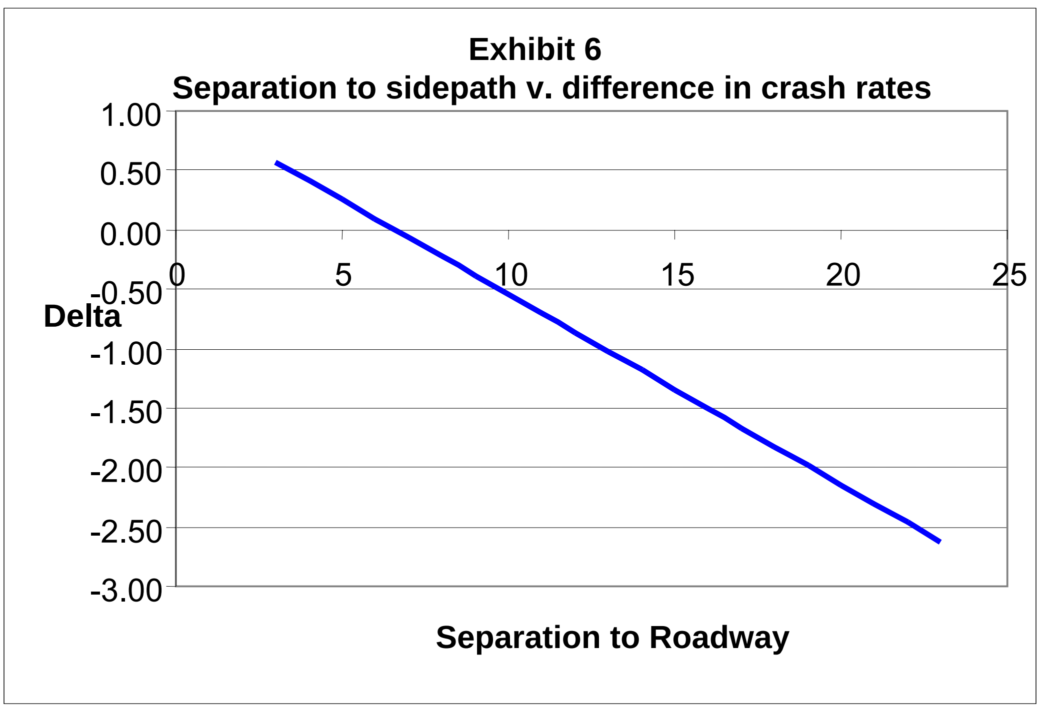
Exhibit 4 presents a graph showing the influence of a sidepath's width on the comparative safety of the sidepath and the roadway. The example roadway used for this analysis is a four-lane, 45 mph roadway, with a separation (defined as "D" in the equation) to the sidepath of 10 feet. As can be seen in the graph, there is an optimum operational width for this sidepath at conflict points – approximately 7 feet. It is assumed that the narrow width (less than that required for two cyclists to comfortably pass in opposite directions) effectively keeps sidepath traffic speeds low, providing more time for motorists and cyclists to observe each other and avoid a conflict or a crash. This trend with an optimal width of about seven feet is consistent across all ranges of variables.



Effect of Sidepath Separation from the Roadway

As can be seen from the two graphs below (Exhibits 5 and 6), whether or not increased separation to a sidepath benefits the safety of the sidepath depends upon the values for the other factors. Exhibit 5 shows the influence of the separation to the sidepath to the roadway on the relative sidepath / roadway bicyclists' crash rates on an example roadway with four lanes, 55 mph posted speed, with a sidepath width of 10 feet. Note that with this facility, a separation "D" of 23 feet or more results in the sidepath having a lower crash rate than the adjacent roadway. Exhibit 6 shows the influence of the separation to the sidepath to the roadway on the relative sidepath / roadway bicyclists' crash rates on an example roadway of four-lanes, 35 mph roadway, with a sidepath width of 8 feet. Under these conditions the sidepath should be placed close to the adjacent roadway for optimal safety.

