UPDATING MULTIMODAL LEVEL OF SERVICE (LOS) CALCULATIONS TO INCORPORATE LATEST FDOT RESEARCH SINCE 2001

FINAL REPORT

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The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation or the U.S. Department of Transportation.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
SYMBOL	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**	**SYMBOL**	**WHEN YOU KNOW**	**MULTIPLY BY**	**TO FIND**	**SYMBOL**
		LENGTH					**LENGTH**		
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
		AREA					**AREA**		
in^2	square inches	645.2	square millimeters	mm^2	mm^2	square millimeters	0.0016	square inches	in^2
ft^2	square feet	0.093	square meters	m^2	^{2}	square meters	10.764	square feet	ft^2
yd^2	square yard	0.836	square meters	m^2	^{2}	square meters	1.195	square yards	yd^2
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi^2	square miles	2.59	square kilometers	km^{2}m	km^2	square kilometers	0.386	square miles	mi^2
		VOLUME					**VOLUME**		
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft^3	cubic feet	0.028	cubic meters	m^3	m^3	cubic meters	35.314	cubic feet	ft^3
yd^3	cubic yards	0.765	cubic meters	m^3	m^3	cubic meters	1.307	cubic yards	yd^3
	NOTE: volumes greater than 1000 L shall be shown in m^3								
		MASS					**MASS**		
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.202	pounds	lb
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")	Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)					**TEMPERATURE (exact degrees)**		
^{o}F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^{o}C	^{o}C	Celsius	1.8C+32	Fahrenheit	^{o}F
		ILLUMINATION					**ILLUMINATION**		
fc	foot-candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2	cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS					**FORCE and PRESSURE or STRESS**		
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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This report is a continuation/assimilation of the FDOT multimodal research to develop Level of Service assessment tools.

16. Abstract
The Florida Department of Transportation (FDOT) has developed, through 8 years of research, Level of Service (LOS) tools for use in multimodal planning. The models have been developed by a series of “Ride or Walk for Science” events, getting feedback in real world situations from user perspectives on how well a facility serves their needs. The multimodal LOS models have been scientifically calibrated and validated to reflect the level of comfort, safety and convenience that a pedestrian, bicyclist, or transit user experiences on a particular roadway. This research effort utilized experts in the transportation planning field and practitioners, who would ultimately be using the tools, to give recommendations for their incorporation into the FDOT 2002 Quality/Level of Service handbook and Art_Plan software. Experts tested the models in a two-day workshop, using data generated on 6 Florida facilities, and applying it to a spreadsheet of all the LOS models. They were asked to examine the sensitivities of the models, and look for any deficiences. Recommendations were made on ways to “tweak” the models to reflect better sensitivity as well as ways that FDOT could publicize and implement a plan for their use. By developing tools to measure and model the needs of pedestrians, bicyclists, transit riders, as well as those of motor vehicle drivers, Florida DOT has been in the forefront of a shift in transportation planning and design. It could not come at a more critical time in our state and nation’s history, with the importance of health and physical activity, safe routes for school children, and the price of gasoline influencing the transportation choices of everyday citizens.

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It would be a great oversight to not recognize also the visionary efforts of Doug McLeod and the Systems Planning office as well as the research office of FDOT who have all along believed in our efforts to create multimodal planning tools, and to better represent the needs of ALL of Florida's users of the transportation system.

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MANY THANKS TO YOU ALL !

UPDATING THE MULTIMODAL LEVEL OF SERVICE CALCULATIONS TO INCORPORATE LATEST RESEARCH SINCE 2001 – EXECUTIVE SUMMARY

Background

In 2000, the Florida Department of Transportation (FDOT) initiated a Multimodal Quality of Service Program to improve the methodologies contained in the Level of Service (LOS) Handbook and ART_PLAN software, so that they could be used to evaluate arterial level of service from a multimodal perspective. This initiative was motivated by several factors: At the national level, ISTEA (Intermodal Surface Transportation Efficiency Act) and TEA-21 (Transportation Equity Act for the 21st Century) were demonstrating a national desire to know the levels of service not only for automobile users, but for transit users, pedestrians, and bicyclists as well. At the state level, the Florida legislature passed HB-17, the *Urban Infill and Redevelopment Act* amending *Florida Statutes# 163.3180*: "Local governments shall use professionally accepted techniques for measuring level of service for automobiles, bicycles, pedestrians, transit, and trucks. The Department of Transportation shall develop methodologies to assist local governments in implementing this multimodal level-of-service analysis. The Florida Department of Transportation shall provide technical assistance to local governments in applying these methodologies."

FDOT has done an admirable job responding to this charge, by conducting a number of "state of the art" Level of Service (LOS) research efforts to quantify LOS from the point of view of the user, be it pedestrian, bicyclist, transit user, or motor vehicle driver. This research has led to the development and calibration of LOS mathematical models for each mode, which have been incorporated into the Department's 2002 Quality/Level of Service Handbook and ART_PLAN software. This software is being used across the nation and state. In this process, shortcomings have been identified which were in need of examination, including the bicycle and pedestrian LOS model "sensitivity" especially applied to arterials with high levels of motor vehicle traffic. Also needed were recommendations for the application and implementation of the models into current FDOT multimodal planning tools for use by practitioners.

Objectives

The objective of this research project is to examine and select the most essential multimodal research tools and to make recommendations regarding their integration into the Quality Level of Service Handbook and software. A second objective is to propose strategies by which these tools and LOS models could be applied and implemented into the planning, design and construction of roadways to serve *all* users.

Supporting Tasks

The following tasks comprise the methodology of the 18-month research project:
1- Assemble advisory team to guide project,
2- Review existing FDOT multimodal LOS research and applicable other research.

3- Establish process to test current models and multimodal research results to determine which methodologies should be recommended for inclusion into current FDOT QLOS Handbook and software. Determine criteria for evaluation of significance in results of testing.

4- Select six corridors (from 3 FDOT districts) for data collection and analysis to determine which methodologies produce significantly improved results over current QLOS methodologies.

5- Host a “practitioners” (people who were already using the models or would be in their scope of work) workshop to run and examine the models with real data and develop recommendations for use of the models for planning and design decisions.

6- Develop recommended methodology for updating 2002 QLOS Handbook and modifying FDOT software.

7- Submit a final report (with appropriate draft review) for guidance in adjustments of the models for QLOS handbook & software, and an implementation strategy for their use.

8- Develop an informational DVD documenting the Multi-Modal LOS Update effort and orientation to multimodal LOS analysis, to be used with presentations and training.

Findings and conclusions: The findings from the research effort fall into three categories: Adjustments to the models, “Practitioners” workshop recommendations for model sensitivities, and Recommendations for model application and implementation.

Adjustments to the models:

It is recommended that FDOT retain the existing *segment* bicycle and pedestrian models, but that they revise the bicycle segment model to address low truck volumes (using number factor) and that both the bicycle and pedestrian LOS models developed in the NCHRP 3-70 research be used for arterial roadways. These models should be adopted for Florida’s QLOS handbook and software if they are approved for inclusion in the Highway Capacity Manual 2010 update.

Further research should be done to calibrate and validate a bicycle *sidepath/shared use pathway* theoretical construct for addition to the Bicycle Level of Service (BLOS) Model. This would widen the range for BLOS to include not only on-road facilities, but facilities within the right of way, and adjacent to, but separated from, the main traffic stream. For Transit LOS, the present FDOT 2002 QLOS handbook takes into consideration adjustment variables for pedestrian LOS, roadway crossing difficulty and presence of obstacles between sidewalks and transit stops. One additional factor that is NOT currently included in the transit LOS procedure that is recommended for further updates is a *load factor* (on board “crowdedness”) as both a quality of service measure and a capacity-related variable.

"Practitioners" workshop recommendations for model sensitivity:

Participants felt that the use of the models requires an understanding of the interplay between modes and the importance of choosing facilities that provide the best practical design in a context sensitive fashion, taking into consideration surrounding land use types. Regarding sensitivity of the models, they felt that some consideration should be given to using a numerical scale vs. alphabetical. Choosing one model (ie. *segment* model) for each mode was preferable, even if the model would need some adjusting, for intersection variables or factors pertinent to the particular facility. The strong influence of traffic volumes and speed on arterial LOS models produced some degree of frustration, particularly when trying to get bicycle and/or Pedestrian LOS scores above D. It led to a recommendation that more research and focus was needed on *safety,* and the comfort and convenience for *all* users of the roadway/right-of-way, over the present emphasis on capacity needs for motor vehicles. Designs balancing the needs of *all modes*, should reflect a multimodal approach as an institutionalized practice.

Recommendations for model application and implementation:

There were a number of recommendations for strategies to implement the models at both planning and design levels, as well as their use for decision-making in funding prioritization. FDOT districts, MPO's, Bicycle/Pedestrian boards, and community decision makers need to be well acquainted with the multimodal analysis tools and their availability, with access to these models on websites, manuals, and through presentations. Training in their use could be provided for universities, and "in-service" courses for practicing engineers and planners. LOS models should be run with design standards and incorporated into the "scopes" for both PD&E processes and construction documents, and a "best practices" manual for Multimodal LOS model use should be developed. Identifying institutional barriers to the use of these models and developing solutions to overcome the barriers is critical to a successful multimodal program.

Benefits of the Project:

The summation and evaluation of FDOT's years of multimodal research and model development is an important step in the effort toward creating a more user responsive roadway system. Florida is leading the nation in this initiative, and continues to ask the hard questions and do the research necessary to answer them. By bringing together a group of practitioners, we were able to test the models on *real people* in *real world* scenarios, and take their recommendations for application of the tools. As the Highway Capacity Committee looks at their new models for Level of Service, Florida's expertise will have made a significant contribution. As we attempt to meet the mobility needs of all of Florida's citizens, we now have proven tools for determining the needs of pedestrians, bicyclists, transit riders, as well as those of motor vehicle drivers, and guidance on ways to attempt to meet these needs. It has come at a critical time in our state and nation's history.

UPDATING THE FDOT MULTIMODAL LEVEL OF SERVICE CALCULATIONS TO INCORPORATE LATEST RESEARCH SINCE 2001

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(* numbers assigned by consultant and obtained from auxillary report)

CHAPTER ONE - INTRODUCTION

Background

Up until the late 1990's, bicyclists, pedestrians and bus riders were not part of the database of information used to quantify the Level of Service of a roadway, and as such, were not part of the decision analysis for design and funding of roads. However, in 1999, in an effort to bridge the divide between poor land use planning and transportation, the Florida Legislature directed the Florida Department of Transportation to develop multimodal assessment tools and a methodology for implementing them.

House Bill-17, the *Urban Infill and Redevelopment Act* amended *Florida Statute 163.3180* which states: "Local governments shall use professionally accepted techniques for measuring level of service for automobiles, bicycles, pedestrians, transit, and trucks. The Department of Transportation shall develop methodologies to assist local governments in implementing this multimodal level-of-service **analysis. The Florida Department of Transportation shall provide technical assistance to local governments in applying these methodologies."**

The Department responded and in 2000, initiated a Multimodal Quality of Service Program to improve the methodologies contained in the *LOS Handbook* and ART_PLAN software, so that they could be used to evaluate arterial level of service from a multimodal perspective. This initiative was motivated by another factor. At the national level, the "ISTEA" (Intermodal Surface Transportation Efficiency Act (ISTEA)) and "TEA-21" (Transportation Equity Act for the 21st century) contained language in the federal transportation funding legislation that demonstrated a national desire to know the levels of service for transit users, pedestrians, and bicyclists, as well as for automobile users.

In an effort to assist local governments, The Florida Department of Transportation has done an admirable job developing, through a series of nationally recognized research projects, tools to measure *Level of Service from the users perspective,* and develop models to be incorporated into the *2002 Quality/Level of Service Handbook* and ARTPLAN software. This software has been used across the state and nation to quantify Bicycle, Pedestrian and transit Level of Service. In this process, shortcomings have been identified and addressed by many research projects funded by FDOT. However, this new body of research needed to be incorporated into the current FDOT multimodel software and Quality of Service manual in order to be useful to practitioners. Further, there was an identified need to gather ideas on implementation of the models so that wider use could be made of these LOS tools for multimodal planning and design criteria for roads serving many users.

Objectives

The objective of this research is to examine and select the most essential multimodal tools developed to date and make recommendations for updates to the *QLOS Handbook* and software. A second objective is to propose strategies by which these tools and LOS models could be applied and implemented into the planning, design and construction of roadways to serve the needs of all users of the system.

CHAPTER TWO – REVIEW OF PREVIOUS RESEARCH

The procedures currently adopted by the Florida Department of Transportation (FDOT) for analyzing operational level bicycle and pedestrian quality of service are the Bicycle Level of Service Model ("bike segment model") and the Pedestrian Level of Service Model ("ped segment model"). These methodologies are contained in FDOT's *2002 Quality/Level of Service Handbook*.[1] Simplified versions of these models and their components are also used in FDOT's conceptual level LOSPLAN analysis software package, which includes the ARTPLAN module.

Since the development of the bike and ped segment models, other non-motorized level of service methodologies have been developed by FDOT and others. These include the following:

- Intersection Level of Service for the Bicycle Through Movement ("bike intersection model");
- Bicycle Level of Service Model for Arterials ("bike arterial facility model");
- NCHRP 3-70 bicycle level of service model for urban arterial streets ("NCHRP bike model");
- Level of Service Model for Pedestrians at Signalized Intersections ("ped intersection model")
- Pedestrian Level of Service Model for Arterials ("ped arterial facility model");
- NCHRP 3-70 pedestrian level of service model for urban arterial streets ("NCHRP ped model"); and
- a sidepath level of service theoretical construct model

A brief discussion of each of the multimodal Level of Service research efforts and the resulting models created from those efforts can be found at the beginning of Chapter 4 –"Discussion and recommendations for LOS model adjustments".
Appendix A contains a summation of all of the models and equations for bicycle, pedestrian and transit modes, from the research to date.

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

CHAPTER THREE - METHODOLOGY

The following lists depict the methodology utilized in this research project and are divided into three categories: experimental design components as outlined in the research contract, tasks for the research progression, and process (a refinement of the tasks as a work plan for conducting the research).

Experimental Design Components:

- Incorporate pedestrian midblock and intersection crossing data and analysis into pedestrian and transit LOS models.
- Incorporate intersection and facility analysis into the current segment analysis for bicycle and pedestrian LOS.
- Expand range of values due to the incorporation of video simulation data collection methods in addition to field data application and analysis.

Contract tasks:

The following tasks were outlined in the contract design and carried out over an eighteen month period:

1. Assemble advisory team to guide project, assist with selection of model components to test, and assist in test locations. This team included the Project manager, representatives from FDOT district Level of Service task force, Public Transportation and Bicycle/Pedestrian Coordinators, NCHRP 3-70 Multimodal Arterial LOS research team, local government officials and others as agreed upon by the project manager and PI
2. Review existing FDOT multimodal LOS research and other applicable research
3. Identify multimodal research products to test for inclusion into FDOT *QLOS Handbook* and software update
4. Establish process to test current models and multimodal research results to determine which methodologies should be recommended for inclusion into current FDOT QLOS Handbook and software

5. Determine criteria for evaluation of significance in results of testing with input from the advisory team to determine locations and corridors to apply process established in Task 3.

