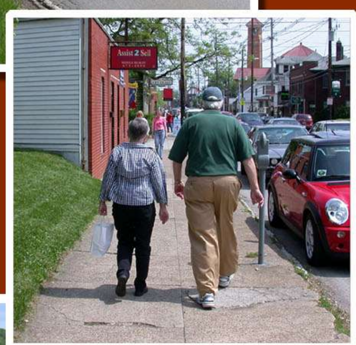
Suitability of Louisville Metro Roads for Bicycling and Walking










Bicycle and Pedestrian Level-of-Service Analysis

Prepared for:

by Turner A. Howard

August 2004

LOUISVILLE METRO PLANNING AND DESIGN SERVICES

Suitability of Louisville Metro Roads for Bicycling and Walking

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Foreword

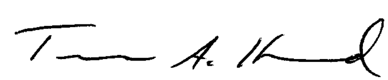
This study originated out of the need to evaluate bicycling and walking conditions on Louisville Metro roads and to identify and prioritize roads in need of improvement. The former Louisville Metro Bicycle-Pedestrian Coordinator, Sheila Andersen, wrote the original grant and secured funding for this project through the Kentucky Transportation Cabinet.

I became involved with this study through my volunteer work with the Metropolitan Louisville Bicycle and Pedestrian Advisory Committee (BPAC). My background in engineering and my familiarity with bicycle and pedestrian issues at the ground level (being a utilitarian bicyclist, bicycle commuter, bicycle tourist, pedestrian, transit rider and car-free citizen) made me well suited to conducting this study, which mostly involved the collection and compilation of road data into a geographic information system (GIS) database and computation of level-of-service factors based on well-documented models that have been used by scores of other cities across the United States.

I went beyond the original scope of work and completed additional analyses that I hope will be useful for citizens, planners and engineers involved in bicycle and pedestrian issues. I have drawn on much of my volunteer work with BPAC; organizations like the National Center for Walking and Bicycling (NCWB) and the Pedestrian and Bicycle Information Center (PBIC); and resources published by federal, state and local government.

The analyses, maps and recommendations presented here are tools for implementing real changes in the road network for the mutual benefit of all road users. It is my hope that this study will help move Louisville Metro toward a more complete and inclusive approach to transportation planning and to create a safer more accessible community for all Louisvillians, no matter how they choose to travel.

Sincerely,



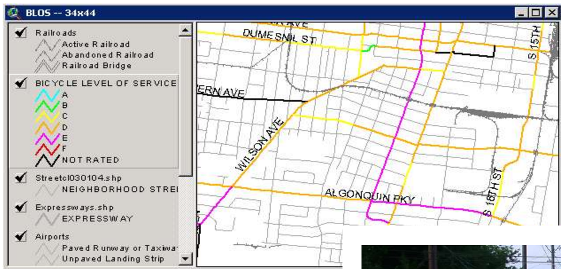
Turner A. Howard

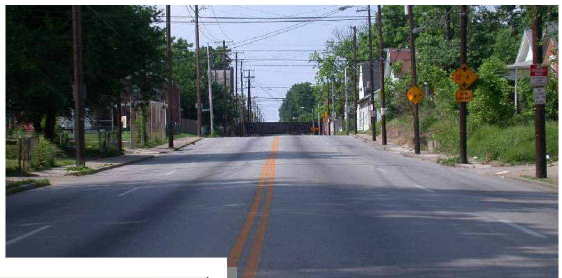
Acknowledgments

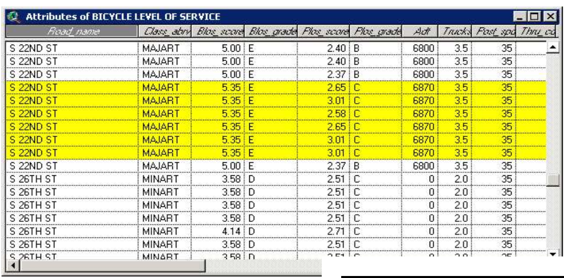
This study was made possible through funding from the Kentucky Transportation Cabinet and was administered by Louisville Metro Planning and Design Services. Much of the work in this study involved the collection and compilation of existing road data. The following individuals and agencies were instrumental in this collection process:

- John Callihan and Kyle Cooper at the Kentucky Transportation Cabinet, District 5, provided a great deal of data for the state highway network throughout Louisville Metro.
- Louisville Metro Public Works provided data including posted speed limits and traffic volume counts. Special thanks are due to Mark Adams, David Williams, Tim Callahan, Dan Curtis, Laura Moore and the GIS staff in Public Works, who helped pull this information together.
- Phil Williams at the Kentuckiana Regional Planning and Development Agency (KIPDA) supplied additional raw traffic count data to help fill in the gaps from other sources.
- Jeff Ackerman at the Louisville/Jefferson County Information Consortium (LOJIC) provided many helpful tips about the LOJIC databases, especially the color aerial imagery, which was used extensively in this study.
- As the project administrator, Louisville Metro Planning and Design Services provided many useful tools and resources for the completion of this study. Special thanks are due to Lee Wells, Paula Vincent and Mohammad Nouri for their assistance.

In addition to these local supporters, Ed Barsotti from the League of Illinois Bicyclists shared his expertise on the pedestrian level-of-service model to help clarify several application issues.