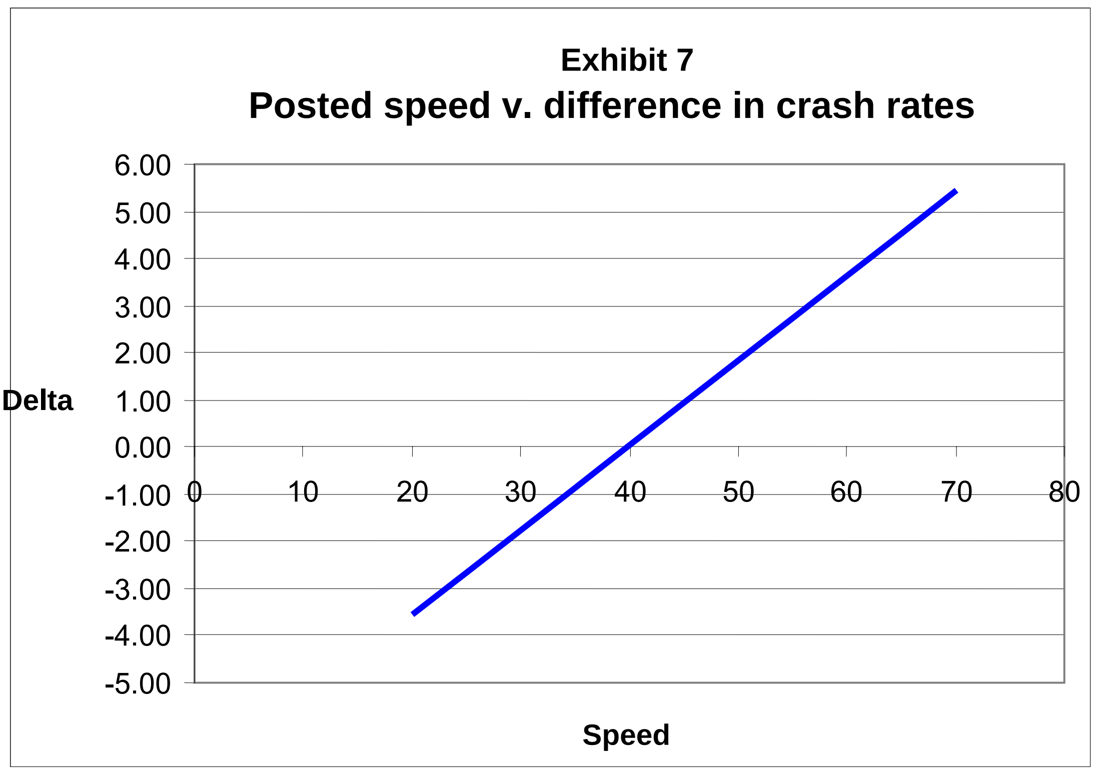




These results suggest that the lower the speed on the adjacent roadway, the safer it is to locate the sidepath near the roadway.

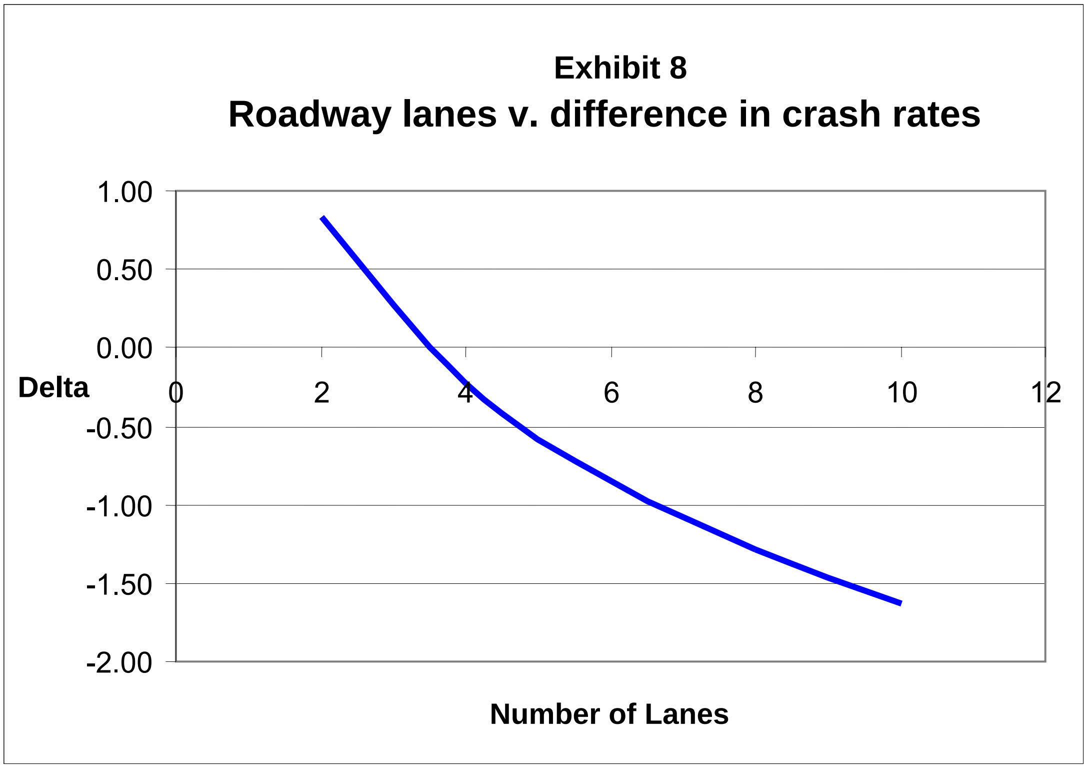
Effect of Posted Speed on the Adjacent Roadway