6. Collect necessary data to run selected models.

7. Analyze the data and models to determine which methodologies produce significantly improved results over current QLOS methodologies

8. Develop recommendations for the use of the various models for planning and design decisions

9. Develop recommended methodology for updating *2002 QLOS* Handbook

10. Develop recommended methods for modifying FDOT software to implement recommended model structure, simplifying assumptions and default variables

11. Develop draft final report for guidance in use of models, including an implementation strategy

12. Developed DVD materials for documenting the Multi-Modal multimodal LOS Update effort and orientation to multimodal LOS analysis to include:
    - A review of the various research efforts and how LOS models were developed
    - Video simulation recordings to demonstrate how roadway design affects LOS, and
    - Implementation methods for LOS models using actual roadway scenarios;

13. Team and project management review draft final report, and

14. Final report submitted to FDOT research office along with DVD summary piece.

Process:

The process utilized in carrying out the above list of tasks requires assistance from subconsultants Theo Petritsch, Bruce Landis, and Peyton McLeod of Sprinkle Consulting, Inc. of Tampa, Florida, working in cooperation with Siva Srinivasan, Department of Civil Engineering, Linda Crider, Department of Urban and Regional Planning, the University of Florida, and with Martin Guttenplan of the Systems Planning office of the Florida Department of Transportation to:

(1) develop a summary of models based on functionality, ease of application, “reasonableness” and sensitivity;

(2) develop criteria for corridor selection and a range of variables that would be utilized to gather and analyze data for roadways in three separate districts;

(3) Identify 6 roadway facilities and gathered appropriate data to field test the models using existing state roadways and one facility in the P.D.&E phase of redesign planning;

(4) videotape sections of the six facilities utilizing a custom bicycle mounted video platform to create visual images for presentation to workshop participants who would be analyzing the data and models;

(5) create an excel spreadsheet of the data collected on the 6 facilities and incorporate into a matrix of the LOS models variables;

(6) host a 2-day workshop in Tampa, Florida, for a group of 21 “practitioners” in the fields of transportation planning and design, who would be the most likely users of the various models and could give feedback on model sensitivity and implementation strategies;

(7) assimilate comments from the workshop participants to incorporate into the report and model recommendations;

(8) further field test the “Side path theoretical construct model” using riders participating in the annual Bike Florida event on March 30, 2008;

(9) utilize a video analysis technique on the internet in a follow up survey with Bike Florida participants who had ridden a myriad of side paths, multiuse paths, and rural road corridors during the spring 2008 weeklong bicycle event;

(10) compile comments from “user groups”, expert advisory team members, workshop practitioners, and the research consultant team, to incorporate into the final report,

(11) using the recommendations of the report and various video footage of the process (including previous research efforts), produce a DVD summary of this project to be used for explanation of research effort and for training in the use of the multimodal LOS models and tools.

Videographer, Michael Munroe of Munroe Multimedia, Alachua, Florida worked on this and a number of previous multimodal research projects. Together with Project manager, Martin Guttenplan, and Project Investigator, Dr. Linda Crider of the University of Florida, Michael assimilated the research efforts to date, and incorporated “real time” segments depicting various LOS rated facilities, “practitioner” interviews from the December workshop and Bike Florida Spring 2008 event participant interviews. This Final Report Summary and DVD will be utilized with FDOT multimodal LOS trainings, and presented at various transportation workshops and conferences throughout the State of Florida and the nation.

CHAPTER FOUR –DISCUSION & RECOMMENDATIONS FOR LOS MODEL ADJUSTMENTS (Sprinkle Consulting, Inc. report)

The principal task of this FDOT project was to develop recommendations on the use of the various LOS models, and specifically to recommend a methodology for updating FDOT's *QLOS Handbook and software.* In the appendix of this report is a summary of the bicycle, pedestrian, transit, and automobile Level of Service (LOS) models from FDOT Research (FL Research), ARTPLAN computer software, and NCHRP 3-70. It represents the current state of practice in Florida and the latest non-motorized Level of Service models developed in Florida and nationwide. Bicycle and pedestrian modes are summarized by intersection, arterial segments, and arterial facilities. There are also bicycle LOS models for sidepaths and pedestrian LOS models for mid-block crossings.

Bicycle LOS models include:

- Intersections
    - FL Research
- Arterial segments
    - ARTPLAN
- Arterial facilities
    - ARTPLAN
    - FL Research
    - NCHRP 3-70
- Sidepaths
    - FL Research
- Alternative Route
    - FL Research

Pedestrian LOS models include:

- Intersections
    - FL Research
- Arterial segment
    - FL Research
    - ARTPLAN
- Mid-block
    - NCHRP 3-70
- Arterial facility
    - ARTPLAN
    - FL Research
    - NCHRP 3-70

Transit and automobile LOS models come from FDOT research sources and were only reviewed and not studied in depth. All models, except for the sidepath LOS model and the mid-block LOS model, have been “field” validated through physical counts or measurements, or through video review.

The bicycle and pedestrian segment models have been used to analyze hundreds of thousands of miles of roadways throughout the United States. Generally speaking, these models consistently produce reasonable results in that users and citizens feel they accurately portray the level of safety and comfort provided to bicyclists and pedestrians within the roadway environment. While some potential shortcomings have been discussed over the past decade (not enough “spread” in the results, the lack of a term for the bike mode that includes conflict points, and the treatment of heavy vehicles as they relate to bicyclists), the models have been proven effective and reliable over an extended period of time.

Bicycle/Pedestrian LOS Models

There are several options for future modifications of the FDOT Q/LOS methodologies. The options recommended for consideration include the following three possibilities, which are not mutually exclusive.

1) retaining the existing segment bicycle and pedestrian models,
2) revising the bicycle segment model to address low truck volumes, and
3) adopting the NCHRP 3-70 models for bicycle and pedestrian level of service on arterial roadways.

These options are discussed below. It is recommended that FDOT pursue the second of these actions. If the NCHRP models are ultimately incorporated into the 2010 *Highway Capacity Manual*, the third action should also be pursued. An additional discussion of side path level of service recommendations is included also in this report.

#1 Retain the existing models.

FDOT could continue to use bike and ped *segment* models as the primary measurements for bicycle and pedestrian quality of service, respectively. As stated above, these models provide reasonable results that represent bicyclists and pedestrians’ perceptions of the roadway environment. This would require no changes to the *Q/LOS Handbook* or to the ARTPLAN software.

#2 Implement a revised Bicycle segment LOS model.

One specific recommended alteration to the bike segment model is a variation on the way heavy vehicles are treated. Currently, heavy vehicles are included only as a percentage of the overall traffic on a roadway. As mentioned above, FDOT staff and others have expressed concerns that this approach can lead to skewed results in certain settings. Specifically, a high percentage of heavy vehicles on very low volume roadways can lead to poor level of service results while the true number of heavy vehicles on the roadways is actually quite low. To address this issue, a truck factor has been developed and is recommended as a modification to the existing model, to be used in place of the heavy vehicle percentage. This factor generally retains the use of the heavy vehicle percentage, but reduces that percentage when particular thresholds of low truck volume are reached.

#3 Implement the NCHRP 3-70 Models.

A national effort, NCHRP 3-70, Multimodal Level of Service Analysis for Urban Streets, has been developing and testing a framework and enhanced methods for determining levels of service for the automobile, transit, bicycle, and pedestrian modes on urban streets. These models are expected to form the basis of the urban streets chapters of the next edition of the *Highway Capacity Manual in 2010*.

The bike and ped models developed as part of this NCHRP project differ from Florida's models in that they are facility-level models (*i.e.*, they have been calibrated based on longer sections of roadways that include multiple segments on relatively busy roadways and through signalized intersections). The NCHRP bike model includes one term that corresponds to the bike segment level of service, but also includes terms for signalized intersection LOS and the frequency of interruptions (conflict points). The NCHRP ped model consists of a pedestrian density LOS and a pedestrian non-density LOS. The density LOS is computed according to the methods provided in the *Highway Capacity Manual*. The non-density LOS is a function of the pedestrian LOS of roadway segments, the pedestrian LOS of intersections, and a roadway crossing difficulty factor.

Because of the national stature of the NCHRP research project and FDOT's desire to stay at the forefront of non-motorized quality of service evaluation techniques, it is recommended that the next edition of the *Handbook* and corresponding software incorporate these models.

One of the innate characteristics of the NCHRP 3-70 bike and ped models is that it is very difficult to achieve a "good" levels of service. This is expected because they are, by definition, arterial models for high volume roadways which do not create a good environment for pedestrians and bicyclists. Just as drivers alter their expectation of the performance of a roadway based on its functional classification, so too do bicyclists and pedestrians. Arterials by nature are designed to carry large volumes of motor vehicle traffic. By choosing to ride on or walk along an arterial roadway, bicyclists and pedestrians generally anticipate a different, and generally less comfortable, travel experience than they do when using lower functional classes of facilities. In this sense, roadways evaluated using the NCHRP 3-70 bike and ped models have a built-in "penalty" associated with them. This characteristic is the reason why the NCHRP 3-70 bike and ped models are recommended as complements to the existing FDOT segment models, and not as replacements, especially for use with rural, collector and local roadways.

If the NCHRP 3-70 models are adopted by the Highway Capacity Committee of TRB, and incorporated into the 2010 *Highway Capacity Manual*, the FDOT may wish to incorporate the NCHRP3-70 bike and ped models into the *Q/LOS Handbook* and ARTPLAN. If this is done, it is recommended that it become the default model for FDOT arterial roadways, and a choice to run the segment models should be provided (perhaps in the Project Properties screen). The bike and ped segment models should always be used for analyses of collector and local roads, and may still be appropriate for arterial analyses as well.

An examination of FDOT's Generalized Level of Service Tables shows that level of service thresholds vary for the motor vehicle mode based on numerous criteria. By adopting the NCHRP 3-70 bike model, FDOT will create a similar situation for the bicycle and pedestrian modes, one in which those who use these tools can choose the appropriate technique to evaluate a particular roadway setting. Consequently, generalized tables would need to be revised for the application of the NCHRP 3-70 models on state roads and additional tables may need to be added for the use of the segment model on non-state roadways. The latter set of service volumes would be based on default values currently provided for major city/county roadways. Because some of these default values (e.g. truck percentages) differ for major city/county roadways, the maximum service volumes could also differ. As an example, ARTPLAN was used to identify the maximum service volumes (AADT for urbanized areas) using the default inputs for bike LOS for urbanized areas. Then, ARTPLAN was again used to determine new maximum service volumes, this time using the default inputs for non-state roadways. Table 1 below provides an illustration of the effects of the non-state roadway defaults.

Table 1 Illustration of Alternative Generalized Table for the Bicycle Mode

Existing Bike LOS maximum service volumes based on arterial defaults shown on top and non-state roadway defaults shown below in parenthesis.

Paved Shoulder/Bike Lane Coverage	Level of Service				
	A	B	C	D	E
0-49%	** (**)	** (1,900)	3,200 (3,300)	13,500 (18,000)	13,500 (18.000)
50-84%	** (**)	2,400 (2,500)	3,800 (3,900)	3,800 (3,900)	*** (***)
85-100%	3,100 (3,200)	7,200 (8,000)	7,200 (8,000)	*** (***)	*** (***)

** Cannot be achieved using default input values.
*** Not applicable using default input values.

Sidepath LOS

While the models described above focus on the quality of service for bicyclists and pedestrians riding in and walking along the roadway, it is also recommended that future updates of the *QLOS Handbook* incorporate techniques that evaluate sidepaths, shared use paths that are located within the right of way of the adjacent road. It is important that FDOT provide guidance regarding these types of facilities because they do function as part of the transportation corridor and because they are becoming increasingly prevalent. This is largely a result of the appeal they offer to casual cyclists and certain user groups (children, families, and the elderly) who are frequently not comfortable traveling close to or within the traffic stream. While sidepaths have numerous apparent benefits and appear to be a safer facility type for bicyclists, they also have serious safety concerns, so an objective evaluation of their characteristics would be helpful to the transportation community.

A sidepath level of service model was recently developed for FDOT District 1, and is being used as part of District 7's non-motorized trip prediction project. However, this model is not user-validated, and should therefore be considered as a "theoretical construct." In its present form, sidepath evaluation is based on the width of the sidepath and its separation from the roadway, as well as the bicycle level of service provided within the roadway using the bike segment model.

At this time, there is no sidepath LOS technique that is sufficient to recommend its inclusion in the *Handbook* and its companion software. The theoretical construct described above would need refinement of its component terms and validation prior to recommendation for incorporation into FDOT's present LOS software. A new theoretical construct that incorporates other aspects of side path quality of service, such as capacity or passing conflicts, may also be appropriate. Ultimately, it is recommended that research be performed that leads to a true user-validated side path level of service model and that the resulting model, if it becomes available in the future, should be incorporated into FDOT's planning documents

Transit LOS Mode

FDOT's *2002 Quality/Level of Service Handbook* also outlines procedures for determining transit LOS at a planning level of analysis. Specifically, it adopts service frequency, expressed as a number of buses per hour, as the primary determining factor of transit quality of service. Several other components that affect the quality of transit service are also identified, and appropriate adjustment factor values are provided to account for these conditions. Three of the four adjustment variables (pedestrian segment LOS, roadway crossing difficulty, and the presence of obstacles between sidewalks and transit stops) are related to pedestrian access to stops; the fourth is the span of bus service provided during the day.

It is recommended that the general structure of determining transit LOS by using service frequency as a base indicator and then applying appropriate adjustment factors should be retained. Of the four current adjustments, two of them (pedestrian segment LOS and roadway crossing difficulty) are always applicable; as such, they should be retained. The other two potential adjustments only occur in special cases, when an obstacle between the sidewalk and the transit stop exists or when the span of service is different from the typical span of service generally offered by transit agencies in Florida. The obstacle situation, while valid in and of itself, is thought to be such a rare enough occurrence that its use should be discontinued, especially to avoid oversaturation of adjustment factors if another is adopted (see "load factor" discussion below). The span of service variable could be considered extraneous to the transit LOS evaluation because the evaluation is, in theory, done at an hourly level (*i.e.,* the service is either provided or not during the analysis period); however, because of the importance of span of service to the numerous potential users who need to access transit service outside of times that are generally accommodated, its use should be retained.

One additional factor that is not currently included in the transit LOS procedure that is recommended for future updates is the *load factor*. Load factor is generally expressed within the context of bus service as the ratio of occupied seats on a vehicle to the total number of seats provided, with values closer to one indicative of more crowded vehicles. While the service frequency and the other adopted components of transit LOS all relate to the ability to access a bus, the load factor deals with on-board conditions. Because users generally prefer less crowded conditions and the ability to ride in relative isolation, higher load factors are considered a detriment to the quality of service provided. Because of the perceived relative importance of load factors to the overall quality of the transit experience, it is recommended to be included as a new adjustment factor.

A unique characteristic of load factor is that it functions as both a quality of service variable and as a capacity-related variable. Up to a certain point, an overcrowded vehicle is simply a nuisance, but at a certain point, if the ratio significantly exceeds one (a relatively uncommon occurrence in Florida) the ability to board the vehicle is compromised. If that point is reached wherein all seats are occupied and standing room is largely filled during the peak riding hours, the load factor should become an overriding consideration and lead to an LOS of "F" because demand has exceeded capacity and rendered the transit service unacceptable in the same way that a total lack of service does. In all other cases, an adjustment factor should be applied and the values in Table 2 below are recommended.

Table 2 Recommended Load Factor Adjustment Values*

Load Factor	Adjustment Factor	Comments
0-0.30	1.1	Passengers can freely avoid sitting next to other passengers.
0.31-0.75	1.0	The vehicle is relatively uncrowded.
0.76-1.00	0.9	Seats are still available for boarding passengers.
1.01-1.25[2]	0.8	Boarding passengers must stand.

**(Consider adapting the Transit Capacity and Quality of Service Manual Exhibit 3-26 which provides LOS scores for load factor. These can then be adapted as adjustment factors.)*

[2] Additional research may be necessary to refine this upper value where demand exceeds capacity.

These values were derived as follows:

- At a load factor value of 0.30 or less a boarding rider would be able to find an empty seat.
- The 0.31 to 0.75 range represents conditions where a boarding passenger will have a relatively large selection of seats from which to choose.
- The 0.76 to 1.0 range represents crowded conditions
- Greater than 1.0 represents overcrowded buses.

Truck volume Calculations

As noted previously, in the Bicycle Level of Service Model, heavy vehicles are included only as a percentage of the overall traffic on a roadway. FDOT staff and others have expressed concerns that this approach can lead to skewed results in certain settings. Specifically, a high percentage of heavy vehicles on very low volume roadways can lead to poor level of service results while the actual number of heavy vehicles on the roadways is actually quite low. To address this issue, a truck factor has been developed to compensate for (assumed) overrepresentation of truck influences at low ADTs and is recommended as a modification to the existing model. This proposed truck factor is described below. It should be noted that this is truck factor is a theoretical construct and has not been user validated.