Attributes of BICYCLE LEVEL OF SERVICE

Road_name	Class_abrv	Blos_score	Blos_grade	Plos_score	Plos_grade	Adt	Trucks	Post_spd	Thru_cu
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
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S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
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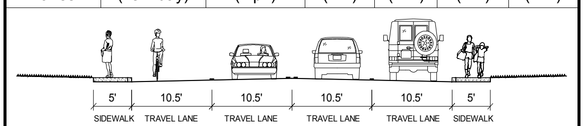
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	4.14	D	2.71	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	

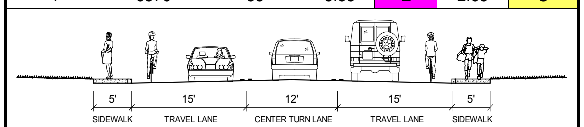
Considering Design Alternatives

Number of Through Lanes	Average Daily Traffic (veh./day)	Posted Speed Limit (mph)	BLOS Score (1-7)	BLOS Grade (A-F)	PLOS Score (1-7)	PLOS Grade (A-F)



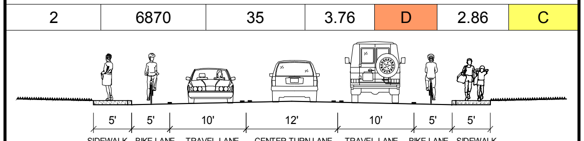
Existing configuration

4	6870	35	5.35	E	2.65	C



Resurface and reconfigure to create wide curb lane

2	6870	35	3.76	D	2.86	C



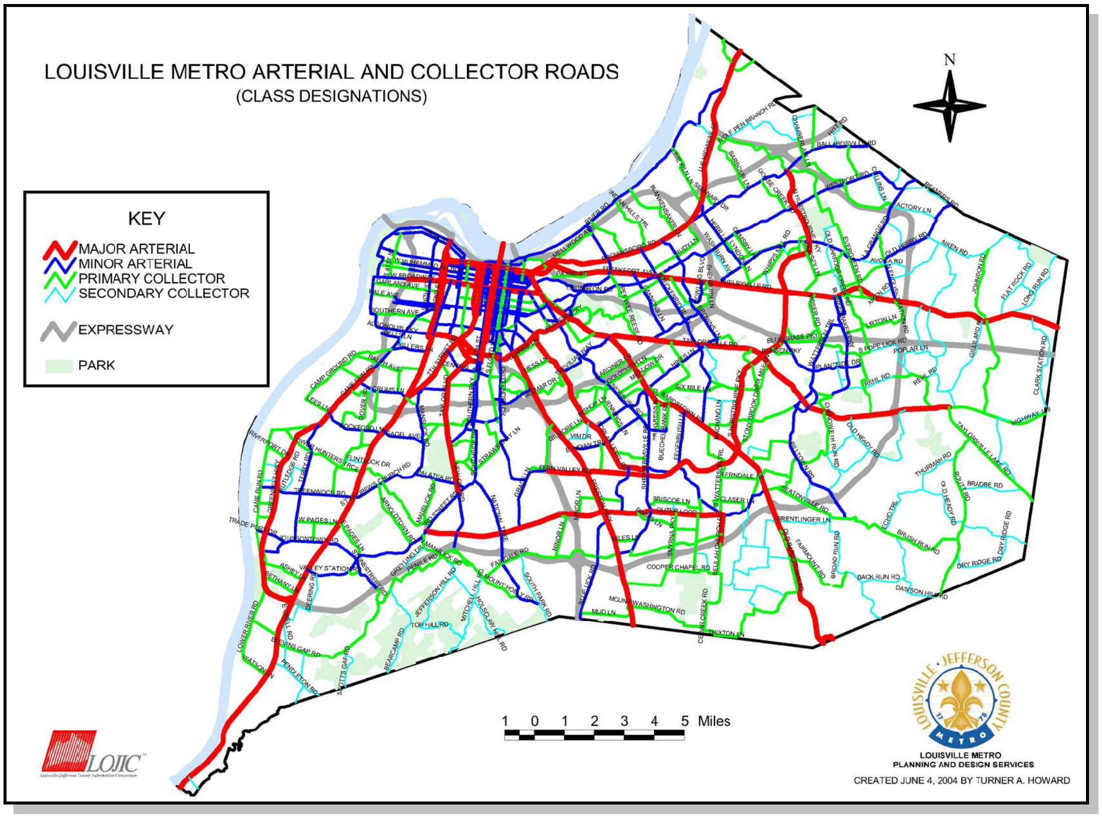
Resurface and reconfigure to add bicycle lane

2	6870	35	2.88	C	2.86	C

Executive Summary

Purpose and Scope of Study

This study uses nationally recognized road suitability measures to evaluate bicycling and walking conditions on Louisville Metro's arterial and collector road network. Road suitability measures use information about a road, such as traffic volumes and speeds, lane widths and sidewalk dimensions, to rate the bicycle- and pedestrian-friendliness of the road.



The arterial and collector road network comprises more than 6,200 road segments measuring approximately 877 miles. Bicycle- and pedestrian-related information for each of these road segments is stored in a spatial database that provides a tool for mapping the suitability of roads for bicycling and walking, locations of existing sidewalks, roads with potential to improve bicycling accommodations and barriers such as freeway crossings (see maps in Appendix A). The maps along with the database are useful for planners, engineers and citizens to identify and prioritize road projects that will improve conditions for bicycling and walking. The suitability measures can also be used to:

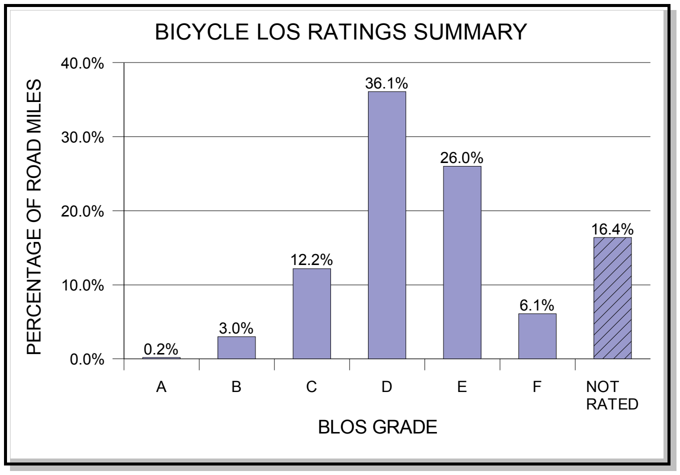
- ✔ Compare alternative design options for improving existing roads;
- ✔ Design new roads to accommodate bicyclists and pedestrians;
- ✔ Help planners and citizens with long-term bicycle and pedestrian planning; and
- ✔ Provide maps for use in route planning by bicyclists.