Exhibit 7 shows the influence of the adjacent roadway's posted speed on the difference in crash rates. The example roadway used for this analysis is a four-lane, with a separation to an eight-foot sidepath of 12 feet. It can be seen that as the speed increases, the greater the relative safety of the sidepath compared to the adjacent roadway. At posted speeds of higher than 40 mph, the sidepath has a lower crash rate than the adjacent roadway. This trend is consistent across all variable ranges.



Effect of the Number of Lanes on the Adjacent Roadway

The final statistically significant variable in the equation is the number of lanes on the adjacent roadway. Exhibit 8 shows the influence of the number of lanes on the difference in crash rates. The example roadway used for this analysis is a 35 mph roadway, with a separation to an eight-foot sidepath of eight feet. As shown in Exhibit 8, if the adjacent roadway has two or three lanes, the sidepath has a lower crash rate than the adjacent roadway. On the other hand, if the adjacent roadway has four or more lanes, it has a lower crash rate than the sidepath.



Step 3: Determine the Existence / Suitability of an Alternative Route.

Before considering the development of a sidepath along a State Road, parallel roadways should be evaluated to determine if they would provide a suitable alternative. The origins and destinations of the bicyclists to be served should be considered in this evaluation. The bicycling conditions (as measured by Bicycle LOS) and significant delays to the bicyclists caused by using the alternative route should also be assessed. The suitability of an alternative route will depend upon four elements:

1. The Bicycle LOS of the route being considered as an alternative route (this includes intersections and roads connecting the alternative route to the primary facility),
2. The offset to the alternative route,
3. The additional delays (as compared the primary facility) along the alternative route, and
4. The frequency of cross-street access from the parallel route to destinations along the primary route.

The resulting evaluation methodology would take the form of an equation in the following format:

Alternative Route Bicycle LOS (ARBLOS) = Bicycle $LOS_{alternate\ facility}$ + D_{ar}+ A_{ar} (Eq. 2)

Where:

D_{ar} = Delay for the alternative route

A_{ar} = Access from the alternative route

Delay on the Alternative Route

The additional delay along the alternative route is a function of the distance, or offset, to the additional route and the number of additional stops along the alternative route. In equation form this can be represented as

$$D_{ar} = \frac{\dfrac{L_{ar}}{V_b} + \dfrac{N_s V_b}{2}\left(\dfrac{1}{a_-} + \dfrac{1}{a_+}\right) - \dfrac{L_{pr}}{V_b}}{\dfrac{L_{pr}}{V_b}} \qquad \text{(Eq. 3)}$$

where

D_{ar} = delay for cyclist riding the alternative route, expressed as a decimal fraction of the travel time for the primary route

L_{ar} = length of the alternative route, ft

V_b = speed of the bicyclists, ft/sec

N_s = number of additional stops for bicyclists using the alternative route

a_- = deceleration rate of bicyclist, ft/sec^2

a_+ = acceleration rate of bicyclist, ft/sec^2

L_{pr} = length of primary route, ft

Assuming the user group being addressed is the Type B (Basic) cyclist as defined in the AASHTO *Guide for the Development of Bicycle Facilities*[3], it is appropriate to use the lower values for acceleration and deceleration given in the AASHTO *Guide*[4] - 1.5 ft/sec^2 and 4 ft/sec^2 respectively. If we further assume the average riding speed of a Type B bicyclist is 12 mph or 17.6 ft/sec (this is consistent with speed studies performed in conjunction with recently completed research, *Evaluation of Safety, Design and Operation of Shared Use Paths*, FHWA), then the previous equation becomes the following:

$$D_{ar} = \frac{L_{ar}}{L_{pr}} + \frac{142 Ns}{L_{pr}} - 1 \qquad \text{(Eq. 4)}$$

Access from the alternative route

Bicyclists will need to access many of the same destinations motorists do, many of which will be located on the primary route. Consequently, alternate routes must provide access to those destinations. The addition of an accessibility term will provide a measure of the possible inconvenience caused by the alternative parallel route not having the same level of access to primary destinations as the primary route. The proposed value of this term is as follows:

[3] *Guide for the Development of Bicycle Facilities,* pg. 6, American Association of State Highway and Transportation Officials. Washington, D.C., 1999.