The truck factor was developed under an assumption that there is a minimum number of trucks below which the sum total of the impacts of truck traffic on bicyclists' perceptions of safety and comfort is reduced below that represented by a percent trucks factor. For this construct, the minimum volume of trucks was assumed to be 3 in a 15-minute period, or one truck passing the cyclist every five minutes. Below this volume the low volume trucks factor reduces the percent heavy vehicles proportionally to the volume of trucks less than 3 per 15-minute period.
In application, a truck factor would be used in place of the percent trucks in the bicycle level of service equation. The low volume truck factor is proposed to be calculated as follows:

If $(Vol_{15}/L)*HV > 3$

Then $TF = HV$

Otherwise, the HV is multiplied by the ratio of the volume of heavy vehicles in fifteen minutes to the cutoff volume of three heavy vehicles in fifteen minutes.

$$TF = HV * (Vol_{15}/L *HV)/3$$
$$= (Vol_{15}/L *HV^2)/ 3,$$ Where

TF = Truck Factor

Vol_{15} = volume of directional motorized vehicles in the peak 15 minute time period
L = number of directional through lanes
HV = Percentage of heavy vehicles

In sensitivity analysis, assume the following base conditions

Table 5.1 Example Data

AADT	=	4000
k	=	0.097
d	=	0.53
phf	=	0.9
Through lanes	=	2
Speed Limit	=	40
PavCon	=	4
Wt	=	22
Wl	=	4
Wps	=	8
%ospa	=	0.45

Given the above the fifteen minute volume in the outside lane, Vol_{15}/L, on this example roadway would be 57 vehicles in fifteen minutes. As an example of the TF application, if we assume a heavy vehicle percentage of eight percent, the number of heavy vehicles in fifteen minutes would be

$Vol_{15}/L * HV$ = 57 * 0.08
= 4.56 heavy vehicles in 15 minutes

Given that 4.56 heavy vehicles in fifteen minutes is more that the cutoff value of three heavy vehicles in fifteen minutes, HV would simply be equal to PV, or eight percent. If however, HV were two percent, then

$Vol_{15}/L * HV$ = 57 * 0.02
= 1.14 heavy vehicles in 15 minutes

Since 1.14 vehicles in fifteen minutes is less than the cutoff value of three heavy vehicles in fifteen minutes, HV would be calculated as follows:

$TF = (Vol_{15}/L * HV^2)/ 3$
$= (57*0.02^2)/3$
$= 0.0076$
$= 0.76\%$

The Table 5.2 illustrates the difference between HV and TF if the percent heavy vehicles is varied. As can be seen in the table, HV and TF are equal until the shown percent heavy vehicles is below six percent. This is because if the percent heavy vehicles exceeds six percent, more than three trucks per fifteen minutes are passing the cyclists. For percents heavy vehicles of five percent or less, however, TF represents a significant reduction from the HV term.

Table 5.2 Comparison of HV and TF Factors
ADT = 4000, HV = varies

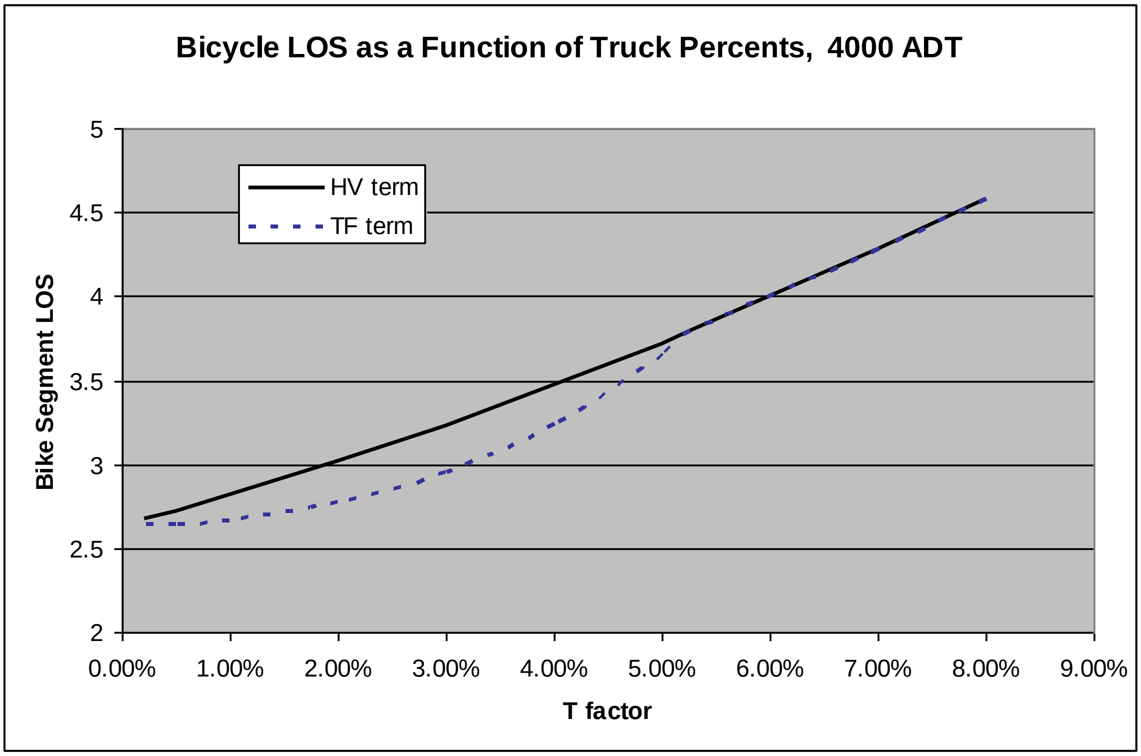
HV (%)	Vol_{15}/L *HV	TF
10	5.71	10.00
8	4.57	8.00
6	3.43	6.00
5	2.86	4.76
4	2.28	3.05
3	1.71	1.71
2	1.14	0.76
1	0.57	0.19
0.5	0.29	0.05
0.25	0.14	0.01

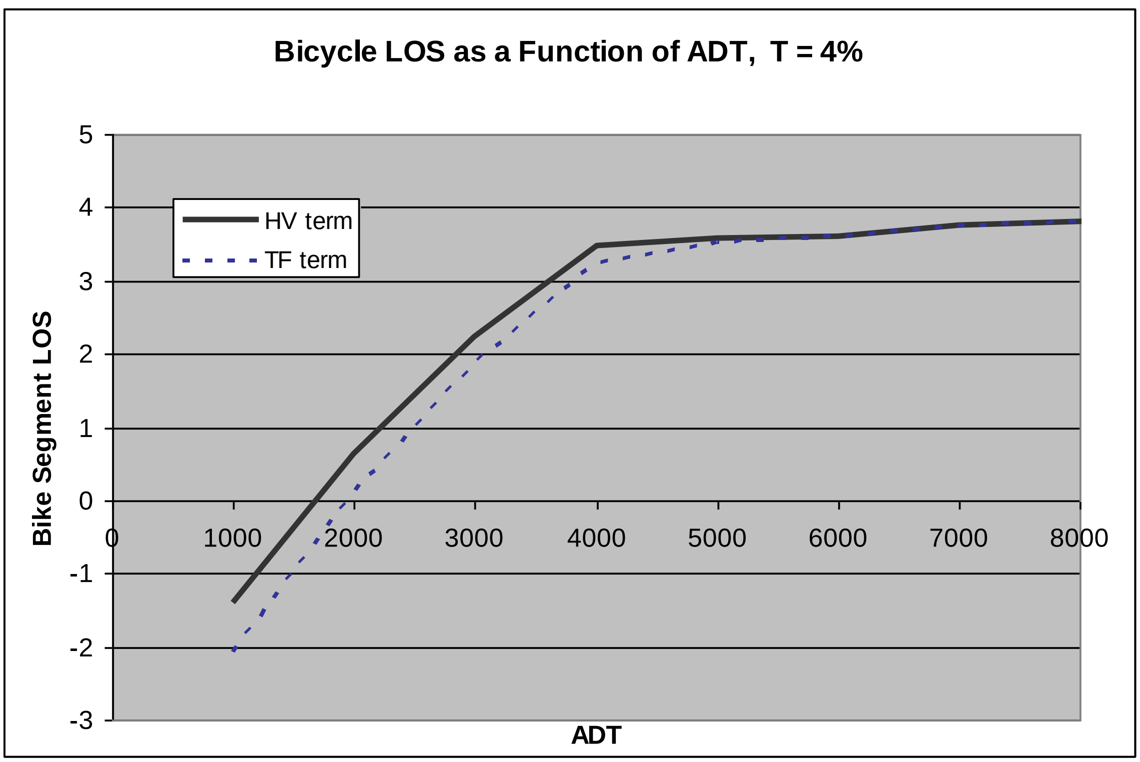
Table 5.3 represents the impact of changing the ADT on TF, assuming a constant actual percent of heavy vehicles of four percent.

Table 5.3 Comparison of HV and TF Factors
ADT = Varies, HV = 4%

ADT	Vol15/L *HV	TF
8000	4.57	4.00
7000	4.00	4.00
6000	3.43	4.00
5000	2.86	3.81
4000	2.28	3.05
3000	1.71	2.28
2000	1.14	1.52
1000	0.57	0.76

Replacing HV with TF impacts the Bicycle LOS as shown in Figures below.





Sidepath Level of Service discussion:

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 construct 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 additional geometric and 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
Where:
Base Sidepath LOS = Modified FDOT Pedestrian LOS equation
c = Congestion Term
d = additional Delay
e = Exposure term
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 Pedestrian Level of Service methodology[3] has been modified to represent the user's perceived comfort / safety on a sidepath. The FDOT's Pedestrian LOS model is provided below:

$$\text{Ped LOS} = -1.2276 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.0091(Vol_{15}/L) + 0.0004\ SPD^2 + 6.0468$$

Where:

W_{ol} = Width of outside lane (feet)
W_l = Width of shoulder or bike lane (feet)
f_p = On-street parking effect coefficient (=0.20)
%OSP = Percent of segment with on-street parking
f_b = Buffer area barrier coefficient (=5.37 for trees spaced 20 feet on center)
W_b = Buffer width (distance between edge of pavement & sidewalk, feet)
f_{sw} = Sidewalk presence coefficient

[3] *2002 Quality / Level of Service Handbook*, pp. 20 – 21, FDOT, Tallahassee, FL, 2002.

$= 6 – 0.3W_s$
W_s = Width of sidewalk (feet)
Vol_{15} = average traffic during a fifteen (15) minute period
L = total number of (through) lanes (for road or street)
SPD = Average running speed of motor vehicle traffic (mi/hr)

The existing pedestrian model may capture the effects of traffic, separation and buffer factor on bicyclists riding on a sidepath. However, pavement condition has also been found to significantly impact bicyclists' perceptions and pavement condition is not accounted for in the pedestrian LOS model. Consequently, the term that represents the impact of pavement condition in the Bicycle Level of Service model[4] $[7.066(1/PR_5)^2]$ is proposed to be added to the Sidepath LOS construct.

Given that the pavement condition term is an additive factor, merely adding the pavement condition term to the pedestrian level of service equation would result in an automatic degradation of the sidepath LOS. For this construct, it is assumed that a pavement condition rating has the same impact on sidepath users as it does on roadway users. Based upon this assumption, the constant term of the Pedestrian LOS equation is proposed to be reduced by resulting value of the pavement condition term given new pavement (0.2826). The presumed safety / comfort Sidepath Level of Service Equation is as follows:

$$\text{Base Sidepath LOS} = - 1.2276 \ln (W_{ol} + W_l + f_p \times \%OSP + f_b \times W_b + f_{sw} \times W_s) + 0.0091(Vol_{15}/L) + 0.0004\, SPD^2 + 7.066(1/PR_5)^2 + 5.7642$$

Where:

W_{ol} = Width of outside lane (feet)
W_l = Width of shoulder or bike lane (feet)
f_p = On-street parking effect coefficient (=0.20)
%OSP = Percent of segment with on-street parking
f_b = Buffer area barrier coefficient (=5.37 for trees spaced 20 feet on center)
W_b = Buffer width (distance between edge of pavement and sidewalk, feet)
f_{sw} = Sidewalk presence coefficient
$= 6 – 0.3W_s$
W_s = Width of sidewalk (feet)
Vol_{15} = average traffic during a fifteen (15) minute period
L = total number of (through) lanes (for road or street)
SPD = Average running speed of motor vehicle traffic (mi/hr)

[4] *2002 Quality/Level of Service Handbook*, pp. 18-19, FDOT, Tallahassee, FL, 2002.

The numeric scores resulting from applying this equation are used to determine the safety / comfort Sidepath LOS, as shown in Table 5.4.

Table 5.4 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

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[5] (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:

$$F = 0.5F_m + F_p$$

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

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

v_{bo} = flow rate of bicyclists in the opposing direction, bicycles per hour
Number of events/hour is used to determine shared off-street path LOS as shown in Table 5.6.

Table 5.6 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. A recent NCHRP-sponsored research project calibrated 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 improves. Table 5.7 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.

Table 5.7 Congestion Factor, C, for Sidepath LOS

		Shared Off-Street Path LOS (Based on HCM 2000 methodology)					
		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.[6] The congestion factors based upon these area type classifications are provided in Table 5.8.B4.

Table 5.8 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 / 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.

It is anticipated that 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

[6] *2002 Quality / Level of Service Handbook*, pg. 47-49, FDOT, Tallahassee, FL, 2002.

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)
e = the exponential function
n = $V_{sp}/600$
and
V_{sp} = volume of sidepath users

Bicyclist Delay

The additional delay along the sidepath 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

$$d_{sp} = \frac{\frac{L_{sr}}{V_b} + \frac{N_s V_b}{2}\left(\frac{1}{a_-} + \frac{1}{a_+}\right) - \frac{L_{pr}}{V_b}}{\frac{L_{pr}}{V_b}}$$

Where:

d_{sp} = delay for cyclist riding the alternative route, expressed as a decimal fraction of the travel time for the primary route
L_{sr} = length of the sidepath 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*[7], it is appropriate to use the lower values for acceleration and deceleration given in the AASHTO *Guide*[8] - 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:

[7] *Guide for the Development of Bicycle Facilities,* pg. 6, American Association of State Highway and Transportation Officials. Washington, D.C., 1999.
[8] *Guide for the Development of Bicycle Facilities,* pg. 65, American Association of State Highway and Transportation Officials. Washington, D.C., 1999.

$$d_{sp} = \frac{L_{sp}}{L_{pr}} + \frac{142Ns}{L_{pr}} - 1$$

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
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, the final proposed form of the Sidepath LOS equation is as follows:

Sidepath LOS = Base Sidepath LOS + c + e + d

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

Results from the Spring 2008 Bike Florida “Trail link” event survey (field interviews & scoring as well as internet DVD viewing/survey scoring – see Appendix F for survey used with Bike Florida event) will be analyzed during the next phase of the side path research and utilized to help in validating the proposed theoretical construct model.

CHAPTER FIVE: DISCUSSION AND RECOMMENDATIONS FROM PRACTITIONERS WORKSHOP

Discussion and recommendations from the practitioners workshop are organized and listed in the following two categories:

1- Discussion on LOS models and their sensitivity

2- Recommendations for model application and implementation

Discussion of LOS model sensitivity

The 21 atendees in the Tampa, Florida December workshop participated in an extensive exercise utilizing computer-loaded spreadsheets that contained data collected from 6 roadway facilities in three FDOT districts. It had an overlay of the segment BLOS, Ped LOS and transit models and MV LOS model. They discussed their observations relative to model use and sensitivity when various roadway characteristics were changed, (ie. increasing or decreasing variables such as AADT or speed on a facility to watch for a change in bicycle or pedestrian LOS). They wanted to see just how accurately these models could reflect the Level of Service for each mode.

The discussion that followed is reflected in some generalized recommendations, supporting the advisory team model choices, with suggestions for adjustments. They gave some further recommendations to try to improve model sensitivity, especially for the pedestrian and bicycle modes on arterial roadways.