Summary of Results

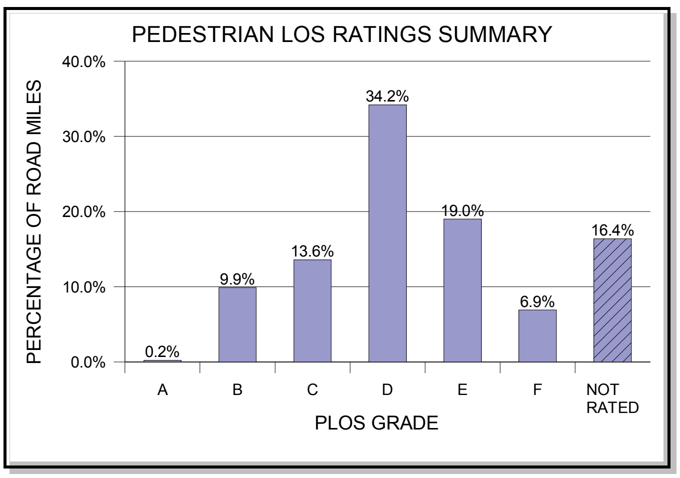
The bicycle and pedestrian Level-of-Service (LOS) methodology is used in this study to evaluate the bicycle- and pedestrian-friendliness of Louisville Metro's roads. The following charts summarize the bicycle and pedestrian LOS analyses and show the percentage of road miles with sidewalks.

Bicycle Level of Service

The bicycle LOS results show that only about 15 percent of the arterial and collector road miles rate C (moderately high level of service) or better. Most roads rate D (moderately low) and E (very low). These low ratings result from high traffic volumes and speeds on narrow travel lanes—conditions that create conflicts between bicyclists and motorists and result in an unnecessarily inconvenient and stressful bicycling experience.



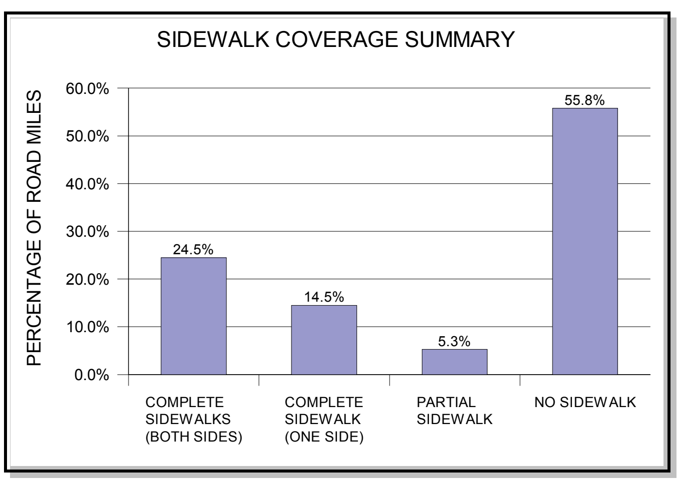
Pedestrian Level of Service



The pedestrian LOS results are slightly better than the bicycle results, with nearly 24 percent of road miles scoring C or better; however, more than half of the studied road miles rate D and E. In general, only roads with pedestrian facilities and moderate traffic volumes and speeds score well. The urban core scores the highest pedestrian ratings, while the suburban and outlying areas typically rate very poorly.

Sidewalk Coverage

The location of sidewalks along arterial and collector roads is needed for the pedestrian LOS computation, but this information can also be examined directly to see where there are gaps in pedestrian facilities and to help prioritize the retrofitting of suburban roads that were not constructed with sidewalks before the adjacent land was developed. Roughly 61 percent of Louisville Metro arterial and collector roads are without sidewalks or have only partially constructed sidewalks, mostly in suburban and outlying areas.



Uses and Outcomes of Study

Road suitability measures are a tool for identifying and prioritizing roads in need of improvement for non-motorized travel. The level-of-service results and maps produced in this study can be combined with other analyses such as bicycle and pedestrian counts, demand forecasts, crash statistics, land-use plans and neighborhood plans to develop comprehensive strategies to improve bicycle and pedestrian facilities on Louisville Metro roads. By merging this information, it will be easier to prioritize projects that have the greatest potential benefit for the community. The results of this study are also useful as a benchmark to track improvements to bicycling and walking conditions. The goals could be to shift the average level of service for bicyclists and pedestrians from D to C and to prevent worsening of conditions where land development is resulting in increased volumes of motor vehicle traffic.

Actions for Improving Bicycle and Pedestrian Facilities

The results of this study indicate that much improvement is needed on many Louisville Metro roads to provide accommodations that people will consider as real options for bicycling and walking. Many of the lowest-rated roads in Louisville Metro are already highly congested at times, have little available space to improve bicycling and walking conditions, and often have no suitable alternative routes. Meeting these challenging constraints with a coordinated planning effort involving citizens, planners, engineers and public officials, and matching this planning effort with substantial funding to construct the needed bicycle and pedestrian facilities is the only way Louisville Metro will make significant progress toward improving bicycling and walking accommodations on its road network. Following are just a few of the specific actions that are necessary to create better bicycling and walking facilities on Louisville Metro roads:

- ✔ Routinely accommodate bicyclists and pedestrians on new roads

When new roads are designed or when existing roads undergo redesign and reconstruction, bicyclists and pedestrians must be routinely considered in the planning, design, construction and maintenance of the road. The Kentucky Transportation Cabinet instituted a bicycle and pedestrian policy in July 2002 that recognizes the importance of bicycling and walking and the need to construct bicycle and pedestrian facilities as part of road projects. Louisville Metro needs to institute its own policy to ensure that bicycle and pedestrian accommodations are routinely constructed as part of all new road projects.

- ✔ Improve the existing road network

Many communities have begun the challenging work of retrofitting their road network to better serve all users. Finding available space to better accommodate bicyclists can often prove challenging; however, in some cases restriping a roadway to create a wide outside lane, a bicycle lane or paved shoulder is the only change necessary for bicyclists and motorists to happily share the same space. Minor shoulder widening done during roadway resurfacing is also an option to create more space for bicyclists and motorists to share. Chapter 4 discusses a number of Louisville Metro roadways that have potential for these cost-effective bicycling improvements.

