3. LOS FOR SHARED-USE PATHS

WHAT IS LOS?

For motor vehicles on roadways, HCM defines LOS as a "quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience."[3] HCM defines six levels of service for a particular facility type and uses letters A to F to represent them, from best to worst. Each LOS represents a range of operating conditions. Safety is not explicitly included in the measures that establish motor vehicle LOS.

The trail LOS model developed through this research is similar to that which is used for motor vehicle LOS. Listed below are some key similarities and differences.

Similarities include:

- The trail LOS model uses six levels of service categories and the letters A to F are used to represent them, from best to worst.
- Maintaining an optimum speed (for the bicyclist) is a key criterion.
- Service measures are primarily related to freedom to maneuver. These include meetings, active passes, delayed passes, and the perceived ability to pass.
- Safety is not included in the set of measures that establish service levels.

The key difference is:

- Trail LOS does not factor in travel time or traffic interruptions such as signals or stop signs at grade crossings.

It is important to note a host of other factors the reader may want to consider in a trail users' assessment of comfort and enjoyment of a trail, such as the following:

- Pavement/surface condition and materials.
- Weather.
- Frequency and design of curves.
- Presence and degree of grade changes (hills).
- Proximity to adjacent motor vehicle traffic.
- Quality of scenery.
- Physical setting.
- Quality of bicycling equipment in use.
- Perceived safety of the surrounding neighborhood.

Just as motor vehicle LOS measures a limited aspect of the experience of driving and does not take into account the quality of the vehicle in which a person travels, the scenery along the road, etc., the trail LOS model has similar limitations. While such factors of trail design are important to the user's experience, they will be left to further research.

THE SHARED-USE PATH LOS MODEL

The Shared-Use Path LOS (SUPLOS) model is a mathematical formula that uses select inputs describing conditions along a trail to calculate an LOS score. A key task in model development was to determine what inputs should be used and what mathematical relationships existed among

them. The goal was to develop a formula that would yield scores consistent with the evaluation of similar conditions made by participants in the perception survey. A secondary objective was to use only those inputs that are truly necessary and most readily available.

Using a variety of statistical methods, the operational and user perception survey variables were examined to evaluate which variables had the most influence in determining the grades users gave to the different conditions represented in the video clips. A model (mathematical equation) was built that would use the most significant factors as inputs to generate LOS scores and grades. The model was tested and adjusted to ensure that it generated grades that closely correlated to the perception scores that trail users gave each video clip.

The equation in figure 1, below, is the basic SUPLOS model. Appendix B provides additional details about the factors used in the model. For a complete explanation of the derivation of the model see chapter 7 of the Final Report.[8]

$$SUPLOS = 5.446 - 0.00809(E) - 15.86(RW) - 0.287(CL) - (DPF)$$

Figure 1. Equation. Basic SUPLOS model.

Where:

E = Events = Meetings per minute + 10 (active passes per minute)
RW = Reciprocal of path width (i.e., 1/path width, in feet)
CL = 1 if trail has a centerline, 0 if trail has no centerline
DPF = Delayed pass factor

The SUPLOS model generates a LOS score between zero and five. Table 5 describes the SUPLOS scale, which shows how raw scores correspond to letter grades. An A is the highest score, excellent, and an F is the lowest score.

Table 5. SUPLOS scale.

LOS Score	LOS Grade	
$X \geq 4.0$	A	Best
$3.5 \leq X < 4.0$	B	↓
$3.0 \leq X < 3.5$	C	
$2.5 \leq X < 3.0$	D	
$2.0 \leq X < 2.5$	E	
$X < 2.0$	F	Worst

INTERPRETING SHARED-USE PATH LOS GRADES

In general, grades A–C can be considered acceptable levels of service and D–F can be considered degraded levels of service. The LOS descriptions in table 6 provide a more refined framework.

A benefit of this LOS model is that it provides a uniform quantitative measurement for use throughout the United States and North America. However, each political jurisdiction and trail managing agency certainly has latitude to adopt different policies covering acceptable levels of service for trails within their own communities, as is the case with roadway levels of service. To

some degree, determining what scores and grades are acceptable can vary for each different application of the model. For example, a jurisdiction may elect to establish a policy to ensure that new trails meet a higher performance standard than the standard considered acceptable for existing trails.

Table 6. Interpreting SUPLOS grades.

A: Excellent. Trail has optimum conditions for individual bicyclists and retains ample space to absorb more users of all modes, while providing a high-quality user experience. Some newly built trails will provide grade-A service until they have been discovered or until their ridership builds up to projected levels.

B: Good. Trail has good bicycling conditions, and retains significant room to absorb more users, while maintaining an ability to provide a high-quality user experience.

C: Fair. Trail has at least minimum width to meet current demand and to provide basic service to bicyclists. A modest level of additional capacity is available for bicyclists and skaters; however more pedestrians, runners, or other slow-moving users will begin to diminish LOS for bicyclists.