Because of the national stature of the NCHRP research project and FDOT's desire to stay at the forefront of non-motorized quality of service evaluation techniques, it is recommended that the next edition of the *Handbook* and corresponding software incorporate the NCHRP 3-70 models for Bicycle and Pedestrian Level of Service.

They felt it was advisable that bicycle segment LOS incorporate not only heavy vehicle (truck) volume adjustment factor, but number of unsignalized intersections (and with urban streets models, number of signalized intersections). Separation will be addressed with continued research on sidepath and multiuse trail facilities, as well as other independent alignment options (parallel bicycle boulevards). Discussion of other factors affecting bicycle and pedestrian LOS also included effects of rumble strips on rural state roads, percentage parked cars and their turnover rate on bicycle lanes in urban areas, and windblast effects of heavy trucks on both rural and urban roads (some of these are already included in models).

Pedestrian model variables that address QLOS pedestrian factors describing adjacent land uses need to reflect user comfort associated with *safety and security* of a particular facility or area for walking. Pedestrians can be considered " a more vulnerable" user if surrounding land use lends the "fear" factor of criminal activity, unpleasant noise, odors, presence of "street people" etc. These are factors that might not be easily assimilated into a scientific model, but nevertheless are part of the user comfort component and will definitely determine whether or not a person will chose to walk on a particular facility.

The existing transit LOS models, adjusted for a "load factor", were supported for use at the planning level. Additional QLOS components that might be addressed in future research relate to ease of access, storage for bikes, and "waiting" conditions, as well as user information. Transit users, when other more critical QLOS factors have been met, are further encouraged to use transit if well located, covered shelters are available with appropriate informational signage. Bicyclists combining a transit and bicycle trip, require bike racks on buses, and/or secure covered parking at transit stops for potential "park, lock & ride" trips.

Motor vehicle LOS, as it interfaces with bicycle, pedestrian and transit LOS, is taking on a new perspective, based on a "quality" factor not previously incorporated into the models. As such, the "delay" factor may be influenced by the users comfort level with the surrounding environment (i.e. hostility vs. beauty of the surrounding land use).

Truck LOS, while relying heavily on "capacity" (and ability to move goods to markets in a timely and efficient manner) might do well to investigate components related to *safety* and access to destinations. More research needs to be incorporated into LOS multimodal and intermodal models looking at techniques for transfer and distribution of goods and safety associated with traffic "mix" on arterials and urban roadways.

Discussion ensued about the price of gasoline and the fact that, as it continues to increase, the bicycle, pedestrian and transit modes will become increasingly popular, out of necessity, perhaps, more than choice. FDOT has an obligation to provide safe, well designed facilities for all road users, who want the same access to destinations that motor vehicle drivers want. Delivery of goods by truck to these same destinations makes the safe and efficient use of facilities for all users a significant challenge.

Workshop participants felt that the use of the models requires an understanding of the interplay between modes and the importance of chosing facilities that provide the best practical design in a context sensitive fashion, taking into consideration surrounding land use types (including high pedestrian volume generators such as schools, shopping areas, parks, libraries, etc.).

The multimodal decision analysis for MPO's and transportation planners at all levels, requires the understanding and adoption of these various multimodal models and how they can be used to prioritize during both the funding and roadway design process. Continued work on obtaining overall LOS for interactions between all modes will be needed especially when urban arterials become more desirable facilities for bicyclists, pedestrian and transit users.

The model sensitivity and strong influence of AADT (average daily traffic factor) on "LOS grades" for the bicycle and pedestrian models was of concern to the workshop participants. On the urban arterials, it was extremely hard to get a good ("C" or better) BLOS or Ped LOS) where both AADT and posted speed were high (typical for arterial sections). It was suggested that perhaps a "stretching" of LOS grades or a use of a numerical grading system could better reflect LOS for bikes and pedestrians in the various roadway classifications.

A focus on SAFETY was a point of discussion, with an identified desire for more research on how roadway design could afford greater safety for all users while at the same time, meeting capacity, and what cost/benefit analysis reflects. Traditional techniques of emphasizing maximum automobile and truck capacity over the safety, comfort, and convenience of other roadway users needs to be re-evaluated. The practice of increasing number of lanes to address roadway capacity must be re-evaluated to include solutions that address multimodal concerns and priorities, along with safety of all users. Arterial roadway re-design plans will necessitate "out of the box" thinking, with lane reduction and lane transfer to other modes as part of the LOS analysis.

Recommendations for model application and implementation:

Finally, a need to "market" the multimodal models was discussed. Workshop participants felt it was very important to devise ways to tell transportation professionals, decision makers and interested citizens:

- Of multimodal model availability,
- existing and potential use in the project development process, and
- roadway analysis for re-design and funding prioritization.

The following suggestions were made during the workshop afternoon brainstorming sessions as ways to make the understanding and use of these models more widely accepted:

a. Training on the use of QLOS software to a wider audience including colleges engineering classes, MTPO's etc.

b. Host a FDOT MMP/LOS design conference for Florida, inviting MPOAC staff, FDOT, local governments and consultants, (perhaps host at UF by engineering college)

c. Utilize Video/DVD for public process training – MPO's, Bike/ped advisory committees

d. Create a "Best Practices" handbook of model use and prioritization processes

e. Incorporate multimodal LOS standards into FDOT design Standard Indices (none presently exist for bike, ped and transit modes in typical sections – establish minimum LOS standards)

f. Run LOS models with other already "approved" design standards, including "three R" projects for road resurfacing and reconstruction

g. Require FDOT application of LOS for all modes in P.D.& E. and other planning for new or redesigned roadways. To accomplish this, FDOT should:
    - Encourage use by FDOT districts
    - Incorporate in chapters on bike /ped facilities in Greenbook and other design manuals
    - Provide guidance and training to bike/ped coordinators on the use of models
    - Request feedback from bike/ped coordinators on the use and applications of these models

- Create “language” in standard project scopes of services, specifying multimodal LOS analysis and performance targets

h. Incorporate language for LOS application as “routine accommodation” in the design of “Complete streets”

i. Require targets to achieve highest potential multimodal LOS, and create “variance” process only when significant barrier to achieving it exists.

j. Use numerical values on 10 point system vs. letter grades to allow more precision,”)

k. Develop training examples for each model (i.e. Segment models) and mode. Include intersection models as needed.

l. Incorporate GIS techniques to interface with ARTPLAN LOS software and areawide modeling (to spatially reference ARTPLAN models)

m. Develop the “ABCDE” test for Sidepath LOS application (a= access, b= BLOS, c= congestion, d= delay, e=exposure)

n. Develop multimodal performance measures for standard “scope of services” in the P.D&E. process and project construction “scope.”

o. Make understanding of LOS measures oriented toward community decision making

p. Bring environmental issues and environmental justice into LOS discussion

q. Look at Regional multimodal Network connection during ETDM process.

r. Reinforce MultiModal Standards

s. Identify “institutional barriers” to present incorporation of models and potential solutions to overcome them

CHAPTER SIX: SUMMARY AND CONCLUSIONS

From this research project a number of summary statements can be presented that incorporate the examination of previous research by experts in the field of multimodal planning and LOS model development, comments by a research advisory team, and discussion with recommendations from practitioners in the field of transportation planning and design. The use of these FDOT models for multimodal Level of Service is a critical development in the field of transportation planning, and comes at an important time in history, with the advent of elevation of gasoline prices and its effect on mode choice/use. New “out-of-the-box” thinking must be applied to assessment of arterial roads for design and re-design that serves *all* modes, and provides safe access for ALL users.

1. The existing LOS models developed by FDOT through previous research efforts should continue to be used in the ARTPLAN LOS software. While they lack some sensitivity especially for bike and ped scores, these models are effective in depicting the quality of the bicycle and pedestrian environment from the users perspective. These models can have some additional applications run as needed, especially for “tweaking” the models to reflect low heavy vehicle volumes (trucks) for BLOS,and a transit “load” factor. In addition, it is advisable to chose one model for each mode (segment BLOS, Ped LOS, Transit QLOS) and “tweak” as needed for intersection characteristics. To increase the model sensitivity, it could be helpful to create a numerical scale of 1 to 10 instead of the present A to E letter grade, thereby allowing for more variance in the scoring.

2. The NCHRP 3-70 models for Bicycle and Pedestrian LOS should be utilized for arterial evaluation, and if they are adopted for inclusion in the Highway Capacity Manual 2010 update, will also become the standards for Florida’s QLOS manual.

3. The interplay between modes for various roadway types requires sensitivity to the context of the land use and to the primary modes using the facilities. The determination of acceptance of pedestrian, bicycle, transit and motor vehicle LOS should be carefully assessed in light of the safety, comfort and convenience of ALL users, and addressed at all levels of planning and design. This includes funding analysis, roadway classifications, “RRR” (resurfacing, rehabilitation and restoration) projects, and most especially in the P.D.& E. process for roadway design and roadway construction.

4. Sidepath research needs to be continued, moving from a “theoretical construct” to an applicable model that can be incorporated into the overall bicycle and pedestrian level of service.

5. Multimodal Levels of Service should be “institutionalized” in FDOT by:

    a. Incorporating into standards in the *FDOT Plans Preparation Manual* manuals, and other manuals and guides offered in roadway planning and design,

    b. Requiring SCOPE OF SERVICE specifications for multimodal LOS analysis and performance targets.

6. Training in the use of the Multimodal planning tools is essential to their effective use and can be offered by FDOT to district level employees as well as to communities at large (through MPO’s, bike/ped advisory committees, CTST’s and others).

7. The use of video/DVD technology for roadway LOS analysis provides an invaluable tool both for further research and for training and educational purposes.

The summation and evaluation of FDOT’s eight years of multimodal research and model development is an important step in the effort toward creating a more user responsive roadway system. Florida is leading the nation in this initiative, and continues to ask the hard questions and do the research necessary to answer them. By bringing together a group of practitioners, people who were already using the models or would be, in their daily work, it was possible to test the models on *real people* in *real world* scenarios, taking their recommendations for application of the tools. As the Highway Capacity Committee looks at their new models for Level of Service, Florida’s expertise will have made a significant contribution.

As we attempt to meet the mobility needs of all of Florida’s citizens, we now have proven tools for determining the needs of pedestrians, bicyclists, transit riders, as well as those of motor vehicle drivers, and guidance on ways to attempt to meet these needs. It has come at a critical time in our state and nation’s history.

APPENDIX

A. Summary of multimodal LOS Models

B. Data Collection Guidelines

C. Chart- Ideal Study segment characteristics

D. Workshop Spreadsheet of LOS models and variables

E. Workshop agenda for December 2007 workshop

F. Bike Florida event survey results for sidepath LOS

G. DVD information

Appendix A- Summary of Multimodal Level of Service Models

Summary of Bicycle LOS Models

(1) Signalized Intersections

(a) FL Research

Summary

The Intersection LOS model for the bicycle through movement provided below is based upon Pearson correlation analyses and stepwise regression modeling of approximately 1,000 combined real-time perceptions (observations) from bicyclists traveling a course through a typical U.S. metropolitan area's signalized intersections. The study's (human subject) participants represented a cross section of age, gender and geographic origin of the population of cyclists. The resulting general model for the Intersection LOS for the bicycle through movement is highly reliable, has a high correlation coefficient (R^2=0.83) with the average observations, and is transferable to the vast majority of United States metropolitan areas. The study reveals that roadway traffic volume, total width of the outside through lane, and the intersection (cross-street) crossing distance are primary factors in the Intersection LOS for bicycle through movements.

$$BLOS = 4.1324 - (0.2144 * W_t) + (0.0513 * CD) + \left(0.0066 * \frac{Vol_{15}}{L}\right)$$

BLOS	Bicycle LOS score for the intersection
W_t	Width of outside through lane
CD	Crossing distance (width of the side street including any median and auxiliary lanes)
Vol_{15}	Volume of directional travel in the outside though lane during a 15 minute period
L	Number of through lanes on the approach to the intersection

Reference:

Landis, B.W., Vattikuti, V.R., Ottenberg, R.M., Petritsch, T.A., Guttenplan., M.A., Crider, L.B. (2003) “Intersection Level of Service: The Bicycle Through Movement”, Transportation Research Record 1828, pp. 101-106.

(2) Arterial Segment

(a) ARTPLAN Model:

Summary

The statistically calibrated level of service model used for the ARTPLAN software in this paper is based upon real-time perceptions from bicyclists traveling in *actual* urban traffic and roadway conditions. The Study’s participants represented a cross-section of age, gender, experience level, and geographic origin of the population of cyclists that use the metropolitan road networks in the United States. The test course is representative of the collector and arterial street systems of North American urban areas. While further hypothesis testing is being conducted and additional studies are planned to test the need for disaggregate models for central business district streets with high turnover parking, truck routes, and two-lane high speed rural highways, the general bicycle level of service model reported in this paper is highly reliable, has a high correlation coefficient ($R^2 = 0.73$), and is transferable to the vast majority of United States metropolitan areas.

$$BLOS = 0.507*\ln(Vol_{15}/L) + 0.199*SP_t*(1+(10.38HV))^2 + 7.066 * (1/PR5)^2 - 0.005 * We^2 + 0.760$$

$$SP_t = 1.1199*\ln(SPp - 20) + 0.8103$$

$$We = Wv - (10*OSP)$$

$$We = Wv + Wl(1-(2*OSP))$$

$$We = Wv + Wl - (2*(10*OSP))$$

$$Wv = Wt$$

$$Wv = Wt *(2-(0.00025 * AADT))$$

BLOS	Bicycle LOS score for the segment
Vol_{15}	volume of directional traffic in 15 minute time period (default K/D factors 0.093 and 0.565 can be used)
L	total number of *through* lanes
SP_t	Effective speed factor
SP_p	posted speed limit
HV	percentage of heavy vehicles (estimated if unavailable)
PR_5	FHWA's five point pavement surface condition rating
W_e	average effective width of outside through lane
W_t	Total width of outside lane and paved shoulder
W_1	Width of pavement between outside lane stripe and edge of pavement
W_{ps}	Width of pavement striped for on-street parking
W_γ	Effective width as function of traffic volume
OSP	Percentage of segment with on-street parking
$AADT$	Average annual daily traffic

*Note: For field data collection guidelines for many of the bicycle/pedestrian model variables, see Appendix A.

References:

Landis, B.W., Vattikuti, V.R., and Brannick., M.T. (1997) "Real-Time Human Perceptions: Toward a Bicycle Level of Service", Transportation Research Record, 1578, pp. 119-126

FDOT (2002) Quality/Level of Service Handbook Page 18-19

(3) Arterial Facility

(a) ARTPLAN Model:

Summary

A method was needed to aggregate the individual segment bicycle analyses into facility analysis. This is important in the consideration of a shoulder/bicycle lane over some segments, but not over the whole facility. Some portions may offer acceptable LOS, however other portions may be so poor, that riding on the entire facility is avoided.

Conceptually, each segment is weighted by its distance and the severity of its bicycle LOS score to determine the facility LOS. The bicycle LOS is given by the following equation:

$$BLOS_f = \frac{\sum_n d_n * (BLOS_n)^2}{\sum_n d_n * (BLOS_n)}$$

$BLOS_f$	Bicycle level of service score for the facility
$BLOS_n$	Bicycle level of service score for the segment n in the facility (see segment LOS description above for details)
d_n	Length of segment n in the facility

References:

Florida Department of Transportation (2002), “Quality/Level of Service Handbook”, p.32-33.

(b) FL research

Summary

Data for the new Bicycle LOS for Arterials model were obtained from the FDOT’s innovative “Ride for Science” field data collection event and video simulations. The data consist of participants’ perceptions of how well roadways met their needs as they rode selected arterial roadways and/or viewed simulations of those and other roadways.