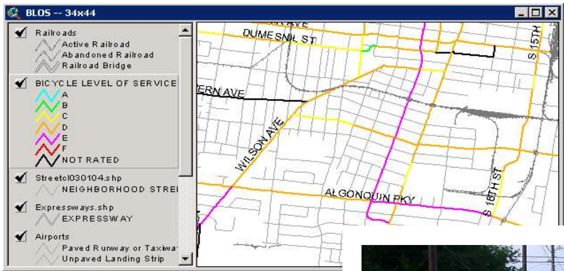
Pedestrians are usually best served by separate facilities like sidewalks. Improving pedestrian accommodations will often require constructing missing sidewalk segments and providing crosswalks, crossing signals, curb ramps and other features that make sidewalks useful and accessible.

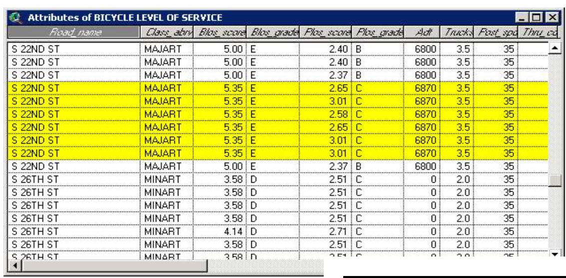
- ✔ Follow appropriate facility design standards

In the past few decades, a wealth of practical design guidance has been developed for on-road bicycle and pedestrian facilities. This information is readily available from federal and state agencies and national organizations such as the Pedestrian and Bicycle Information Center and the National Center for Walking and Bicycling. These tools can help Louisville Metro build local expertise in bicycle and pedestrian facility design, operation and maintenance. Louisville Metro must make its facility design standards clear to the engineering firms that design new roads and hold these firms accountable for incorporating bicycle and pedestrian accommodations as a routine element of road projects.

Concluding Remarks

Despite the challenges and risks, there are many Louisvillians who frequently choose bicycling and walking for recreation and transportation. These citizens experience the benefits and joy of non-motorized travel in a metropolitan area dominated by automobile transportation. Their choices result in tangible benefits for the entire community and must be routinely supported, promoted and celebrated to encourage more people to discover the benefits for themselves. Adequately funding improvements for bicycling and walking accommodations on Louisville Metro roads must be part of this support to capture the greatest benefit for the community.

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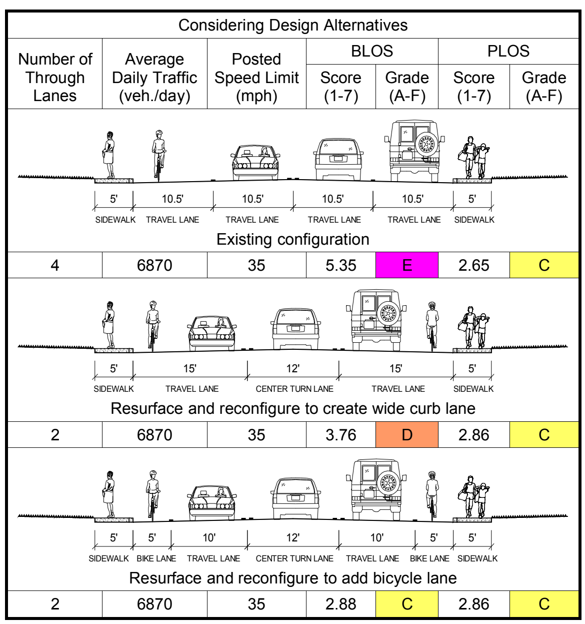

Considering Design Alternatives

Number of Through Lanes	Average Daily Traffic (veh./day)	Posted Speed Limit (mph)	BLOS		PLOS	
			Score (1-7)	Grade (A-F)	Score (1-7)	Grade (A-F)
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Resurface and reconfigure to create wide curb lane						
2	6870	35	3.76	D	2.86	C
Resurface and reconfigure to add bicycle lane						
2	6870	35	2.88	C	2.86	C

Chapter 1

Introduction

Vision for the Future

Bicycling and walking are efficient, clean, healthful and viable means of transportation and are popular recreational activities, yet both bicycling and walking remain underutilized in the United States. The Intermodal Surface Transportation Efficiency Act (ISTEA), passed by the United States Congress in 1991, recognized the significant role of bicycling and walking in the national transportation system and the benefits of these travel modes both to individuals and their communities. The final report of *The National Bicycling and Walking Study*, published in 1994 by the U.S. Department of Transportation, set specific goals for enhancing bicycling and walking as travel options; provided federal, state, and local action plans for achieving those goals; and expressed a clear vision of the intermodal future of transportation set forth by the ISTEA legislation.* Over a decade later, these goals and vision are as important as ever and reveal how much work remains for many American communities to promote and support bicycling and walking as real transportation options.

***The National Bicycling and Walking Study* sets forth a clear vision of intermodal transportation.**

> "The vision of this program is a Nation of travelers with new opportunities to walk or ride a bicycle as part of their everyday life. They may walk or bike to a carpool or bus or train as part of a new intermodal trip pattern or they may find that they can walk or bike with safety and ease all the way to their destination. Many will find that they do not have to use a motor vehicle for trips to the store, to church, to work, or to school. They will like what they are doing for the community and for themselves. America will have a changed transportation system—better balanced to serve *all* travelers."
>
> "The vision of this program is a transportation system that provides new levels of personal mobility at modest cost while encouraging cleaner air and a healthier populace. America will feel good about the new intermodal opportunities and everybody will benefit. Individuals will choose to walk or bicycle and view these choices as personally and socially desirable. Walking and bicycling will become as socially acceptable as driving a motor vehicle."
>
> "This is the vision—to create a changed transportation system that offers not only choices among travel modes for specific trips, but more importantly presents these options in a way that they are *real* choices that meet the needs of individuals and society as a whole. Making this vision a reality must begin now."

Two goals were set by *The National Bicycling and Walking Study*.

- Double the current percentage (from 7.9% to 15.8%) of total trips made by bicycling and walking; and
- Simultaneously reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes.

* *The National Bicycling and Walking Study: Transportation Choices for a Changing America*, Final Report, Federal Highway Administration, Publication No. FHWA-PD-94-023, 1994.