[4] *Guide for the Development of Bicycle Facilities,* pg. 65, American Association of State Highway and Transportation Officials. Washington, D.C., 1999.

$$A_{ar} = \left(\frac{1}{c_s} \right)^2 \quad \text{(Eq. 5)}$$

Where

A_{ar} = Access term for the alternative route

c_s = Cross streets (per mile) connecting alternate route to the principal roadway

Graphs showing the sensitivity of the ARBLOS are provided below (Exhibits 9 - 11). Each of the graphs shows the influence on one variable on the ARBLOS. The graphs were created assuming the following:

- The State Route segment being considered is 1 mile long.
- The Bicycle Level of Service score for the roadways being considered for an alternative route is 2.5.
- The alternative route is 1.25 miles long.
- There are 2 additional stops per mile on the alternative route.
- There are two cross street accesses per mile to the alternative route.

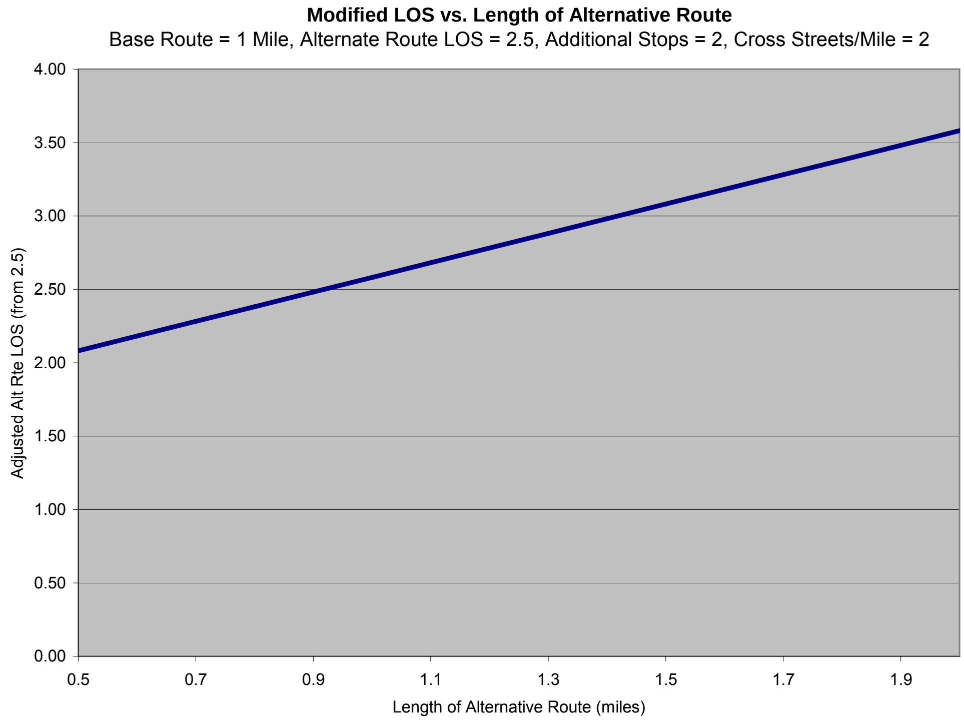


Exhibit 9 The influence of the alternative route length on ARBLOS

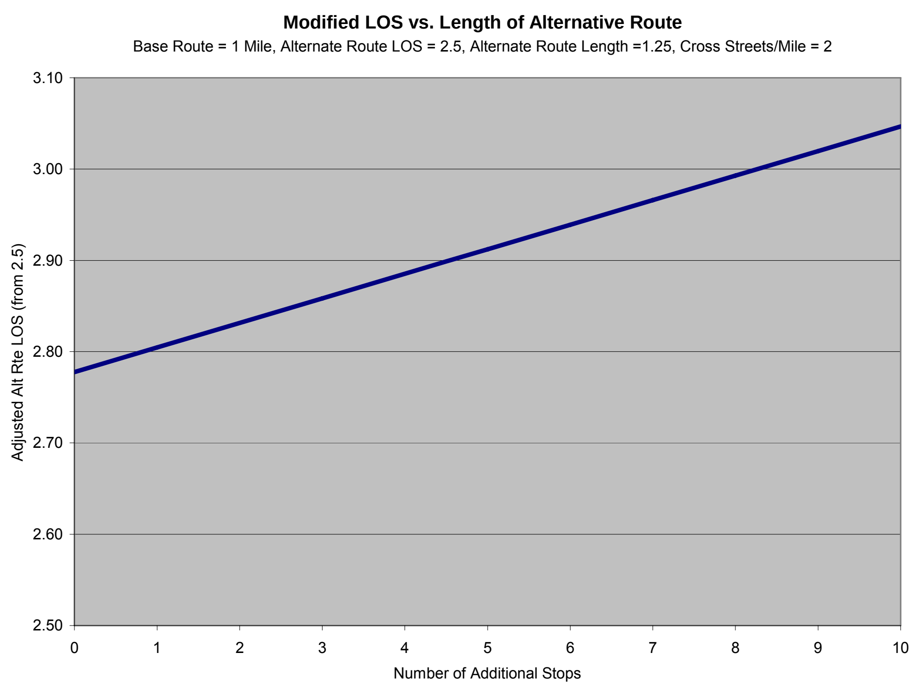


Exhibit 10 The influence of additional stops on the alternative route on ARBLOS

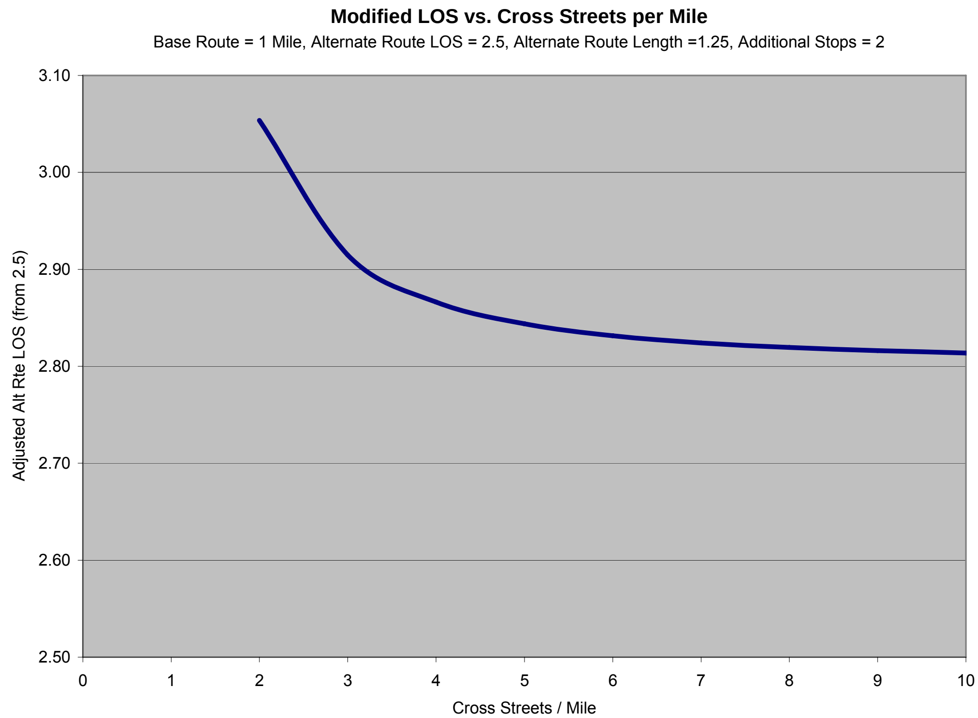


Exhibit 11 The influence of cross street access on ARBLOS

If the Bicycle LOS score exceeds some pre-specified value (such as being an LOS D or worse), it should not be considered an appropriate alternative route. In this case, a sidepath within the primary facility's right-of-way may be considered.

This alternative route LOS equation, while theoretically sound, has not been field validated. A field-calibrated route choice model could result in a significant improvement in this selection process.