The Bicycle LOS for Arterials model is based upon Pearson correlation analyses, stepwise regression, and PROBIT modeling of approximately 700 combined real-time perceptions (observations) from bicyclists riding a course along arterial roadways. An additional 700 combined perceptions obtained from the participants viewing a video simulation (discussed in another paper) were used to refine the model for arterial roadways. The study participants represented a cross section of age, gender, riding experience, and residency. The Bicycle LOS for Arterials model provides a measure of the bicyclist's perspective on how well an arterial roadway's geometric and operational characteristics meets his/her needs. Although further hypothesis testing may be conducted in a future study, this model is highly reliable, has a high correlation coefficient (R^2=0.74) with the average ordinal observations, and is transferable to the vast majority of metropolitan areas in the United States.

$$BLOS_f = 1.370 + (0.797 * WBLOS_{seg}) + (0.131 * NumUSInt)$$

$BLOS_f$	Bicycle level of service score for the facility
$WBLOS_{seg}$	Distance weighted average bicycle LOS score for the segments along the facility
NumUSUInt	Number of unsignalized intersections per mile

<u>Reference:</u>

Petritsch, T.A., Landis, B.W., Huang, H.F., McLeod, P.S., Lamb, D., Farah, W. Guttenplan., M.A. (2006) "Bicycle Level of Service for Arterials".

(c) NCHRP 3-70:

Summary

An aggregate model was initially considered for the development of the bicycle LOS for arterials model. It was chosen for several reasons. The aggregate model uses a stepwise approach which is capable of addressing individual intersections or specific segments. It also contains variables for intuitively and mathematically significant factors to bicyclists along a roadway. Linear regression modeling was chosen because it is more intuitive than probit modeling and easier to understand. The PROBIT model was used to confirm the validity of the linear regression. The following equation for bicycle LOS was proposed:

$$BLOS_f = 0.160*(BLOS_{seg}) + 0.011(\exp(BLOS_{int})) + 0.035(Confltpm) + -0.398*PopDum01 + 3.25$$

$BLOS_{seg}$	The calculated length weighted segment bicycle LOS
$BLOS_{int}$	Exponential of the average Intersection LOS, where e is the base of natural logarithms and IntLOS is the calculated intersection bicycle LOS
Confltpm	Number of unsignalized conflicts per mile, i.e., the sum of the number of unsignalized intersections per mile and the number of driveways per mile
PopDum01	Two term dummy variable for MSA population (0 if Pop<1M, 1 if Pop>1M)

References:

NCHRP 3-70, selected sections

(4) Sidepath

(a) FL Research:

Summary

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 (Level of Service) the proposed sidepath would provide.

The calculation of the sidepath level of service (referenced in the last step of the process) is performed using the following equation:

Sidepath LOS = Base Sidepath LOS + C + E + D

Base Sidepath LOS	Modified FDOT bicycle equation
C	Congestion term
E	Exposure term
D	Additional delay

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

As described above.

Congestion Term. A congestion term based upon the Highway Capacity Manuals congestion based LOS for pathways was initially proposed to quantify the congestion along a sidepath. 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 the final methodology proposed using the FDOT Area Type classifications defined in the FDOT Quality of Service Manual.[1] 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

The *exposure to motorist conflict factor* is calculated using the following equation:

$$E = \left(1 - \frac{1}{e^{n}}\right)\left(0.1d_{ch} + 0.01d_{cl} + 0.001d_{r}\right)$$

E	exposure to motorist 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	$V_{sp}/600$

[1] *2002 Quality / Level of Service Handbook*, pg. 47-49, FDOT, Tallahassee, FL, 2002.

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

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

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*[2], it is appropriate to use the lower values for acceleration and deceleration given in the AASHTO *Guide*[3] - 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:

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

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

$$D_{ar} = \frac{L_{ar}}{L_{pr}} + \frac{142Ns}{L_{pr}} - 1$$

References:

Petritsch, T.A., Landis, B.A., Huang, H.F., Challa, S.K. "Sidepath Facility Selection and Design" Final Report, FDOT District 1, Bartow, FL, 2006.

(4) Alternative Route

(a) FL Research:

Summary

The Sidepath facility selection process also includes an evaluation of potential alternative routes. This analysis is performed by calculating an effective Level of Service for any proposed alternative route as described below.

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. Aws with the sidepath level of service it is represented by the following equation:

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

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 rou

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:

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

Where

A_{ar} = Access term for the alternative route

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

References:

Petritsch, T.A., Landis, B.A., Huang, H.F., Challa, S.K. "Sidepath Facility Selection and Design" Final Report, FDOT District 1, Bartow, FL, 2006.

Summary of Pedestrian LOS Models

(1) Signalized Intersections

(a) FL Research:

Summary

This model incorporates perceived safety/comfort (*i.e.*, perceived exposure and conflicts) and operations (*i.e.*, delay, and signalization). Data for the model were obtained from an innovative "Walk for Science" field data collection event and video simulations. The data consist of (1) participants' perceptions of safety/comfort and operations as they walk selected signalized intersections and (2) the design and operational characteristics of these intersections. The resulting model provides a measure of the pedestrian's perspective on how well an intersection's geometric and operational characteristics meets his/her needs.

The Pedestrian LOS model for intersections is based upon Pearson correlation analyses and stepwise regression modeling of approximately 800 combined real-time perceptions (observations) from pedestrians walking a course through a typical U.S. metropolitan area's signalized intersections. An additional 800 combined perceptions obtained from the same participants viewing a video simulation were used to refine the model for complex intersections. The study participants represented a cross section of age, gender, walking experience, and residency. Although further hypothesis testing may be conducted in a future study, the resulting general model for the Pedestrian LOS at intersections is highly reliable, has a high correlation coefficient (R^2=0.73) with the average observations, and is transferable to the vast majority of metropolitan areas in the United States. The study reveals that right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, mid-block 85th percentile speed of the vehicles on the street being crossed, the number of lanes being crossed, the pedestrian's delay, and the presence or absence of right-turn channelization islands are primary factors in the Pedestrian LOS model for intersections.

$$PLOS = 0.5997 + 0.005689*(Turn_{15}) + 0.0001274*(Vol_{15} * Spd_{15}) + 0.6810*(L_p^{0.514}) + 0.0.04011*LN(PedDelay) - RTCI*(0.0027*Vol_{15} - 0.1946)$$

$$PedDelay = \frac{0.5 * (C - g)^2}{C}$$ [Equation 18-5, HCM 2000, pp. 18-7]

PLOS	Pedestrian level of service score for the intersection
$Turn_{15}$	Sum of the number of right-turn-on-red and permitted left-turn vehicles in a 15 minute period
Vol_{15}	Volume of motorized vehicles in the outside lane of the street being crossed in a 15 minute period
Spd_{15}	Mid-block 85th percentile speed on the street being crossed in a 15 minute period
L_p	Number of lanes crossed by the pedestrian
RTCI	Number of right turn channelization islands on crossing
PedDelay	Average delay of pedestrians at signalized intersections (secs)
C	Cycle length
g	Effective green time for the pedestrians

References:

Petrisch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S., and Guttenplan, M. (2005) "Pedestrian Level of Service Model for Signalized Intersections", Transportation Research Record 1939, pp. 55-62.

(2) Arterial Segment

(a) FL Research

Summary - A method is needed to objectively quantify pedestrians' perception of safety and comfort in the roadside environment. This quantification, or mathematical relationship, would provide a measure of how well *roadways* accommodate pedestrian travel. Essentially it would provide a measure of pedestrian level of service within a roadway environment. Such a measure of walking conditions would greatly aid in roadway cross-sectional design and also help evaluate and prioritize the needs of existing roadways for sidewalk retrofit construction. Furthermore, the measure can be used to evaluate traffic calming strategies and streetscape designs for their effectiveness in improving the pedestrian environment. Such a measure would enable pedestrian facility programming to be merged into the mainstream of transportation planning, design and construction.

To meet the need for such a method, as well as to fulfill a state mandate to establish levels of service standards for *all* transportation modes, the Florida Department of Transportation sponsored the development of the *Pedestrian Level of Service (LOS) Model* as described within this paper. The *Model* was developed through a stepwise multi-variable regression analysis of 1250 observations from an event that placed 75 people walking on a roadway course in the Pensacola metropolitan area in Florida. The *Pedestrian LOS Model* incorporates the statistically significant roadway and traffic variables that describe pedestrians' perception of safety or comfort in the roadway environment between intersections. It is similar in approach to the methods used to assess the automobile operators' level of service established in the *Highway Capacity Manual*.

$$PLOS = -1.2021 \ln(W_{ol} + W_l + f_p * \%OSP + f_b * W_b + f_{sw} * W_s) + 0.253 \ln(Vol_{15}/L) + 0.0005\, SPD^2 + 5.3876$$

W_{ol}	Width of outside lane (feet)
W_l	Width of shoulder or bike lane (feet)
f_p	On-street parking effect coefficient (=0.20)
%OSP	Percent of segment with on-street parking
f_b	Buffer area barrier coefficient (=5.37 for trees spaced 20 feet on center)
W_b	Buffer width (distance between edge of pavement and sidewalk, feet)
f_{sw}	Sidewalk presence coefficient (= 6 - 0.3 W_s)
W_s	Width of sidewalk (feet)
Vol_{15}	Average traffic during a fifteen (15) minute period (default K/D factors 0.093
L	total number of (through) lanes (for road or street)
SPD	Average running speed of motor vehicle traffic (mi/hr)

<u>References:</u>

Landis, B.A., Vattikuti, V.R., Ottenberg, R.M., McLeod, D.S., and Guttenplan, M. (2001) "Modeling the Roadside walking environment: A pedestrian level-of-service", Transportation Research Record 1773, pp. 82-88.

<u>(b) ARTPLAN Model:</u>

Summary

The Pedestrian LOS Model in an operational model that has been applied throughout Florida and other areas of the United States. The model is based on four variables with relative importance, called the "T statistic". They are as follows:

- Existence of a sidewalk
- Lateral separation of pedestrians from motorized vehicles
- Motorized vehicle volumes
- Motorized vehicle speeds

Each variable is weighted by relative importance and a numerical LOS score can be determined along with the corresponding LOS letter grade. The model was developed using step-wise regression analyses with real-time observations conducted in 2000. Pedestrian LOS are determined using the following equation:

$$PLOS = -1.2276 * \ln\left(W_{ol} + W_l + (0.2 * OSP) + (5.37 * W_b) + (6 - 0.3W_s) * W_s\right)$$
$$+ 0.0091 * (Vol_{15} / L) + 0.0004 * SPD^2 + 6.0468$$

PLOS	Pedestrian level of service score for the arterial segment
W_{ol}	Width of outside lane
W_l	Width of shoulder or bicycle lane
%OSP	Percent of segment with on-street parking
W_b	Buffer width (distance between edge of pavement and sidewalk, in feet)
W_s	Width of sidewalk
Vol_{15}	Volume of motorized vehicles in the peak 15 minute period
L	Total number of directional through lanes
SPD	Average running speed of motorized vehicle traffic (mi/h)

Numerical LOS values can be converted into letter grades using the following table:

Table 2-1 Bicycle and Pedestrian LOS 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

References:

Landis, B.A., Vattikuti, V.R., Ottenberg, R.M., McLeod, D.S., and Guttenplan, M. (2001) "Modeling the Roadside walking environment: A pedestrian level-of-service", Transportation Research Record 1773, pp. 82-88.

Florida Department of Transportation (2002) "FDOT Quality/Level of Service Handbook" pp 20-21.

(3) Mid-Block Crossings

(a) NCHRP 3-70

The pedestrian mid-block crossing factor is computed as a function of the mid-block crossing LOS and the pedestrian facility LOS (with the mid-block factor set to 1.0).

The mid-block crossing LOS is computed based on the maximum of the waiting-for-a-gap LOS and diverting-to-a-signal LOS.

MidLOS = *Max* [*WaitForGapLOS, DivertToSignalLOS*]

MidLOS	Mid-block crossing LOS
WaitForGapLOS	LOS of waiting for safe gap to cross
DivertToSignalLOS	LOS of diverting to nearest signalized intersection to cross

The Wait-For-Gap LOS Calculation is computed based on the expected waiting time required to find an acceptable gap in the traffic to cross the street. The acceptable gap is computed as a function of the number of lanes, their width, and the average pedestrian walking speed, with 2 seconds added.

Acceptable Gap = (*Number of Lanes* * 12 *feet/lane*)/3.5 *feet/second* + *2 seconds*

The expected waiting time until an acceptable gap becomes available is computed as follows:

MeanWait = [exp(-λt)-(1+λt)]/[λ*(1-exp(-λt))]

t	The acceptable gap plus the time it takes for a vehicle to pass by the pedestrian
	The average pass-by time = Avg Vehicle Length/Avg Speed, converted to seconds
λ	The average vehicle flow rate in vehicles per second
Exp	The exponential function

Pedestrian LOS	Delay Threshold Seconds	Equivalent LOS Numerical Score Range	Equivalent LOS Midpoint Score
A	10	≤1.5	1
B	20	>1.5 and ≤2.5	2
C	30	>2.5 and ≤3.5	3
D	40	>3.5 and ≤4.5	4
E	60	>4.5 and ≤5.5	5
F	>60	>5.5	6

Ped Geometric Delay = (*Block Length*/3.5)/*Ped Walking Speed*

Ped Control Delay = (*Cycle Length* – *Green Time*)^2/(2**Cycle Length*)

Total Ped Deviation Delay = Ped Geometric Delay + Ped Cycle Delay

<u>Reference:</u>

NCHRP 3-70, selected sections.

(b) FL Research

This methodology is capable of providing a measure of effectiveness that indicates pedestrians' perceived quality of service in crossing roads at mid-block locations. This measure of effectiveness can then be converted to a level of service designation. This methodology should be generally consistent with other level of service methodologies being developing as part of the FDOT's Multimodal Quality of Service Program. The study will attempt to determine what variables are correlated with pedestrians' perceived quality of service for mid-block crossing. This will be done through a statistical calibration and validation process involving collecting actual site characteristics and stated levels of quality of service by a sample of persons at a sample of sites. These variables will include those that are most important to the FDOT and local governments for the purpose of improving pedestrian mobility, safety, and livability.

Gender	Age	Average Grade (1-6)	Standard Deviation	Number of Observations
Female	18-24	2.66	1.463	119
	25-64	2.92	1.736	345
	65+	3.75	1.721	60
	Total	2.94	1.692	524
Male	18-24	2.93	1.616	56
	25-64	2.96	1.510	165
	65+	2.55	1.262	22
	Total	2.92	1.514	243
Total	18-24	2.75	1.514	175
	25-64	2.94	1.665	510
	65+	3.29	1.667	82
	Total	2.93	1.636	767

Variables	Units	Mean	Standard Deviation
65 years or older dummy	0-1	0.11	0.31
Nearside total volume	1000 vehicles/hour	4.43	3.79
Far-side total volume	1000 vehicles/hour	3.67	2.42
Nearside turning movements	vehicles/hour	137	183
Far-side turning movements	vehicles/hour	127	150
Average speed	miles/hour	32.1	5.5
Nearside crossing width	feet	26.7	7.4
Far-side crossing width	feet	28.5	9.2
Width of restricted median	feet	7.5	13.1
Width of painted median	feet	3.5	5.8
Crosswalk dummy	0-1	0.51	0.5
Pedestrian-signal dummy	0-1	0.23	0.42
Nearside cycle length	seconds	27.3	49.3
Far-side cycle length in	seconds	25.8	46
Signal spacing	feet	4075	1614

References:

National Center for Transportation Research (2001), “Pedestrian Mid-Block Crossing Difficulty”, p. 11.

(4) Arterial Facility

(a) ARTPLAN:

A method was needed to aggregate the individual segment pedestrian analyses into facility analysis. This is important in the consideration of a sidewalk over some segments, but not over the whole facility. Some portions may offer acceptable LOS, however, other portions may be so poor, that the entire facility is avoided.

Conceptually, each segment is weighted by its distance and the severity of its pedestrian LOS score to determine the facility LOS. The pedestrian LOS is given by the following equation:

$$PLOS_f = \frac{\sum_n d_n * (PLOS_n)^2}{\sum_n d_n * (PLOS_n)}$$

$PLOS_f$	Pedestrian level of service score for the facility
$PLOS_n$	Pedestrian level of service score for the segment n in the facility
d_n	Length of segment n in the facility

References:

Florida Department of Transportation (2002), “Quality/Level of Service Handbook”, p.33-34.