Promoting and Supporting Bicycling and Walking as Travel Choices

The goals of *The National Bicycling and Walking Study* were established to increase the number of people who ride a bicycle and walk for recreation and transportation and to improve the safety of bicycling and walking. Many state and local governments have adopted these goals and have established their own goals in an effort to promote bicycling and walking and take advantage of the many benefits of these travel modes. As the study notes in its concluding remarks, these goals can only be achieved through a coordinated effort of government, citizen groups and the private sector, and by institutionalizing bicycling and walking into the greater transportation system to ensure that they are promoted and supported at a level that captures the greatest benefits for local communities.

Several conclusions were drawn from *The National Bicycling and Walking Study.*

"If we are to meet the goals of doubling the current levels of bicycling and walking in the United States while decreasing by 10 percent the number of crash-related injuries and deaths, coordinated and committed effort must be put forth at every level of government. In addition, government agencies, private organizations, and citizen groups must all work together to support one another's efforts to promote safe bicycling and walking."

"We must continue working toward institutionalizing bicycling and walking into the Nation's transportation system at the Federal, State, and local levels. It is through this evolving and long-term process that the support, facility improvement, promotion, education, enforcement, and enthusiasm needed to achieve our stated goals will come. Bicycling and walking can then become attractive options and valuable components within our Nation's transportation system."

Strategies for Promoting and Supporting Bicycling and Walking

There are many actions that must be coordinated at all levels—nationally to locally—to promote and support bicycling and walking. Educating pedestrians, bicyclists and motor vehicle operators on proper behavior to effectively share a road is one of the most important steps in realizing these goals. Equitable enforcement of traffic laws can also encourage all road users to improve their behavior. In addition, there are many strategies that can be employed to encourage more people to travel by bicycle and on foot. Bike- and Walk-to-Work events can raise awareness and build a base of citizens who choose non-motorized travel more frequently. Commuter programs that support and subsidize walking and bicycling along with customary employee parking or transit subsidies can help encourage more people to choose non-motorized transportation. Creating a culture of active lifestyles that recognizes the health benefits of bicycling and walking can also go a long way toward changing the image of these travel choices and moving them more into the mainstream. However, none of these strategies for increasing the number of people choosing to walk and bike will work if people do not believe the benefits are greater than the risks.

Improving the safety of walking and bicycling and providing convenient access to the places people want to go must be high priorities.

Improving the safety of walking and bicycling and providing convenient access to the places people want to go must be high priorities to encourage more people to choose non-motorized transportation. To achieve these goals, land-use and transportation planning; and transportation project design, construction and operation activities must *routinely* incorporate the needs of all road users.

Transportation policies and road designs that consider only motorized vehicles typically result in poor conditions for bicyclists and pedestrians. Sidewalks are often not provided along collector and arterial roads, and high volumes of motor vehicle traffic are carried on relatively narrow travel lanes. No provisions for sidewalks and narrow travel lanes exclude much of the walking and bicycling traffic that might otherwise pass through these roads. People who must walk on these roads or who choose to walk despite the poor conditions, often have to beat their own path in the roadside or are forced to walk on shoulders, in the travel lanes, through parking lots, over narrow bridges, and across hazardous intersections with no crossing signals or crosswalks.

Those who choose to bike on these roads find them equally problematic, being forced into narrow travel lanes where faster moving vehicles cannot safely pass while sharing the same lane. On roads with high traffic volumes, this situation can lead to bicyclists delaying other traffic, motor vehicles passing too close and drivers harassing bicyclists, even those bicyclists who obey all traffic laws. The result is an extremely stressful bicycling environment that few people are willing to endure. Even the most experienced bicyclists may avoid many roads because there is no comfortable place to ride. For many other bicyclists faced with these situations, they choose to ride illegally on the sidewalks (where they exist) or they take to alleys, parking lots, or any other route that may bypass busy roadways. Some bicyclists may also resort to wrong-way riding on roads where they feel threatened by overtaking motor vehicles. These bicycling behaviors result from a lack of knowledge about traffic laws and riding experience in mixed traffic, but also from a *serious* lack of roads suitable for bicycling.

Figure 1: Pedestrians beat their own path in the roadside along Dixie Highway just north of Greenwood Rd.

Figure 2: Narrow travel lanes and high motor vehicle volumes make Lower Hunters Trace poorly suited for bicycling.

To understand how well existing roads serve bicyclists and pedestrians requires additional knowledge, experience and tools for planners, engineers and citizens. Road suitability measures have been developed in recent years that rate roads based on how well they serve bicyclists and pedestrians. The suitability of a road for bicycle and pedestrian travel can be thought of as the compatibility of bicycling and walking with motor vehicle use on shared roads; it is the bicycle- and pedestrian-friendliness of the road. With these and other emerging tools, metropolitan areas are beginning to improve the safety and accessibility of their road network for bicycle and pedestrian travel.

Conditions for Bicycling and Walking in Louisville Metro

This study uses nationally recognized road suitability measures to evaluate the bicycling and walking conditions on Louisville Metro's arterial and collector road network. The scope is limited to arterial and collector roads because they carry the highest volumes of motor vehicle traffic at the highest speeds and often provide the worst service for pedestrians and bicyclists who choose to use them or have no other transportation choices. Neighborhood streets typically provide adequate service for bicyclists and pedestrians because they carry lower volumes of traffic at slower speeds, minimizing the conflicts between users and travel modes. Arterial and collector roads are also a natural choice for analysis because they represent a highly interconnected network that enables travel to all destinations, and often they provide the only connections where neighborhood streets dead-end into cul-de-sacs, providing little or no connectivity for through-travel.

The arterial and collector roads identified for this study include more than 6,200 road segments, each with its own characteristics. More than 30 different bits of information, such as lane widths, motor vehicle traffic volumes and the presence of sidewalks, were gathered for each road segment and compiled into a spatial database using geographic information system (GIS) tools. Much of the required information for this study was available though the Louisville/Jefferson County Information Consortium (LOJIC), the Kentucky Transportation Cabinet (KYTC), the Kentuckiana Regional Planning and Development Agency (KIPDA), Metro Planning and Design Services and Metro Public Works. The remainder was estimated and collected through field assessments.