D: Poor. Trail is nearing its functional capacity given its width, volume, and mode split. Peak-period travel speeds are likely to be reduced by levels of crowding. The addition of more users of any mode will result in significant service degradation. Some bicyclists and skaters are likely to adjust their experience expectations or to avoid peak-period use.

E: Very Poor. Given trail width, volume, and user mix, the trail has reached its functional capacity. Peak-period travel speeds are likely to be reduced by levels of crowding. The trail may enjoy strong community support because of its high usage rate; however, many bicyclists and skaters are likely to adjust their experience expectations, or to avoid peak-period use.

F: Failing. Trail significantly diminishes the experience for at least one, and most likely for all user groups. It does not effectively serve most bicyclists; significant user conflicts should be expected.

LOS SCORES FOR 15 STUDY TRAILS

Table 7 provides LOS scores and grades for 15 trails studied as part of this research. This table includes two-way and one-way user volumes, mode splits, trail widths, and presence of centerline variables. It also provides a data profile for the average trail and its corresponding LOS score and grade (3.15, C).

6. IMPLICATIONS OF THIS RESEARCH FOR TRAIL DESIGN

The central findings of this study have important implications for trail design. The following is a list of key findings that can be used to inform design choices:

1. Width is the key factor in determining LOS, and every additional foot of trail width has a positive impact on LOS.
2. Bicyclists' LOS on pathways is very sensitive to user mix; when the amount of foot traffic (runners and pedestrians) surpasses 15 percent of trail use, bicyclists' LOS is significantly impacted.
3. Bicyclists are affected by a centerline stripe dividing directional flows.

TRAIL WIDTH

The findings of this study provide strong support for the standard trail width guidance provided in the AASHTO *Guide for the Development of Bicycle Facilities*.[2] Trails having 2.4-m (8.0-ft) width, which AASHTO recommends only in "rare instances," were found to have poor LOS, except at very low volumes or with user mixes that included few pedestrians and runners. The findings of this research support AASHTO's minimum "recommended paved width for a two-directional shared-use path of [3.0 m] ten feet." *

The study found that widths of 3.4–4.6 m (11.0–15.0 ft) provide improved LOS for higher volumes and more balanced user mixes than narrower widths. This is consistent with AASHTO recommendations that "under certain conditions it may be necessary or desirable to increase the width of a shared-use path to 3.8 m (12.0 ft) or even to 4.3 m (14.0 ft), due to substantial use by bicycles, joggers, skaters and pedestrians, ..." † Trails of 3.4–4.6 m (11.0–15.0 ft) are wide enough to operate as three-lane paths. The increased passing capacity provided by a trail that operates as three lanes improves LOS and increases the trail's ability to absorb higher volumes and more diverse mode splits without severely degrading service.

Design Implications—Width

- During design of new trails and widening of existing trails, designers may want to consider varying the trail width to achieve LOS goals in key locations but not overbuild in other locations. Adding width to improve LOS is valuable to trail users, even if it is provided only on selected segments.

- When considering wider trails, designers and decisionmakers may want to think in 0.3-m (1-ft), rather than 0.6-m (2.0-ft), increments. Typical practice has been to consider trail widths in 0.6-m (2.0-ft) increments. Using this approach may miss opportunities to provide measurable increases in LOS while at the same time containing costs and minimizing environmental impacts.

CENTERLINE STRIPING

A striped centerline was found to have strong impact on the bicyclist's perception of freedom to maneuver. This finding appears to support the intent of trail designers in providing a centerline, which is clear delineation of opposing travel lanes. A centerline reinforces the idea that, to pass a

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* *Guide for the Development of Bicycle Facilities*, AASHTO, 1999, p. 35.
† ibid, p. 36.

slower-moving user, the cyclist may need to use the travel lane of opposing trail users and should pass only when the opposing lane is open.

This research found that the presence of a centerline stripe results in a significant reduction in the LOS. It appears that bicyclists may feel less comfortable making a same-direction passing movement when a centerline stripe is present. While this finding might appear initially to mean that a centerline stripe degrades pathway LOS and should not be used, it is important to note that there may be other valid safety reasons for providing a centerline stripe, particularly on crowded trails, on curves with limited sight distance, and in other appropriate circumstances.

MULTILANE STRIPING

Only two trails in this study were striped with more than two travel lanes. The Pinellas Trail was striped as a three-lane trail, with one lane in each direction for bicycles and skaters and one lane for pedestrians. The Lakefront Trail was striped as four lanes, with two lanes in each direction. These two examples did not represent a sufficient number of study trails to fully assess the impact of multilane striping patterns on LOS. However, it is likely that having sufficient trail width for a four-lane operation (a minimum of 4.6 m (15.0 ft)) increases the ability of bicyclists to pass slower-moving users without encountering blockage from trail users in the opposing lanes.

MULTIPLE TREADWAYS

A number of shared-use trails have been designed with two treadways in the same trail corridor. Often, one is paved and the other is a soft surface. Frequently, one of the treadways is provided for exclusive use by one or two trail user groups, or user restrictions are imposed on both paths in an effort to segregate users.