Step 4: Determine if Right-of-Way is Available for a Sidepath.

If it is decided there is no suitable alternative route for bicyclists, and that a sidepath is to be considered, a preliminary assessment must be made of right-of-way availability. When making this assessment, consider the following factors:

- The FDOT Plans Preparation Manual (PPM), Chapter 8, states “The minimum width for a two-way shared use path is 12 feet. Under certain conditions it may be necessary or desirable to increase the width of a path due to substantial use by bicycles, joggers, skaters and pedestrians, by large maintenance or emergency vehicles and steep grades. Only under severe constraints should providing less than 12 feet be considered.” The Florida *Greenbook*, the AASHTO *Guide for the Development of Bicycle Facilities* and the *Florida Bicycle Facilities Planning and Design Handbook* provide design guidelines for the widths of shared use paths.
- The design of shared use paths differs significantly from that of sidewalks. Design criteria for grades, horizontal and vertical clearances, turning radii and sight distance are provided in the PPM.
- FDOT and AASHTO recommend a minimum 5-foot separation from the sidepath to the edge of the shoulder or back of curb.
- At driveways the speed of the turning drivers will have an impact on the location of the pathway crossing. If it is not practical to bring the sidepath near the roadway at every driveway, then additional right of way will be needed to provide adequate sight / stopping distances for driveway / path intersections.