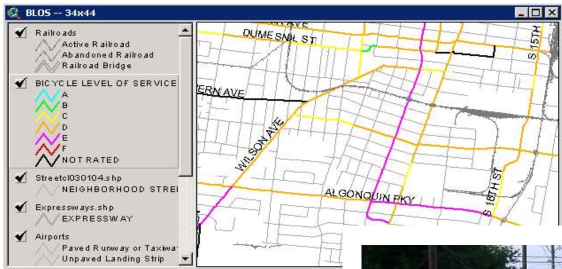
The bicycle and pedestrian database was used to generate maps showing the suitability of roads for bicycling and walking, locations of existing sidewalks, roads with potential to improve bicycling accommodations and barriers such as freeway crossings (see maps in Appendix A). The maps and database are useful for planners, engineers and citizens to identify and prioritize road projects that will improve conditions for bicycling and walking. Additional uses for bicycle and pedestrian suitability measures are shown in Table 1.

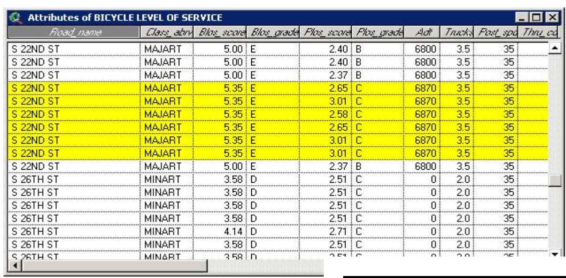
Table 1: There are several uses for bicycle and pedestrian suitability measures.

- ✔ Identify and prioritize roads in need of improvement for bicycling and walking.
- ✔ Compare alternative design options for improving existing roads.
- ✔ Design new roads to accommodate bicyclists and pedestrians.
- ✔ Help planners and citizens with long-term bicycle and pedestrian planning.
- ✔ Provide maps for use in route planning by bicyclists.

The bicycle and pedestrian database provides a current snapshot of the overall bicycling and walking conditions on Louisville Metro roads. By maintaining and updating the database, long-term progress toward improving conditions for bicycling and walking can easily be charted. As new tools and methods become available, this database can serve as a foundation for additional analysis of bicycling and walking conditions throughout Louisville Metro.

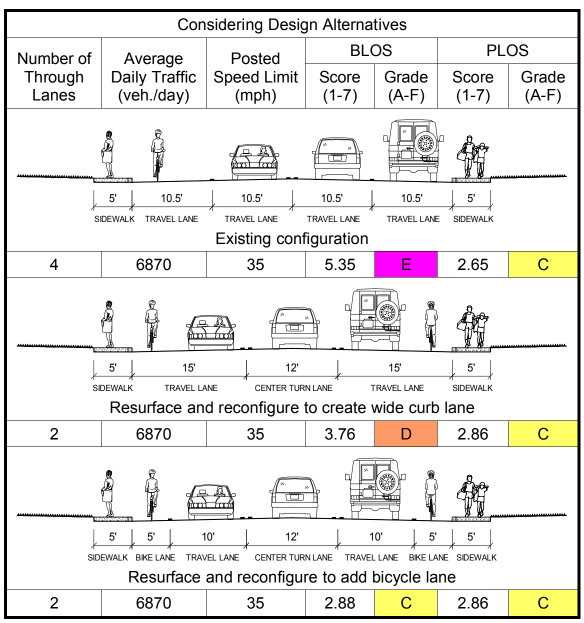
The following chapter provides detailed information about the suitability measures used in this study to compute the bicycle and pedestrian level of service. Chapter 3 discusses the creation of a spatial database for bicycle- and pedestrian-related information and the compilation of data from a number of sources. Chapter 4 is a presentation of the significant results of this study including the application of the bicycle and pedestrian level-of-service models, creation of maps and investigation of roads with potential to improve bicycling conditions through cost-effective measures. Finally, Chapter 5 provides a number of detailed recommendations, including actions needed to improve Louisville Metro's roads for bicycling and walking and methods for updating and using the bicycle and pedestrian database to its full potential.





Attributes of BICYCLE LEVEL OF SERVICE

Road_name	Class_abrv	Blos_score	Blos_grade	Plos_score	Plos_grade	Adt	Trucks	Post_spd	Thru_c
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.58	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	4.14	D	2.71	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	



Considering Design Alternatives						
Number of Through Lanes	Average Daily Traffic (veh./day)	Posted Speed Limit (mph)	BLOS Score (1-7)	BLOS Grade (A-F)	PLOS Score (1-7)	PLOS Grade (A-F)
Existing configuration						
4	6870	35	5.35	E	2.65	C
Resurface and reconfigure to create wide curb lane						
2	6870	35	3.76	D	2.86	C
Resurface and reconfigure to add bicycle lane						
2	6870	35	2.88	C	2.86	C

Chapter 2

Background

Figure 3: Louisville Metro has a wide array of road configurations from dense urban streets (right) to narrow rural roads (far right).

Suitability of Roads for Bicycle and Pedestrian Travel

Roads are the public rights-of-way that serve nearly all of the personal transportation needs in metropolitan areas. Whether they are called roads, streets or highways, they all serve the same basic purpose—providing a public space for people to travel. Unfortunately, bicycling and walking are often neglected in transportation planning and road design, resulting in public spaces that are difficult or impossible for anyone outside a motor vehicle to traverse.

Making the existing roads safer, more convenient and more accessible to bicyclists and pedestrians is key to improving bicycling and walking conditions as a whole.

Many cities and states are undertaking comprehensive bicycle and pedestrian planning to address the lack of appropriate spaces for walking and bicycling. What many planners are realizing is that enhancing and retrofitting the existing road network for improved bicycle and pedestrian safety and access is often the most effective and least costly approach. Off-road facilities such as trails and shared-use paths can offer excellent connections in the overall bicycle and pedestrian network, and exceptional recreational opportunities. They can be used, for instance, to connect schools to residential areas to provide safe routes for children or to connect neighborhoods to shopping and employment centers. These facilities have also proved their worth for recreation based on their popularity and level of usage, but their cost and requirement for new rights-of-way limit their application. Because the road network already takes users to virtually all destinations, using the existing roads is often the most efficient and practical choice for all users no matter what mode of travel they choose. For many trips the road network provides the only access for bicyclists and pedestrians. Even users of recreational facilities must typically arrive at the facility on the road network. Thus, making the existing roads safer, more convenient and more accessible to bicyclists and pedestrians is key to improving bicycling and walking conditions as a whole.