Given this study's findings about the impact of user mix on bicyclist LOS, a multiple treadway design that effectively reduces the number of pedestrians and runners mixing with bicyclists will have significant LOS benefits for the treadway used by bicyclists. This study did not address compliance with use restrictions, an issue that is often raised by trail managers as a problem when separate treadways are provided.

TRAIL OPERATIONS AND MANAGEMENT

While this study did not examine issues related to trail operations and management, the framework of the tool may lend itself to applications in this area. Such possibilities might include the use of LOS grades in warrants for trail etiquette or warning signs. Trail etiquette signs address the sharing of treadways or the use of designated passing protocols. LOS may also be useful in setting trail speed limits or other advisory or regulatory protocols that will increase user safety and moderate user conflicts.

Shared Use Path Flow Analysis Tool

Trail Level of Service (LOS) Calculator

Draft Spreadsheet Based on Federal Highway Administration Shared Use Path Study

North Carolina State University and Toole Design Group

Trail LOS Scale	
LOS Score	LOS Grade
X≥4.0	A
3.5≤X<4.0	B
3.0≤X<3.5	C
2.5≤X<3.0	D
2.0≤X<2.5	E
X<2.0	F

ROW #1

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	95.0	55.0%	20.0%	10.0%	10.0%	5.0%	100.0%	**3.42**	**C**	**66.22%**	**48.32**	**0.40**	**0.40**	**3.02**	**3.02**	**C**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

ROW #2

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	155.0	55.0%	20.0%	10.0%	10.0%	5.0%	100.0%	**3.32**	**C**	**82.33%**	**98.02**	**0.82**	**0.82**	**2.51**	**2.51**	**D**

Click Here for Default Mode Split

ROW #3

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	160.0	55.0%	20.0%	10.0%	10.0%	5.0%	100.0%	**3.31**	**C**	**83.24%**	**102.31**	**0.85**	**0.85**	**2.46**	**2.46**	**E**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

MODEL ASSUMPTIONS

Trail volume represents the actual number of users counted in the field (the model adjusts this volume based on a peak hour factor of 0.85).

Bicyclists will pass all trail users that are traveling less than 12.8 miles per hour (average bicyclist speed)

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Trail LOS Scale	
LOS Score	LOS Grade
X≥4.0	A
3.5≤X<4.0	B
3.0≤X<3.5	C
2.5≤X<3.0	D
2.0≤X<2.5	E
X<2.0	F

ROW #1

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	130.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**3.33**	**C**	**79.99%**	**96.42**	**0.80**	**0.80**	**2.52**	**2.52**	**D**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

ROW #2

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	150.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**3.29**	**C**	**84.17%**	**117.07**	**0.98**	**0.98**	**2.31**	**2.31**	**E**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

ROW #3

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**10.0**	1	170.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**3.25**	**C**	**87.44%**	**137.83**	**1.15**	**1.15**	**2.10**	**2.10**	**E**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

ROW #4

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**8.0**	1	150.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**2.89**	**D**	**84.17%**	**117.07**	**0.98**	**0.98**	**1.92**	**1.92**	**F**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

MODEL ASSUMPTIONS

Trail volume represents the actual number of users counted in the field (the model adjusts this volume based on a peak hour factor of 0.85).

Bicyclists will pass all trail users that are traveling less than 12.8 miles per hour (average bicyclist speed)

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X≥4.0	A
3.5≤X<4.0	B
3.0≤X<3.5	C
2.5≤X<3.0	D
2.0≤X<2.5	E
X<2.0	F

ROW #1

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**11.0**	1	150.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**3.43**	**C**	**34.93%**	**48.58**	**0.40**	**0.40**	**3.03**	**3.03**	**C**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

ROW #2

Segment Name	Path Width	Centerline	Volume (users per hour in 1 direction) and Mode Split							User Perception		Delayed Passings Adjustment				Prelim LOS Score	Trail Level of Service	
	Closest 0.5 ft.	0=No Centerline	*Volume*	*Mode Split (%)**								*Adj. Factor (subtract from User Percep. score)*						
Name	Width (ft)	1=Centerline	One-Way (per hour)	Adult Bicyclists	Pedestrians	Runners	In-Line Skaters	Child Bicyclists	All Modes	Score	Grade	Percent	# Per Hr	Pre Adj Fac	Fin Adj Fac	Prelim LOS Score	LOS Score	LOS Grade
ELST 2B	**12.0**	1	150.0	45.0%	25.0%	12.5%	12.5%	5.0%	100.0%	**3.55**	**B**	**34.93%**	**48.58**	**0.40**	**0.40**	**3.15**	**3.15**	**C**

*Default mode split is 55% adult bicyclists, 20% pedestrians, 10% runners, 10% in-line skaters, and 5% child bicylists.

Click Here for Default Mode Split

MODEL ASSUMPTIONS

Trail volume represents the actual number of users counted in the field (the model adjusts this volume based on a peak hour factor of 0.85).

Bicyclists will pass all trail users that are traveling less than 12.8 miles per hour (average bicyclist speed)