(b) FL Research

This model represents pedestrians’ perceptions of how well urban arterials with sidewalks (a combination of roadway segments and intersections) meet their needs. This model incorporates traffic volumes on the adjacent roadway and exposure (*i.e.*, crossing widths) at conflict points with intersections and driveways. Data for the model were obtained from an innovative “Walk for Science” field data collection event. The data consist of participants’ perceptions of how well urban arterials with sidewalks meet their needs as pedestrians traveling along the roadway. The Pedestrian LOS model for roadway facilities described in this paper is based upon Pearson correlation analyses and stepwise regression modeling of approximately 500 combined real-time perceptions (observations) from pedestrians walking a course along a typical U.S. metropolitan urban area's streets. The study participants represented a cross section of age, gender, walking experience, and residency. Although further hypothesis testing may be conducted in a future study, the resulting general model for the Pedestrian LOS of urban arterials with sidewalks has a high correlation coefficient (R_2=0.70) with the average observations, and is transferable to a significant number of metropolitan areas in the United States. The study reveals that traffic volumes on the adjacent roadway and the density of conflict points along the facility are the primary factors in the LOS model for pedestrians traveling along urban arterials with sidewalks.

$$PLOS_f = 1.43 + 0.001*(XW) + 0.008*Vol_{15}$$

$PLOS_f$	Pedestrian level of service score for the facility
XW	Total width of crossing conflicts = total width of all intersections and driveways per mile of facility (feet/mile)
Vol_{15}	Average 15 minute volume on the adjacent roadway

Reference:

Petritsch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S. Skaggs, C.L. Guttenplan., M.A., Vattikuti, V. (2005) "Pedestrian Level of Service Model for Urban Arterial Facilities with Sidewalks".

(c) NCHRP 3-70

Ped LOS = Worse of (Ped Density LOS, Ped Other LOS)

Ped LOS	The letter grade level of service for the urban street combining density and other factors.
Ped Density LOS	The letter grade level of service for sidewalks, walkways and street corners based on density
Ped Other LOS	The letter grade level of service for the urban street based on factors other than density

Ped Density LOS = f (minimum pedestrian space) determined from the HCM 2000 Table provided below.

Table 18-3, HCM 2000, pp. 18-4

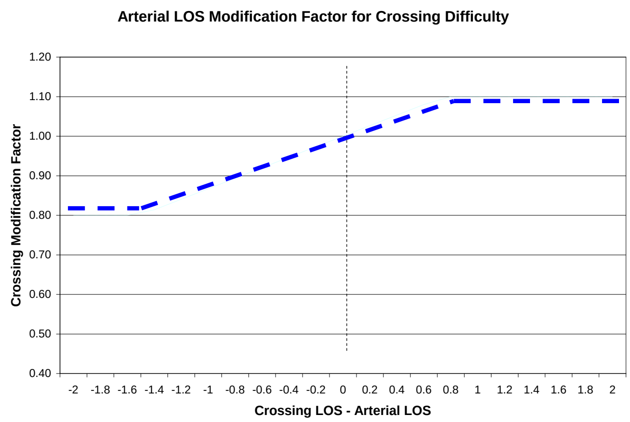
LOS	Minimum Pedestrian Space
A	> 60 SF per person
B	>40
C	>24
D	>15
E	>8
F	≤8 SF

Ped Other LOS = f (segment pedestrian LOS score, intersection pedestrian LOS score, mid-block crossing)

$$PLOS_f = MBC * \left(1.606 + (0.318 * PLOS_s) + (0.220 * PLOS_i) + (0.140 * MSAPop)\right)$$

$PLOS_f$	Pedestrian level of service score for the facility
$PLOS_s$	Pedestrian level of service score for the segment
$PLOS_i$	Pedestrian level of service score for the signalized intersection
MBC	Mid-block crossing modifying factor

$MBC = f\left(\mathrm{CrossLOS}, \mathrm{ArtLOS}\right)$ as shown in the graph below:



ArtLOS is the $PLOS_f$ with the MBC factor set to 1.

$$CrossLOS = Max(GapLOS, DivertLOS)$$

CrossLOS	Mid-block crossing LOS
GapLOS	LOS of waiting for safe gap to cross
DivertLOS	LOS of diverting to nearest signalized intersection to cross

$$GapLOS = f(\text{average waiting time to find an acceptable gap})$$

$$AverageWait = \frac{\exp(-\lambda t) - (1 + \lambda t)}{\lambda[1 - \exp(-\lambda t)]}$$

$$t = AccGap + PassbyTime$$

$$AccGap = (NL * 12)/3.5 + 2$$

$$PassbyTime = \frac{AVL}{AVSp}$$

λ	Average vehicle flow rate (veh/sec)
NL	Number of lanes
AVL	Average vehicle length
AVSp	Average vehicle speed

$$DivertLOS = f(Geodelay, Intdelay)$$
$$= f(\text{extra time walking to the nearest signalized intersection and crossing there})$$

$$Geodelay = \frac{BL}{3.5 * WalkSp}$$

BL	Block length
WalkSp	Pedestrian walk speed

$$IntDelay = \frac{0.5 * (C - g)^2}{C}$$ [Equation 18-5, HCM 2000, pp. 18-7]

The delay measures are converted to an LOS score using the table below:

Pedestrian LOS	Delay Threshold (Seconds)	Equivalent LOS Numerical Score Range	Equivalent LOS Midpoint Score
A	10	≤ 1.5	1
B	20	>1.5 and ≤ 2.5	2
C	30	> 2.5 and ≤ 3.5	3
D	40	> 3.5 and ≤ 4.5	4
E	60	> 4.5 and ≤ 5.5	5
F	>60	> 5.5	6

<u>Reference:</u>

Petrisch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S., Skaggs, C.L., Guttenplan, M., and Vattikuti, V. (2006) “Pedestrian Level of Service Model for Urban Arterial Facilities with Sidewalks”, Transportation Research Record 1982, pp. 84-89.

Florida Department of Transportation (2002) “FDOT Quality/Level of Service Handbook” pp 34-35.

NCHRP 3-70, selected sections

Summary of Transit LOS Models

(a) FL Research

Summary

The FDOT Quality/Level of Service handbook calculates transit LOS based largely on the frequency of the service available (headway), the value of which is adjusted upward or downward based on several adjustment factors including the Pedestrian LOS Factors, the Roadway Crossing Adjustment Factors, and Bus Span of Service Factors.

Level of Service	Adjusted Service Frequency (Vehicles/hour)	Headway (minutes)	Comments
A	>6.0	<10	Passengers don't need schedules
B	4.01 to 6.0	10 to 14	Frequent service, passengers consult schedules
C	3.0 to 4.0	15 to 20	Maximum desirable time to wait if transit vehicle missed
D	2.0 to 2.99	21 to 30	Service unattractive to choice riders
E	1.0 to 1.99	31 to 60	Service available during hour
F	<1.0	>60	Service unattractive to all riders

Pedestrian LOS Adjustment Factors on Bus LOS

Pedestrian LOS	Adjustment Factor
A	1.15
B	1.10
C	1.05
D	1.00
E	0.80
F	0.55

Roadway Crossing Adjustment Factors

Conditions that must be met:				
Arterial Class	Median	Number of Mid-Block Through Lanes	Automobile LOS	Crossing Adjustment Factor
I	All situations	2	A or B	1.05
II	All situations	2	A, B or C	
III	All situations	<=4	A or B	
IV	All situations	<=4	All levels of service	
I	None or Nonrestrictive	>=4	B, C, D, E or F	0.80
	Restrictive	>=8	All levels of service	
II	None or Nonrestrictive	>=4	C, D, E or F	
	Restrictive	>=8	All levels of service	
III	None or Nonrestrictive	>=4	D, E, or F	
	Restrictive	>=8	All levels of service	
All cases not included in conditions for factor 1.05 and 0.80 =				1.00

Bus Span of Service Adjustment Factors

Level of Service	Hours of Service per Day	FDOT Adjustment Factor	Comments
A	19-24	1.15	Night or owl service provided
B	17-18	1.05	Late evening service provided
C	14-16	1.0	Early evening service provided
D	12-13	0.90	Daytime service provided
E	4-11	0.75	Peak hour service/limited mid-day service
F	0-3	0.55	Very limited or no service

<u>Reference:</u>

Florida DOT (2002) “FDOT Quality/Level of Service Handbook,” p. 21.

Summary of Automobile LOS Models

The motor vehicle mode of transportation is included for the purpose of identifying the effects on MVLOS as the various bike/ped models presented in this summary are tested. Quality/level of service analyses are based on three types of characteristics: roadway, traffic, and control (signalization).

Roadway variables include:

- Area Type
- Number of through lanes
- Roadway class
- Posted speed
- Free flow speed
- Length Interchange spacing
- Median type
- Left turn lanes
- Terrain
- Percent no passing Zone
- Passing lanes

Reference:

Florida Department of Transportation (2002) “FDOT Quality/Level of Service Handbook”, p. 39.

Appendix B: Data Collection Guidelines

Direction of Survey – is the direction in which the data are collected.

Number of Through Travel Lanes (L) – is the total number of directional *through* traffic lanes of the road segment and its configuration. (e.g., D = Divided, U = Undivided, OW = One-Way, S = Center Turning Lane). The presence of continuous right-turn lanes should be noted in the comments field.

Posted Speed Limit (S_p) – is recorded as posted, only when a change occurs.

W_t Total Width of Outside Lane and Shoulder - is measured from the center of the road, yellow stripe, or (in the case of a multilane configuration) the lane separation striping to the edge of pavement or to the gutter pan of the curb. When there is angled parking adjacent to the outside lane, W_t is measured to the traffic-side end of the parking stall stripes.

W_l Width between Edge Stripe and Edge of Pavement - is measured from the outside lane stripe, if one exists, to the edge of pavement or to the gutter pan of the curb. When there is angled parking adjacent to the outside lane, W_l is measured to the traffic-side end of the parking stall stripes.

W_{ps} Width Striped for On-Street Parking – is parking to the right of a striped bike lane. Record this factor *only if such conditions exist*. If there is parking on two sides on a one-way, single lane street, report the combined width of the striped parking.

OSPA % - is the estimated percentage (measured in increments of 25%) of the segment (excluding driveways) along which there is occupied on-street parking at the time of survey. Each side should be recorded separately. If parking is allowed only during off-peak periods and parking restrictions change widths and laneage, indicate the geometric changes in the comments field. Note: Indicate any "angled parking" in the comments field.

Pavement Condition - is a measure of the quality of road surface. The pavement condition ratings used for the Bicycle Level of Service measure are shown below:

RATING	PAVEMENT CONDITION
5.0 (Very Good)	Only new or nearly new pavements are likely to be smooth enough and free of cracks and patches to qualify for this category.
4.0 (Good)	Pavement, although not as smooth as those described above, gives a first class ride and exhibits signs of surface deterioration
3.0 (Fair)	Riding qualities are noticeably inferior to those above; may be barely tolerable for high speed traffic. Defects may include rutting, map cracking, and extensive patching
2.0 (Poor)	Pavements have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement has distress over 50 percent or more of the surface. Rigid pavement distress includes joint spalling, patching, etc.
1.0 (Very Poor)	Pavements that are in an extremely deteriorated condition. Distress occurs over 75 percent or more of the surface.

Source: U.S. Department of Transportation. Highway Performance Monitoring System-Field Manual. Federal Highway Administration. Washington, DC, 1987

Cross-section Type – is an indicator of the presence or absence of a curb and gutter system. A “C” is recorded if there is a curb and gutter on the segment, an “S” if there is an open shoulder.

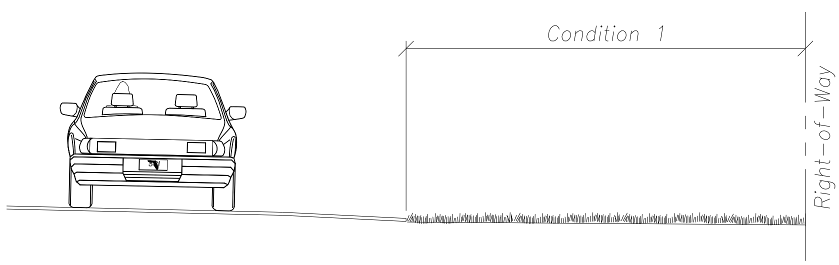
Buffer Width (W_b) - is the width of a grass buffer. The width of the buffer is measured from the edge of pavement (including the width of the curb if present) to the beginning edge of the sidewalk. If a sidewalk has trees planted in it, then the horizontal width of the sidewalk occupied by the trees should be collected as a buffer.

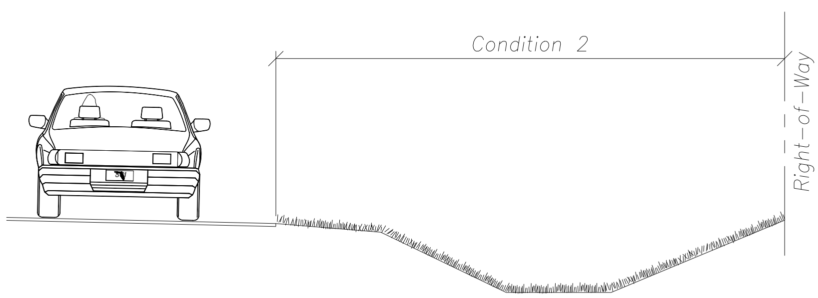
Sidewalk Width (W_s) – is the width of the sidewalk, measured from the edge of pavement (including the curb) if a grass buffer is not present. If a grass buffer is present, the width is measured from the edge of the buffer to the backside of the sidewalk.

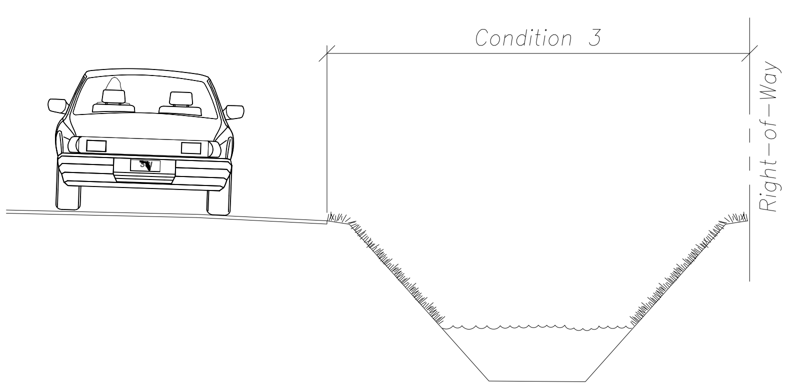
Sidewalk Surface Type - is the material composition of the sidewalk.

Tree Spacing in Buffer- is the spacing of trees within a buffer measured from foot on center (width of spacing between trees). Trees can either be in a grass buffer or in a sidewalk. This field is only collected if the tree spacing is 75 feet or less.

Roadside Profile Condition –is the area between the outside edge of the pavement and the right-of-way line. This data item will be compiled and/or collected to assist in determining the lateral area available for bicycle lane or paved shoulder construction; the profile condition can assist in determining the type of facility, hence its cost [i.e., bicycle lane or paved shoulder or bike path]. Additionally this data item can be used, with the other listed data to determine if a section would be classified as a *Hazardous Walking Condition* for school children as defined in Section 1006.23, (4), F.S. **Condition 1**, buildable shoulder is defined as an area adjoining the edge of pavement with a minimum width of seven feet and a maximum cross-slope of 6%. **Condition 2** is a swale. **Condition 3** is a ditch or canal.