Facing Challenging Bicycling and Walking Conditions

In Kentucky, a bicycle is legally defined as a vehicle and is given the same rights and responsibilities as other vehicles. This legal definition entitles bicyclists to use the same paved roadways as other vehicles. Unfortunately, most of the existing roadways throughout Louisville Metro were not designed with bicyclists in mind. In general, the arterial and collector roads with high traffic volumes are poorly suited for bicycle travel due to narrow lane widths and the lack of paved shoulders. The inability of motorists to pass bicyclists safely while sharing the same lane causes conflicts that discourage many cyclists from using the roadway and creates a stressful environment for those experienced cyclists who do make use of arterial and collector roads. Bicyclists who are uncomfortable riding in these conditions often take to the sidewalk where they create conflicts with pedestrians and put themselves at greater risk when crossing streets.* Figure 4 shows some typical sidewalk riding behavior on Louisville Metro streets. A number of other factors, such as pavement quality, traffic speed, number of large vehicles, air pollution, and barriers like freeway interchanges or topography can also discourage bicyclists from using a road; however, in many cases, creating a wide outside lane, striping a bicycle lane or paving a shoulder are the only changes to a roadway that are necessary for bicyclists and motorists to happily share the same space.

Figure 4: Many bicyclists ride on sidewalks where they may feel threatened by motor vehicles. A bicyclist uses the sidewalk on Chestnut St, riding the wrong way in the street to avoid pedestrians (far left). A bicyclist rides on the sidewalk along Bardstown Rd (left).

Pedestrians are faced with equally challenging walking conditions on a number of Louisville Metro roads. As the outlying areas developed over the past decades, it is clear that accommodating pedestrians was often not part of the transportation decisions. Many arterial and collector roads were built without sidewalks and few sidewalks were added as the intensity of land development increased. This situation has resulted in a number of high-speed, high-volume roads with no place to walk other than on the roadway, through parking lots, through drainage ditches and around a host of other obstacles. Making matters worse, few safe options for crossing these roads have been provided, further reducing the safety and accessibility of many roads to pedestrians. Even where sidewalks exist, they are often discontinuous, in poor repair, and are not coupled with crosswalks, crossing signals, curb ramps and other features that make them useful and accessible. Including these important details in road projects is critical for providing improved safety and accessibility. Figure 5 shows examples of challenging walking conditions on Shelbyville Rd.

* Studies have shown that riding on sidewalks is a contributing factor in many bicycle/motor vehicle crashes. Motorists are often not looking for relatively fast-moving bicyclists crossing driveways and entering intersections from the sidewalk. Wrong-way riding on sidewalks is particularly dangerous. See the Pedestrian and Bicycle Information Center bicycling crashes report for more information: http://www.bicyclinginfo.org/bc/index.htm

Figure 5: Shelbyville Rd is a popular commercial corridor, yet it lacks many basic pedestrian accommodations. Few sidewalks are present, forcing pedestrians to beat their own path (right). A bus stop provides no connection to nearby shopping centers (far upper right). Multiple free-flowing travel lanes make crossing this side street difficult (far lower right).

Because road design is still predominantly focused on motor vehicle use, it is necessary to change the policies and design standards to include bicyclists and pedestrians as mainstream users. This change in policy and practice will help improve the walking and bicycling conditions on new or reconstructed roads, but much of the road network is already built. Planners are finding a need to evaluate the street network to determine how suitable the existing roads are for bicycle and pedestrian travel. This information helps them prioritize improvements to bicycle and pedestrian access with the limited funding that is currently available. Establishing this baseline picture of bicycling and walking conditions also helps a community chart its long-term progress toward improving non-motorized travel.

Road Suitability Measures for Bicycle and Pedestrian Travel

Road suitability measures have been developed in recent years that help planners, engineers and citizens understand how well their roads serve bicyclists and pedestrians. The suitability of a road for bicycle and pedestrian travel can be thought of as the compatibility of bicycling and walking with motor vehicle use on shared roads; it is the bicycle- and pedestrian-friendliness of the road. Level-of-service (LOS) models are emerging as the method of choice for evaluating how suitable a roadway is for bicycling and walking. Bicycle and pedestrian LOS models predict a user’s comfort level based on geometric and operational conditions of a road. The models were developed using actual bicyclists' and pedestrians’ ratings of their comfort level when exposed to various roadway conditions. Factors that can affect a bicyclist's or pedestrian's perception of the road are shown in Table 2.

- ✔ Width of outside travel lane
- ✔ Motor vehicle volume
- ✔ Motor vehicle speed
- ✔ Heavy vehicle volume (trucks)
- ✔ Pavement surface condition
- ✔ Type of adjacent land use
- ✔ Presence of sidewalks
- ✔ Presence of buffer space between roadway and sidewalks
- ✔ Presence of on-street parking
- ✔ Presence of bicycle lane or paved shoulder

Table 2: There are many factors that affect how suitable a road is for walking and bicycling.

Bicycle Suitability Measures

Two bicycle level-of-service models are emerging as standards in the United States. The Bicycle Level of Service (BLOS) was developed by Sprinkle Consulting, Inc. and was first published in 1997.* The University of North Carolina Highway Safety Research Center with support from the Federal Highway Administration published another model in 1998 called the Bicycle Compatibility Index (BCI).**

Both the BLOS and BCI models are based on bicyclists' ratings of their comfort level when exposed to various roadway conditions. The models predict LOS at mid-block locations, not at intersections. The BLOS model was developed using ratings of roadway segments by bicyclists who rode through a test course under real traffic conditions that represent the range of roadway characteristics typically encountered by bicyclists in metropolitan areas throughout the United States. The BCI model was developed using a similar method; however, the ratings were collected from participants who viewed video clips of bicycling conditions rather than riding in actual traffic conditions.