It is critically important that for any design revisions made to the sidepath’s pavement width and placement w/ respect to the roadway, the model to determine the relative safety of the sidepath versus the roadway be re-evaluated. This needs to be done to confirm that the sidepath design is still appropriate and safe.

If it is determined that there is available right-of-way, then it may be appropriate to install a sidepath.

Step 5: Evaluate the Access Provided by the Sidepath to Likely Destinations.

A sidepath should provide the bicyclists using the path access to their desired destinations. Unless sidepaths are to be provided on both sides of the roadway, consideration must be given to providing access to destinations on the far side of the adjacent street. This is a particular concern along corridors with long block lengths and few crossing opportunities. In this situation, the bicyclists would have two alternatives to riding on the street to access a midblock destination: to first pass the destination, cross the roadway at an intersection, and then backtrack along a sidewalk on the other side, or to ride against traffic on a sidewalk on the opposite side.

Some facilities will serve primarily a through traffic function. For instance, a facility may serve as an access route to a school or park. Alternatively, a sidepath along a waterway may not need to provide frequent access to the far side of the street. In some areas, there may be frequent crossing opportunities (short block lengths or frequent midblock crossings) to minimize any access concerns. In summary, if a sidepath will provide access to likely destinations along the roadway facility, then a sidepath may be appropriate in this segment of roadway.

Step 6: Evaluate Proposed Sidepath Length and Termini.

Sidepaths should be continued for a length that is consistent with their proposed function. For instance, if the function of a proposed sidepath is to provide access to a scenic vista, the route should continue for the length of the vista. If a sidepath's purpose is to provide connectivity in an existing network, it should begin and end at existing bicycle facilities. A sidepath can also be effective in providing connections between two or more major destinations.

The termini of the sidepath also need to be addressed. Transitions must be provided to allow bicyclists to conveniently and safely access the on-street system from the sidepath's termini. If the proposed sidepath has an appropriate length with its function and has logical termini, then a sidepath may be an appropriate design treatment.

Step 7: Evaluate the Level of Service of the Proposed Sidepath.

Before the final decision to provide a sidepath is made, the Level of Service for the sidepath should be evaluated. If the Sidepath Level of Service is acceptable, and other criteria are met, a sidepath would be an appropriate facility type.

Currently, there are LOS methodologies for on-street bicycle facilities (segment and intersection models) and pedestrians (segment, intersection, and facility models). A proposed *Sidepath* Level of Service methodology involves incorporating components of these current methods into an equation that considers the following factors:

- The user comfort / perceived safety of the proposed sidepath.
- The expected level of congestion along the proposed sidepath.
- The number of motorist conflicts associated with the intersections and driveways along the sidepath.
- The number of control delays experienced by bicyclists riding along the section, and the volume of bicyclists on the sidepath.

Sidepath LOS = Base Sidepath LOS + C + E + D (Eq. 6)

Where:

Base Sidepath LOS = Modified FDOT Bicycle LOS equation

C = Congestion Term

E = Exposure Term

D = Additional Delay

How these terms will be determined is described in the following sections:

User Comfort / Perceived Safety

One of the key considerations for expanding the population of those who choose to ride bicycles for transportation is the perceived safety / comfort of the bicycle facility for its users. This level of comfort is related to users' perceived safety on a facility. The FDOT's existing Bicycle Level of Service methodology[5] has been modified to represent the cyclists' perceived comfort / safety on a sidepath. A factor that addresses the separation of the sidepath from the roadway (emphasized with **bold** font) has been included within the effective width term, w_e, and a factor modifying w_e, based upon roadway volumes has been removed. The presumed safety / comfort Sidepath Level of Service Equation is as follows:

$$BLOS = 0.507\ln\left(\frac{Vol_{15}}{L_n}\right) + 0.199SP_t\left(1+10.38HV\right)^2 + 7.066\left(\frac{1}{PR_5}\right)^2 - 0.005W_e^{\ 2} + 0.760$$

(Eq. 7)

Where:

Vol_{15} = Volume of directional traffic in 15 minute time period

$$Vol_{15} = \frac{ADT * D * K_d}{4 * PHF}$$

where:
ADT = Average Daily Traffic on the segment or link
D = Directional Factor
K_d = Peak to Daily Factor
PHF = Peak Hour Factor

L_n = Total number of directional *through* lanes
SP_t = Effective speed limit

$$SP_t = 1.1199\ln\left(SP_n - 20\right) + 0.8103$$

where:

[5] *2002 Quality / Level of Service Handbook*, pg. 20 – 21, FDOT, Tallahassee, FL, 2002.