APPENDIX C - FDOT Multi-Modal LOS:
Ideal Study Segment Characteristics (based on identified critical variable ranges)

Variable	Approximate Desired Value
# of mid-block through lanes	2
width of outside lane (feet)	10
width of outside lane and bike lane/paved shoulder (feet)	10
% w/ on-street parking	50
daily traffic volume	10,000-20,000
posted speed limit (mph)	35
cross streets per mile	10
driveways per mile	10
sidewalk width (feet)	8
buffer width (feet)	5
sidepath width (feet)	0
signal spacing (signals/mile)	1-3

Variable	Approximate Desired Value
# of mid-block through lanes	4
width of outside lane (feet)	12
width of outside lane and bike lane/paved shoulder (feet)	16
% w/ on-street parking	0
daily traffic volume	20,000-30,000
posted speed limit (mph)	50
cross streets per mile	2
driveways per mile	5
sidewalk width (feet)	0
buffer width (feet)	20
sidepath width (feet)	10
signal spacing (signals/mile)	2-5

Variable	Approximate Desired Value
# of mid-block through lanes	2
width of outside lane (feet)	12
width of outside lane and bike lane/paved shoulder (feet)	17
% w/ on-street parking	0
daily traffic volume	5,000-10,000
posted speed limit (mph)	55
cross streets per mile	1
driveways per mile	0
sidewalk width (feet)	0
buffer width (feet)	0
sidepath width (feet)	12
signal spacing (signals/mile)	1-3

Variable	Approximate Desired Value
# of mid-block through lanes	6
width of outside lane (feet)	12
width of outside lane and bike lane/paved shoulder (feet)	0
% w/ on-street parking	0
daily traffic volume	50,000-60,000
posted speed limit (mph)	45
cross streets per mile	5
driveways per mile	15
sidewalk width (feet)	6
buffer width (feet)	0
sidepath width (feet)	0
signal spacing (signals/mile)	2-5

Variable	Approximate Desired Value
# of mid-block through lanes	4
width of outside lane (feet)	14
width of outside lane and bike lane/paved shoulder (feet)	0
% w/ on-street parking	0
daily traffic volume	30,000-40,000
posted speed limit (mph)	45
cross streets per mile	5
driveways per mile	5
sidewalk width (feet)	6
buffer width (feet)	0
sidepath width (feet)	0
signal spacing (signals/mile)	2-5

Variable	Approximate Desired Value
# of mid-block through lanes	6
width of outside lane (feet)	11
width of outside lane and bike lane/paved shoulder (feet)	15
% w/ on-street parking	0
daily traffic volume	35,000-45,000
posted speed limit (mph)	50
cross streets per mile	5
driveways per mile	10
sidewalk width (feet)	0
buffer width (feet)	10
sidepath width (feet)	8
signal spacing (signals/mile)	2-5

Note: In all cases, the study segment should be at least two miles in length with a reasonably consistent cross-section. Signal characteristics are expected to vary.

APPENDIX D

	A	C	F	G	H
1	**Variable and Model Name**	**Base Option**	**Option 2**	**Option 3**	**Option 4**
2					
3	Number of through lanes	4	4	4	4
4	Number of right turn lanes	1	1	1	1
5	Number of left turn lanes	1	1	1	1
6	Number of right turn channelization islands	0	0	0	0
8	AADT	13456	12000	12000	12000
9	K factor	0.097	0.097	0.097	0.097
10	D Factor	0.53	0.53	0.53	0.53
11	T Factor	0.02	0.02	0.02	0.02
12	PH Factor	0.9	0.9	0.9	0.9
13	Vol_{15}	192	171	171	171
14	Number of lanes being crossed	6	6	6	6
15	Number of right turn channelization islands on crossing	0	0	0	0
16	Number of directional through lanes on the segment	2	2	2	2
17	Number of mid-block through lanes	4	4	4	4
18	Width of side street including median and auxilary lanes	24	24	24	24
19	Width of the outside lane	12	12	12	12
21	Width of shoulder or bicycle lane	0	5	5	5
23	Width of pavement striped for on street parking	0	0	0	0
25	Distance between edge of pavement and sidewalk (Buffer width)	5	5	15	5
26	Width of sidewalk or sidepath	5	5	5	5
28	Length	20	20	20	20
31	Width of median	12	12	12	12
34	% of segment with on street parking	0	10	0	0
35	Percent no passing zone	10	10	10	10
37	Length of the segment/block	0.3	0.15	0.15	0.15
40	Number of signalized intersections per mile	2	2	2	2
41	Number of unsignalized intersections per mile	2	2	2	2
42	Number of RTOR and permitted left-turn vehicles in 15-minute period	120	120	120	120
43	Volume of traffic on outside lane of street being crossed in a 15 minute period	192.1591556	171	171	171
44	Volume of traffic in the peak 15 minute period	192.1591556	171	171	171
45	Average 15 minute traffic volume on the roadway	192.1591556	171	171	171
46	Volume of travel during a 15-minute time period	192.1591556	171	171	171

	A	C	F	G	H
47	Average vehicle flow rate (veh/sec)	0.213510173	0.19	0.19	0.19
48	AADT	13456	12000	12000	12000
49	Interchange spacing	20	20	20	20
50	Nearside total volume	1537.273244	1370.9333	1370.9333	1370.9333
51	Farside total volume	1537.273244	1370.9333	1370.9333	1370.9333
52	Nearside turning movement	77	69	69	69
53	Farside turning movement	77	69	69	69
56	Posted speed limit	55	45	45	45
58	Cycle Length	70	70	70	70
61	Ped volume (15 minute)	50	100	100	100
67	Population ("1"<750,000<"2"<1,000,000<"3")	1	1	1	1
69	Median type (Restrictive = 1, Non-Restrictive = 2, , None =3)	1	1	1	1
71	Headway	10	10	10	30
73	Hours of service per day	15	15	5	15
80	Residential driveways/mile (<20 ADT)	2	10	5	15
81	Low-volume commercial driveways/mile (<1000 ADT)	5	5	5	5
82	High-volume commercial driveways/mile (>1000 ADT)	5	5	5	5
84	WALK time	5	5	5	5
88	PAVCON 5 point rating	4	4	4	4
89	Green signal time	42	42	42	42

APPENDIX E

AGENDA - MULTIMODAL PLANNING/ LOS WORKSHOP
DEC. 6-7, 2008 TAMPA, FLORIDA FDOT DISTRICT 7

THURSDAY, DEC. 6 6:30 – 8:30 Embassy Suites Hotel meeting room (water & Soft drinks will be provided, "Happy Hour" in lobby area of hotel is from 5:00 – 7:00 p.m. with drinks and light snacks)

6:30 Gathering, introductions, Overview
7:00 PowerPoint presentation on history of multimodal models
7:20 Video of one model research effort
7:45 Presentation on Friday's task and procedures

FRIDAY, DEC. 7 8:00 am – 4:00 p.m.

8:00 Overview of Multimodal models
Description of Selected Corridors for data analysis collection

8:30 Explanation of spreadsheet on data for corridor analysis
Presentation of each of 6 corridors, beginning with video clips of corridor and proceeding to "What if" analysis, comparing current LOS to projected LOS with various roadway changes & variable alterations; (With each corridor, we will have discussion and feedback from participants relative to the sensitivity of models and the variables, for "accuracy" of Level of Service analysis).

12:00 Lunch (nearby local restaurants – on your own)

1: 15 Discussion on recommendations for any potential changes to LOS software for use with Multimodal planning models

2:30 Identify barriers/issues regarding implementation of MMP/LOS tools

3:00 Suggested approaches to implementation strategies for use of the models and MMP software (i.e. How do we get these models in common use, for project development at the District level, for facility or corridor analysis project prioritization, and as part of a 'tool kit' for designing roadways systems that serve the many users of our transportation system?)

Total Started Survey:	**230**
Total Completed Survey:	**172 (74.8%)**

BIKE FLORIDA SURVEY VIDEO DEBRIEFING CARD

1. What would have caused you to rate a segment D, E, or F?

- ***Number of participants who answered the question: 117***

	Comment Text
1.	narrow pathway and traffic
2.	This was hard to do as no criteria were mentioned -safety issues? beauty of the area? I chose segments that illustrated what the Bike FLA ride looked like, and those that raised safety issues
3.	I participated in this survey during the ride and felt it was as poorly planned as the rest of the ride!
4.	none
5.	Dangerous
6.	traffic, too hilly, too much sun-no shade
7.	Not an enjoyable part of the ride. I considered it dangerous. I considered it something that slowed me down. Unable to pass or ride without danger. Not relaxing.
8.	Concern for safety around traffic
9.	Heavy traffic, no shoulder, frequent starts / stops
10.	too close to traffic, no scenery, not visually stimulating, bad road crossings
11.	Riding in town next to parked cars whose doors could be opened into the biker while traffic is moving on your left.
12.	Dangerous exposure to car traffic and/or multiple crossings.
13.	It was not safe. The trail was too narrow. I don't like road riding.
14.	riding on a sidewalk or very busy four-lane road with no shoulder
15.	I don't understand what you want? Besides, I DON'T like trails!!!!!!!!!!!!!!!!!!!!!!! and would never choose to ride on one. I almost didn't do BF this year for that reason.
16.	Lack of separation from high-speed traffic.
17.	High traffic and no designated bike lanes.
18.	Too much traffic

19.	I did this on tour. So have not repeated it.
20.	MIDDLE OF TRAFFIC ON BIKE LANES
21.	Busy Roads riding close to traffic
22.	Too close to traffic, no signs for cars to "share the road", riding against traffic.
23.	Lots of cars. high speed, no shoulder
24.	I did this video already during trip
25.	could not view video with dial-up
26.	Safety, scenery
27.	Safety Issues and noise and scenery issues. Sometimes I didn't like an otherwise safe trail simply because it was close to a noisy highway with no shrubbery to block the highway noise.
28.	wrong way on road with no shoulder; narrow path; heavy traffic in close proximity
29.	Extremely dangerous situations. There were none.
30.	Based on relative safety
31.	Less enjoyment, poor safety, and more noise.
32.	Riding on wrong side of road. Traffic.
33.	Riding on the wrong side of the road, riding on a sidewalk,
34.	Congestion
35.	Lack of any services like a place to get water
36.	no lane, on left side of rd.
37.	no bike path
38.	Unsafe riding area
39.	Narrow, busy, boring or too many driveways.
40.	Dangerous riding conditions with no markings or road shoulder for bicyclist.
41.	No shoulder at all, lots of driveways or roads intersecting bike lane/sidewalk.
42.	safety of the road way
43.	Heavy traffic, no shoulder, poor road condition
44.	No bike lane or bike lane combined with a sidewalk going against the flow of traffic
45.	Conditions were dangerous
46.	Fast auto traffic close to the biking lane
47.	If a segment is on a busy road with no divider then that is really not fun riding, rather scary.

48.	Bouncing camera
49.	Too much starting and stopping. Too much traffic turning, dangerous situations
50.	I already did this while I was at Bike Florida. I did not do it again.
51.	Side walks in the city or no shoulder on a road
52.	poorly designed bike path or none at all
53.	too narrow, danger from other vehicles, too many stops, car doors opening on you
54.	Lots of traffic close to the cycle lane or lots of urban crossing streets
55.	Unable to download the video.
56.	There was not a bike lane.
57.	I have already participated in this study. There should have been a survey question asking if we had participated earlier and if so, given an option to skip these questions.
58.	No shade, high fast traffic, dangerous situations.
59.	I did the survey in Inverness. I did not like riding with heavy traffic, did not like sidewalk trails where you are on the wrong side.
60.	not safe
61.	traffic
62.	No shoulder
63.	Too much traffic, too many stops, Trails along highways, routes on busy roads
64.	Heavy traffic on road, riding on sidewalks, no access due to fence in case of trouble.
65.	I was confused on segment 17
66.	City escape, I live in a rural area
67.	I did the video thing while at the tour
68.	conditions which would have made me nervous
69.	High traffic roads, no bike lane, poor pavement
70.	condition of road, no bike path marked, bike path on wrong side of road
71.	Safety
72.	I don't like to ride on the roads
73.	Poor riding room
74.	Riding in traffic with no marked bike path, and no shoulder
75.	No separate bike lane or too narrow a lane in heavy traffic
76.	Heavy Traffic close to bicyclist

77.	Wrong way. No shoulder. Excessive traffic. sidewalk
78.	Traffic patterns, crossing traffic, no separation cars and bikes, foot traffic congestion, traveling against car traffic, narrow paths
79.	Having to ride in the traffic lane. No shoulder. Riding on sidewalk. Designated path, but too narrow.
80.	Dangerous conditions
81.	Traffic
82.	I was unable to view the video at my present location. I see no option for completing this part later. Sorry.
83.	Roadway shared w/ pedestrians, skaters& runners, dog walkers. roadway going against traffic
84.	I completed this during BIKE FLORIDA
85.	Riding on wrong side of road. sidewalk riding bad
86.	Did not watch video. Don't know how to get into it, or how to start it.
87.	Bicycling incorrectly on wrong side of street.. High density, big city street traffic ..... long stretches of trail with nothing to look at except trees and traffic whizzing by
88.	I didn't watch all video clips. Too time consuming... d,e,f traffic
89.	not enough space to safely bike
90.	High traffic, narrow road, lack of separation from auto traffic.
91.	No paved shoulders. Peds walking against cyclists. Too narrow trails. Double lined roads; no paved shoulders. Riding in obvious door zones!
92.	Heavy traffic High speed automobiles.
93.	proximity to traffic
94.	I have dial up and I did not have the patience to wait long periods of time for it to move. So I did not rate it..
95.	I already did this on the ride
96.	you didn't have the section where we were forced to walk bikes through sand for one mile or ride off road on road bikes
97.	Road with no shoulder or bike-specific path
98.	Dangerous intersection, too much foot traffic on trail, I don't like sidewalks!
99.	congestion, no barriers between bike and cars
100.	2-traffic & squeezed into parked cars 13-no shoulder & fast traffic 17-narrow path &cyclist could be forced into oncoming cars by approaching cyclist-very dangerous
101.	no shoulders, bike lane on wrong side of road at honeymoon park

102.	too ordinary, nothing happening to cause the cyclist to think or react to a situation
103.	lack of a shoulder on a busy road, too narrow of a bike path
104.	poor bike lanes, crossing traffic, amount of traffic
105.	I took the video survey while on Bike FL
106.	Not that safe.
107.	Too dangerous, i.e. lack of shoulder. Too many stops and curb cuts, uneven pavement.
108.	dull footage of bike lanes with nothing happening
109.	Traffic; too flat. Sorry I did not finish all the segments
110.	1. Safety 2. Seemed like absolutely nothing to do nearby
111.	Unsafe conditions
112.	dangerous conditions in which the bicycle was too close to traffic
113.	lots of traffic, crossing driveways, roads
114.	Traffic, urban, width of path
115.	wrong direction, too narrow, crossing roadways
116.	faded or poor lane markings, no lane markings, no lanes, vehicle parking, poor maintenance
117.	traffic, lack of scenery, straight line

2) What would have caused you to rate segments as A?