SP_p = Posted speed limit (a surrogate for average running speed)

HV = Percentage of heavy vehicles (as defined in the 1994 Highway Capacity Manual)

PR_5 = FHWA's five point pavement surface condition rating

W_e = Average effective width of outside through lane:

Where $W_l = 0$

$$W_e = W_t - (10 * \%OSPA) + 1.277 Ln\left(f_b w_b + f_{sp} w_{sp}\right)$$

Where $W_l > 0$

$$W_e = W_t - W_l(1 - 2 * \%OSPA) + 1.277 Ln\left(f_b w_b + f_{sp} w_{sp}\right)$$

Where $W_l > 0$ & $W_{ps} > 0$ and a bike lane exists

$$W_e = W_t - W_l - 2(10 * \%OSPA) + 1.277 Ln\left(f_b w_b + f_{sp} w_{sp}\right)$$

where:

W_l = width of paving between the outside lane stripe and the edge of pavement

W_t = total width of outside lane (and shoulder) pavement

OSPA = percentage of segment with occupied on-street parking

W_b = width of buffer between roadway and sidepath

f_b = buffer area barrier coefficient

W_{sp} = width of sidepath

f_{sp} = sidepath presence factor

The numeric scores resulting from applying this equation are used to determine the safety / comfort Sidepath LOS, as shown in the following Exhibit 12.

Exhibit 12 Sidepath Level of Service Categories

Level of Service	Score
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

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These resultant scores from the safety / comfort Sidepath LOS equation would be modified by the values determined for the other Sidepath LOS factors – congestion, exposure, and delay.

Congestion

The congestion of a sidepath may serve as a deterrent to those who might wish to use bicycles on the path for transportation. The Highway Capacity Manual[6] (HCM) provides a methodology for determining the Level of Service for shared off-street paths. This methodology would provide the basis for developing this term of the Sidepath LOS equation. The HCM equation for shared off-street paths is as follows:

$$F = 0.5F_m + F_p \qquad \text{(Eq. 8)}$$

Where:

$F_p = 3v_{ps} + 0.188v_{bs}$

$F_m = 5v_{po} + 2v_{bo}$

And where

- F = total number of events on path, with a 0.5 weighting factor for opposing events, events/hr
- F_m = number of opposing events, events/hr
- F_p = number of passing events, events/hr
- v_{ps} = flow rate of pedestrians in subject direction, peds/hr
- v_{bs} = flow rate of bicyclists in the subject direction, bicycles/hr
- v_{po} = flow rate of pedestrians in opposing direction, peds/hr
- v_{bo} = flow rate of bicyclists in the opposing direction, bicycles per hour

[6] *Highway Capacity Manual,* pg. 19-2 – 19-5, Transportation Research Board, National Research Council, Washington, D.C., 2000.

The number of events/hour is used to determine the shared off-street path LOS as shown in Exhibit 13.

Exhibit 13 Shared Off-Street Path Level of Service Categories

LOS	Frequency of Events Two-way / Two-lane Paths[a] (events/hour)	Frequency of Events Two-way /Three-lane Paths[b] (events/hour)
A	≤ 40	≤ 90
B	41 - 60	91 – 140
C	61 – 100	141 – 210
D	101 – 150	211 – 300
E	151 – 195	301 – 375
F	> 195	> 375

a. 8-ft wide paths
b. 10-ft wide paths

Both two- and three-lane paths are shown because both are given in the HCM. It is unlikely FDOT would construct an 8-ft sidepath. There is ongoing FHWA sponsored research to calibrate the HCM methodology for wider pathways.

The influence of congestion on the Sidepath LOS will increase as the comfort / perceived safety score of the sidepath increases. Exhibit 14 provides a proposed congestion term, C, for the Sidepath LOS equation. The below congestion terms reflect this increasing effect of congestion on sidepaths with lower HCM pathway LOS scores.

Exhibit 14 Congestion Factor, C, for Sidepath LOS

		Shared Off-Street Path LOS					
		A	B	C	D	E	F
Safety / Comfort Sidepath LOS	A	-	0.5	1.0	1.5	2.0	2.5
	B	-	-	0.75	1.25	1.75	2.25
	C	-	-	-	1.0	1.5	2.0
	D	-	-	-	-	1.25	1.75
	E	-	-	-	-	-	1.5
	F	-	-	-	-	-	-

While this methodology provides for an accurate evaluation of the conflicts on a shared-use path, it requires a significant data collection effort. Additionally, it would require volumes of pedestrians and bicyclists be predicted for proposed pathways. Consequently we propose a methodology using the FDOT Area Type classifications defined in the FDOT Quality of Service Manual.[7] The congestion factors based upon these area type classifications are provided in Exhibit 15.