- ***Number of participants who answered the question: 103***

	Comment Text
1.	safety
2.	I chose segments that illustrated what the Bike FLA ride looked like, and those that raised safety issues
3.	beach, ocean front
4.	Safe
5.	flatter, shadier, no traffic
6.	An enjoyable part of the ride. Not dangerous, very save. Able to just ride, without worrying about traffic, or passing with much danger. Very relaxing.
7.	Traffic risk is low

8.	Full separation from auto traffic, wide lane, infrequent cross traffic
9.	Away from traffic, enjoyable place to ride, away from traffic, businesses, better road crossings if any
10.	No cars on bike path.
11.	No opportunity for cross traffic, away from traffic noise, wide smooth riding surface and hopefully shade occasionally.
12.	They were excellent, safe rides.
13.	interesting view
14.	Separation and safe riding for cyclist.
15.	Bike paths, with few cross streets
16.	QUIET, NO TRAFFIC NO CROSSINGS
17.	No traffic, trees, birds chirping, riding along the water
18.	Double paths for walkers and bikers; wider paths to accommodate walkers and riders. Signed paths to remind bikers to share the path.
19.	something to see/towns/water
20.	Safety, scenery
21.	Safe bike lane on the highway, or separated trail. If the scenery along the trail is picturesque - all the better!
22.	wider trails, rural setting
23.	Safe and shaded (essential in Florida)
24.	Nice ride, separate path, scenery , safety
25.	Enjoyment, safety and less noise.
26.	Scenery Trails
27.	Bike trail totally separated from traffic
28.	Scenic. Bike Friendly
29.	available services, bike lanes
30.	trail nice, good lane on rite side
31.	no interaction with cars
32.	Safe riding conditions
33.	Separated bikeway or wide marked lane. Scenic.
34.	Off road trail for bicycles only.
35.	Separated from traffic by physical barrier. Extra points for trees, etc.
36.	safety of road way

37.	Good bike path or trail, with limited auto crossing.
38.	Bike lane that is exclusively for bikes and multi use.
39.	safety, relatively adequate pavement, few crossroads
40.	Dedicated trail with scenery
41.	Segments that are scenic, away from busy roads & road noise, or totally separated from a roadway by a barrier or grass median.
42.	None - But I like the sense of speed on a few of the segments. Needed more interaction with passing bikers.
43.	Safety and ability to ride at pace greater than 19mph
44.	We had a friend to be killed while riding a bike here in Auburn, AL this year. He was riding on a four lane road - similar to some of the ones Bike Florida has used in the past. Even though he was obeying the law and doing everything right, he's dead now and his wife is alone. Please do not have or encourage riders to be on high traffic roads!!
45.	Isolated trails or designated path with a buffer zone (White hashed stripes between car path and bike path)
46.	nice trail
47.	wide, no traffic, shady,
48.	No auto traffic and great scenery
49.	Bike path or bike lane.
50.	Shade, safe, ideal situations.
51.	I loved so many of the trails we visited because they got us out of the traffic, and we were in beautiful places.
52.	It would be a good place to ride
53.	no traffic
54.	Wide lanes, room to pass and meet other cyclist. No intersections
55.	minimal traffic on back roads or beside trails, good scenery
56.	No traffic, nice scenery, access to off path stores or locations.
57.	Not exactly sure what I am being asked to grade. However, if it was did I enjoy riding car free on the trails the answer is yes. The only problem was that it is sometimes monotonous
58.	Rural
59.	conditions which I would prefer
60.	bike path, low traffic areas, bike lane on road, new pavement, scenery
61.	bike trail that is clean of hazards no driveway crossing

62.	safety
63.	Good bike trails - no cars!
64.	Open riding
65.	Bike path separate from road
66.	Minimal traffic if on road, some quiet and scenery
67.	wide bike paths without stop signs, nicely separated from traffic
68.	open country road with little or no traffic
69.	Separation from all car traffic, light foot traffic, smooth surface.
70.	Wide path separate from road.
71.	Pleasant riding conditions, safe and fun!
72.	Nice trails
73.	clean open wide trails, roads
74.	bike lanes on road, low traffic roads, bike/walking trails
75.	scenic trails and roads... rural areas and farms to look at, and if the mood and opportunity strikes, stop for a moment to smell the roses learn something, and possibly brighten someone's day
76.	Classic riding
77.	safe biking and good scenery
78.	rural setting, wide smooth surface, separation from other traffic
79.	Wide paved trails.
80.	No traffic Varied terrain
81.	off road, separated from traffic
82.	road riding for road bikes
83.	Bike trail, away from traffic, shade
84.	scenic ride on road
85.	good viewing, limited traffic, passing options
86.	Most pathways are relatively safe die to width and escape routes (i.e. cyclist can get off path and onto shoulder)
87.	bike path or shoulder on road
88.	significant situation for information or safety of cyclist
89.	clearly marked bike path, wide shoulder, or wide enough bike path
90.	Separated bike path, great when in wooded areas.
91.	no crossing traffic, wide lanes

92.	Safe, smooth, pretty
93.	Wide trail or roads with adequate shoulder
94.	More action -- shots of rest stops, camp sites, bikers doing something
95.	no traffic, slight hills or deviation from the flatness of the path; beautiful roads
96.	None rated A
97.	Safety of bikers
98.	there was very little possibility of a collision between bicycle and cars
99.	safe, paved bike lane
100.	Opposite of above
101.	vehicular cycling support
102.	connector to places of interest, no highway access, barrier from highway traffic
103.	scenery, curving trail, no traffic

3) What do you consider to be the three primary factors that influence your feelings of how well sections meet your needs as a bicyclist?

	Response Percent	Response Count
1st Factor	**100%**	**101**
2nd Factor	**95%**	**96**
3rd Factor	**85.1%**	**86**

1st Factor

	Comment Text
1.	safety -away from traffic
2.	safety
3.	Must be out of traffic
4.	road
5.	Protected from traffic
6.	traffic
7.	out of the flow of traffic
8.	surface
9.	Separation from auto traffic

10.	designated trails
11.	Safety
12.	Safety
13.	width
14.	scenery
15.	Separation
16.	Sufficient designated space for bicycle safety.
17.	Traffic
18.	5 FT. BIKE LANE IN TRAFFIC
19.	Safety from traffic and escape path for bikers from bad drivers.
20.	safe
21.	Safety
22.	Safety (separate, designated five foot bike lane on highway, or scenic trail separated from traffic)
23.	sufficient room for easy passing
24.	Safe
25.	safety
26.	enjoyment
27.	Safety
28.	controlled traffic junctions
29.	Safety
30.	scenery
31.	protection
32.	no cars
33.	vehicle traffic
34.	Safe (wide enough for peds and bikes)
35.	Safety
36.	Synergy with cars (either away from them or clearly sharing
37.	safety
38.	Shoulder or bike path or trail
39.	Bike only, not attached to road,
40.	safety

41.	feeling of relative safety
42.	safe
43.	Sense of being there on the bike
44.	safety
45.	Safety
46.	Isolation from cars
47.	wide path
48.	wide
49.	Quality of road or trail
50.	paved road
51.	safety
52.	safety of rider
53.	low traffic
54.	Smoothness of pavement
55.	flat
56.	Low traffic impact
57.	Road Quality, bike lanes
58.	no cars
59.	safety form cars/trucks/motor vehicles
60.	traffic
61.	safety
62.	safety
63.	bikes only - no cars
64.	low traffic
65.	Dedicated bike path and/or bike lane markings
66.	safety--adequate bike lanes on a road and sufficiently wide trails
67.	lack of traffic
68.	interesting terrain
69.	location
70.	well marked designated bike lane
71.	Safety
72.	rest stops

73.	road markings
74.	bike lanes
75.	car travel/safety
76.	see above
77.	space to bike safely
78.	road surface
79.	Segregation from traffic
80.	Good road quality
81.	traffic
82.	safe road conditions
83.	smoothness of riding surface
84.	bike lane
85.	Riding experience on all kinds of roads, paths, weather
86.	shoulder
87.	help explain a traffic situation
88.	Safety from cars
89.	lack of traffic competing with bicycles
90.	Feeling of safety
91.	Condition of pavement
92.	overall scenery
93.	variation in terrain
94.	safety
95.	Pavement
96.	separation from traffic
97.	security-no much automobile traffic to encounter
98.	Safety
99.	multi-lane roadways are better than single for vehicular cycling
100.	town or city connector
101.	rural area

2^{nd} *Factor*

	Comment Text
1.	road surface
2.	portrayal of the Bike FLA ride
3.	Must not cross a lot of busy roads without lights
4.	bike lane
5.	wide enough
6.	shade
7.	not on the shoulder of a high traffic area
8.	direction of traffic flow
9.	Wide lane / path
10.	away from traffic
11.	Access to food, drink & supplies if needed.
12.	Smooth non littered riding path
13.	condition of road/trail
14.	riding surface
15.	Safety
16.	Motorist awareness of bicycles.
17.	Paved roads
18.	BIKE PATH NO TRAFFIC
19.	Pavement safe for bike tires
20.	bike shoulders
21.	Scenery
22.	proximity to traffic
23.	fun
24.	scenery
25.	safety
26.	Scenery
27.	a shoulder or space that allows three feet of separation
28.	Scenic
29.	availability of services

30.	passage
31.	infrequent cross streets
32.	Noise from traffic
33.	Scenic and connects to shopping, work, schools, towns.
34.	Room to ride out of way of traffic.
35.	safety
36.	scenery
37.	Limited or little auto traffic
38.	well marked lines
39.	good pavement
40.	auto traffic not too close to bike lane
41.	scenic
42.	Interesting scenery
43.	speed
44.	Safety
45.	path surface
46.	wider roads
47.	marked off road rather than a sidewalk
48.	Separation from cars and trucks
49.	smooth road-not bumpy
50.	scenery
51.	road you ride on
52.	shaded roads/paths
53.	room to ride and pass safely
54.	low traffic
55.	Access to services
56.	light car traffic, courteous drivers
57.	great rural scenery
58.	enough room to pass folks going slower or in the opposite direction
59.	pavement
60.	how wide
61.	smoothness of surface

62.	open non stop riding
63.	scenery
64.	lack of stop signs
65.	safety
66.	width
67.	off road path at least 8' wide
68.	Varied terrain
69.	condition of road / route
70.	berms
71.	convenience store availability
72.	scenery
73.	low traffic
74.	Wide enough paved shoulder.
75.	Low traffic, lack of stop signs/traffic lights
76.	curves (visibility of oncoming cyclists and foot traffic)
77.	low traffic roads
78.	interference with cross-traffic, including pedestrian
79.	limited traffic
80.	age-should be getting smarter and I don't like to travel on roads that I feel are unsafe unless absolutely necessary
81.	no potholes
82.	informative in general
83.	View of nature
84.	separation of bike area from car areas
85.	smooth surface
86.	Width of riding area
87.	shots of typical route sections
88.	safety especially from trucks
89.	access to things to do
90.	Safe conditions
91.	limited access to traffic
92.	paved

93.	Number of users
94.	wider roads with no shoulders are better than marked shoulders
95.	ease of access/location
96.	scenery

3rd Factor

	Comment Text
1.	scenery
2.	scenic beauty
3.	Florida drivers are crazy and very dangerous to cyclists
4.	traffic
5.	hills
6.	not riding up and down a sidewalk or around parked cars
7.	separation from traffic
8.	Infrequent cross traffic (starts / stops)
9.	visual view
10.	Scenic
11.	Pleasant scenery
12.	on road or trail
13.	Clarity of space use
14.	Scenery and unimpeded progress.
15.	Access to restaurants
16.	SHARED BIKE PATH
17.	Signs for bikers and traffic to share the road
18.	I don't see any places for food or water
19.	Comfort
20.	rural setting
21.	challenging
22.	services access
23.	noise

24.	Crowded
25.	consistency in common bicycle/traffic handling
26.	Bike Friendly
27.	terrain
28.	smooth surface
29.	lack of car noise
30.	Is the scenery enjoyable
31.	Separated (Not in the flow of car and truck traffic)
32.	Markings when in traffic alerting them to bike lanes.
33.	lack of or separation from pedestrians, cross traffic driveways
34.	Good road condition
35.	bike lane going with the flow of traffic
36.	few crossroads
37.	Access to water & bathrooms every 10 miles or so.
38.	Stable platform (I got dizzy on some segments)
39.	ability to form pace lines
40.	Safety
41.	business of sidewalks and curbs
42.	bike paths not crossing roads
43.	bikes only
44.	Visually interesting
45.	wide to accommodate more than 1 cyclist
46.	shade
47.	visibility
48.	good pavement
49.	lack of traffic
50.	scenic
51.	Nice scenery or area attractions
52.	interesting scenery or sites
53.	a small town with small town restaurants and /or dinner
54.	limited access, crossings, asphalt surface
55.	scenery

56.	limited cross traffic
57.	views
58.	quality of riding surface
59.	wide bike paths separated from the roadway
60.	challenge
61.	smooth surface
62.	not too many cross streets
63.	Some rural and some city areas
64.	bike trails
65.	topography
66.	light vehicle traffic
67.	separation from auto traffic
68.	Designated and signed bike lanes.
69.	Varied terrain
70.	surface of trail
71.	not a lot of starting and stopping
72.	scenery
73.	Trails and/or wide shoulders provide a space for a more relaxed ride
74.	nice bikepath
75.	Lack of pedestrians
76.	quality of paved surface
77.	beauty
78.	Ability to ride without frequent stops
79.	action shots of camping, rest stops, activities
80.	width with safety so I can ride with partner
81.	does a car expect you to be there
82.	Road markings
83.	smooth surface
84.	scenic
85.	Noise
86.	little traffic

VIDEO SIMULATION SCORECARD

	A	B	C	D	E	F	Rating Average	Response Count
Section 1	**39.4% (41)**	31.7% (33)	19.2% (20)	6.7% (7)	1.9% (2)	1.0% (1)	4.97	104
Section 2	4.9% (5)	8.8% (9)	25.5% (26)	**27.5% (28)**	6.9% (7)	26.5% (27)	2.98	102
Section 3	5.9% (6)	18.8% (19)	**32.7% (33)**	22.8% (23)	5.9% (6)	13.9% (14)	3.54	101
Section 4	**59.6% (59)**	31.3% (31)	8.1% (8)	0.0% (0)	1.0% (1)	0.0% (0)	5.48	99
Section 5	**55.0% (55)**	28.0% (28)	14.0% (14)	2.0% (2)	1.0% (1)	0.0% (0)	5.34	100
Section 6	**51.0% (51)**	36.0% (36)	11.0% (11)	2.0% (2)	0.0% (0)	0.0% (0)	5.36	100
Section 7	**75.2% (76)**	17.8% (18)	4.0% (4)	3.0% (3)	0.0% (0)	0.0% (0)	5.65	101
Section 8	28.0% (28)	**44.0% (44)**	25.0% (25)	2.0% (2)	1.0% (1)	0.0% (0)	4.96	100
Section 9	**68.0% (68)**	21.0% (21)	8.0% (8)	3.0% (3)	0.0% (0)	0.0% (0)	5.54	100
Section 10	12.0% (12)	27.0% (27)	**38.0% (38)**	17.0% (17)	5.0% (5)	1.0% (1)	4.21	100

Section 11	12.0% (12)	30.0% (30)	**34.0% (34)**	13.0% (13)	8.0% (8)	3.0% (3)	4.16	100
Section 12	30.0% (30)	**40.0% (40)**	20.0% (20)	9.0% (9)	1.0% (1)	0.0% (0)	4.89	100
Section 13	4.0% (4)	20.2% (20)	19.2% (19)	19.2% (19)	9.1% (9)	**28.3% (28)**	3.06	99
Section 14	21.6% (21)	**38.1% (37)**	28.9% (28)	9.3% (9)	1.0% (1)	1.0% (1)	4.67	97
Section 15	9.1% (9)	21.2% (21)	**34.3% (34)**	19.2% (19)	11.1% (11)	5.1% (5)	3.83	99
Section 16	29.3% (29)	**45.5% (45)**	18.2% (18)	6.1% (6)	1.0% (1)	0.0% (0)	4.96	99
Section 17	8.1% (8)	**20.2% (20)**	**20.2% (20)**	**20.2% (20)**	12.1% (12)	19.2% (19)	3.34	99
Section 18	4.1% (4)	10.2% (10)	**29.6% (29)**	23.5% (23)	20.4% (20)	12.2% (12)	3.17	98
Section 19	**66.7% (66)**	23.2% (23)	6.1% (6)	3.0% (3)	1.0% (1)	0.0% (0)	5.52	99
Section 20	**63.0% (63)**	22.0% (22)	14.0% (14)	0.0% (0)	1.0% (1)	0.0% (0)	5.46	100
Section 21	36.1% (35)	**43.3% (42)**	12.4% (12)	5.2% (5)	3.1% (3)	0.0% (0)	5.04	97
Section 22	**76.5% (75)**	15.3% (15)	6.1% (6)	1.0% (1)	1.0% (1)	0.0% (0)	5.65	98

Appendix G. Florida Multimodal LOS Research – a Summary DVD

As part of the final report submitted to the Florida Department of Transportation For "Updating the FDOT Multimodal Level of Service Calculations to incorporate latest research since 2001", the Project manager and Project investigator wanted to include a DVD that could be used for presentations and trainings, explaining and summarizing the Multimodal research efforts from 1995 to 2008. Included with this report is the 12 minute DVD, done by Munroe Multimedia, in cooperation with the authors of this report. Twenty copies are part of the final report presented to the FDOT research office. Additional copies can be obtained by contacting:

Mike Munroe

Munroe Multimedia

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