Exhibit 15 Congestion Factor, C, for Sidepath LOS

		Safety / Comfort Sidepath LOS					
		A	B	C	D	E	F
Area Type	Urbanized	0.0	0..5	0.5	0.75	0.75	1.0
	Transitioning / Urban	0.0	0.0	0.0	0.5	0.5	0.75
	Rural Developed	0.0	0.0	0.0	0.0	0.0	0.0
	Rural Undeveloped	0.0	0.0	0.0	0.0	0.0	0.0

<u>Exposure to Motorist Conflict</u>

The number of motorist conflicts along the section can adversely impact the perceived safety of a sidepath. Motorists turning left or right into a side street /

[7] *2002 Quality / Level of Service Handbook*, pg. 47-49, FDOT, Tallahassee, FL, 2002.

driveway can create problems for bicyclists if these motorists are not yielding appropriately. The degree of conflicts along a section would be a function of the frequency and types of intersections / driveways along a section. The hazard increases with the number of driveways and the motor vehicle volume turning into and out of the driveways.

It is hypothesized that the degree of the perceived hazard associated with driveway frequency and volumes is affected by the volume of bicyclists along a sidepath. At low bicyclist volumes, motorists may not anticipate bicyclists riding along the trail. Thus, as the volume of bicyclists increases from very low to low, the potential for conflicts increases. However, as the volume on the path increases so does the motorists' awareness of the path and its users. So as the volume on the path increases, the likelihood of motorists' not-yielding decreases because of increased motorists' awareness. Consequently, a high level of use would likely reduce the problems associated with motorist conflicts.

We anticipate the value of the exposure to motorist conflict factor would probably be calculated as follows:

$$E = \left(1 - \frac{1}{e^n}\right)\left(0.1d_{ch} + 0.01d_{cl} + 0.001d_r\right) \qquad \text{(Eq. 9)}$$

Where

- E = exposure to motorists conflict factor
- d_r = residential driveways / mile (<20 ADT)
- d_{cl} = low-volume commercial driveways / mile (<1000 ADT)
- d_{ch} = high-volume commercial driveways / mile (>1000 ADT)
- n = $V_{sp}/600$

and

- V_{sp} = volume of sidepath users

<u>Bicyclist Delay</u>

As with the alternative route Bicycle LOS discussed above (with respect to alternative routes), the number of locations where the bicyclists can expect to be delayed is a factor that can impact the utility of a bicycle facility. This is true of sidepaths as well as roadways. If bicyclists using a pathway are required to stop or significantly slow frequently along a route, some will choose not to use the sidepath and use the roadway instead[8]. Other bicyclists may decide not to ride their bikes at all because of the inconvenience of stopping at numerous locations on the path. This concern can usually be addressed by designing driveway and roadway intersections so that the path can have the same priority as the adjacent roadway. If there are many driveways, this may result in a pathway that meanders excessively, again adding delay to travel on the sidepath facility.

Just as with the alternate roadway facility, the percent difference in travel time between the sidepath and the roadway will be used to produce a term factor, D, for the Sidepath LOS equation. This term will represent the effect of delay on bicyclist convenience and should be considered for inclusion in the Sidepath LOS equation. The proportion additional delay/mile on the sidepath to uninhibited travel on the roadway can be calculated using the same format as delay equation for alternative routes:

$$D_{sp} = \frac{L_{sp}}{L_{pr}} + \frac{142Ns}{L_{pr}} - 1 \qquad \text{(Eq. 10)}$$

Where:

N_s = number of additional stops on sidepath between beginning and end of facility

L_{pr} = length of the primary roadway section in feet

[8] This situation can result in the harassment of bicyclists using the roadway by motorists who feel bicyclists belong on any available sidepath.

L_{sp} = length of the sidepath in feet

The delay term would be included in the Sidepath LOS equation.

Sidepath Level of Service Equation

As stated earlier (on page 18), the final proposed form of the Sidepath LOS equation is as follows:

Sidepath LOS = Base Sidepath LOS + C + E + D (Eq. 6)

This sidepath LOS equation, while theoretically sound, has not been field validated. A field calibrated model could result in a significant improvement in this selection process.

Summary

The above proposed sidepath selection methodology is a step-by-step process for determining if a sidepath is an appropriate facility. It was developed to function as an expert system that addresses the need for a sidepath, design and operational considerations, and safety.

The sidepath selection procedure considers the following issues:

- level of accommodation for bicyclists on the adjacent roadway, paired with the potential bicycle travel demand along the roadway,
- potential safety of a sidepath facility;
- the presence of alternative routes,
- adequacy of right-of-way to accommodate a sidepath,
- access to probable destinations,
- appropriateness of sidepath length and the design of termini, and
- the level of comfort and safety the proposed sidepath would provide.

This method provides for an objective, rational method for determining whether or not a sidepath is an appropriate facility.