In 2001, the League of Illinois Bicyclists and the Bicycle and Pedestrian Task Force of the Chicago Area Transportation Study evaluated both the BLOS and BCI models to determine which model was best suited to application in their region.*** They found that the BLOS model, provided the best assessment of the wide range of local bicycling conditions. Based on their recommendation, the BLOS was used in a comprehensive study of roads in Kane County, IL, resulting in a useful planning tool

* Bruce W. Landis et.al., *Real-Time Human Perceptions: Toward a Bicycle Level of Service*, Transportation Research Record 1578, Transportation Research Board, Washington DC, 1997. http://www.sprinkleconsulting.com/Research/trb9703b.htm

** *Development of the Bicycle Compatibility Index: A Level of Service Concept*, Final Report, Federal Highway Administration, FHWA-RD-98-072, 1998. http://safety.fhwa.dot.gov/fourthlevel/pdf/bcifinalrpt.pdf

*** Ed Barsotti, Gin Kilgore, *The Road Network is the Bicycle Network: Bicycle Suitability Measures for Roadways and Sidepaths*, 2001. http://www.bikelib.org/roads/roadnet.htm and maps for use by planners, interested citizens and bicyclists. A number of other communities and states have adopted the BLOS methodology including: Anchorage, AK, Baltimore, MD, Birmingham, AL, Buffalo, NY, Gainesville, FL, Houston, TX, Lexington, KY, Philadelphia, PA, Sacramento, CA, Springfield, MA, Tampa, FL, Washington, D.C.; Delaware Department of Transportation, Florida Department of Transportation, New York State Department of Transportation, Maryland Department of Transportation, and Virginia Department of Transportation, among others.* Given the wide spread use of the BLOS model and its positive review, it was selected for application in this study. Since the BLOS and BCI models share many of the same variables, the BCI model could be applied with a small amount of additional data collection.

Bicycle Level of Service Model

The BLOS model was developed using data from actual bicyclists' experiences riding in real traffic conditions that represented many types of land uses and road configurations found in metropolitan areas throughout the United States. A 17-mile course with 30 distinct road segments was set up in the Tampa Bay area. Nearly 150 participants, divided almost equally by gender and representing a wide range of ages and bicycling experience levels, were selected to ride through the course and rate their experience on each road segment from A (best service) to F (worst service). The participant ratings were then used to develop a statistically calibrated model for predicting the bicycle level of service using measurable roadway parameters.

Table 3: The Bicycle Level of Service is rated with a letter grade A-F based on the computed score.

Grade	Score	Level of Service
A	≤ 1.5	extremely high
B	> 1.5 and ≤ 2.5	very high
C	> 2.5 and ≤ 3.5	moderately high
D	> 3.5 and ≤ 4.5	moderately low
E	> 4.5 and ≤ 5.5	very low
F	> 5.5	extremely low

After the initial publication of the BLOS model in 1997, the model was refined based on the experiences of a number of communities that applied it to their own road networks. The modifications to the model resulted in the development of the BLOS model Version 2, which is currently in wide use across the United States and has a higher correlation coefficient than the original model.**

Table 4 shows the basic form of the BLOS model with an explanation of each variable used to compute the BLOS score for a road segment. The score is computed by collecting the geometric and operational data for a road and entering them into the formula. The numerical scores are then converted to BLOS grades that rate the level of service as shown in Table 3.

* *A Summary of the Bicycle Level of Service Model*, Toole Design Group, Roanoke Valley-Alleghany Regional Commission Bicycle Suitability Analysis Training, May 2003. http://www.rvarc.org/bike/blosdescription.pdf

** *Bicycle Suitability Evaluation of Roadways: Lexington-Fayette Urban County Government,* Final Report, Sprinkle Consulting Inc., 2001. http://www.chem.uky.edu/bikes/PDFs/LEXBLOSREPORT.pdf

Table 4: The Bicycle Level of Service is computed based on the geometric and operational characteristics of a road.

$$BLOS = a_1 \ln\left(\frac{Vol_{15}}{L_n}\right) + a_2 SP_t\left[1 + 10.38\left(\frac{HV}{100}\right)\right]^2 + a_3\left(\frac{1}{PR_5}\right)^2 + a_4 W_e^2 + C,$$

where:

Vol_{15} = $\frac{ADT \times D \times K_d}{4 \times PHF}$ = volume of directional traffic in 15 minutes,

where:

ADT = average daily traffic (vehicles/day)
D = directional factor (assumed to be 0.5)
K_d = peak to daily factor (assumed to be 0.1)
PHF = peak hour factor (assumed to be 1.0)

L_n = total number of directional through lanes

SP_t = $1.1199 \ln(SP_p - 20) + 0.8103$ = effective speed limit,

where:

SP_p = posted speed limit (miles per hour)

HV = percentage of heavy vehicles
PR_5 = FHWA five-point pavement surface condition rating
W_e = average effective width of outside through lane (feet),

where:

$W_e = W_v - [10 \times (OSPA/100)]$, if $W_l = 0$

$W_e = W_v + W_l[1 - 2 \times (OSPA/100)]$, if $W_l > 0$ and $W_{ps} = 0$

$W_e = W_v + W_l - 2[10 \times (OSPA/100)]$, if $W_l > 0$ and $W_{ps} > 0$ and bike lane exists

$W_v = W_t$, if ADT > 4,000

$W_v = W_t(2 - 0.00025 \times ADT)$, if ADT ≤ 4,000 and road is not divided or striped,

where:

W_t = total width of outside through lane (feet)
$OSPA$ = percentage of segment with occupied on-street parking
W_l = width of pavement between the edge stripe and the edge of pavement (feet)
W_{ps} = width of pavement striped for parking adjacent to a bicycle lane (feet)
W_v = effective width as a function of traffic volume (feet)

and:

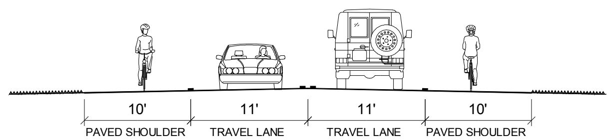
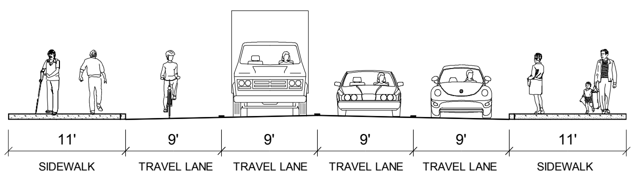
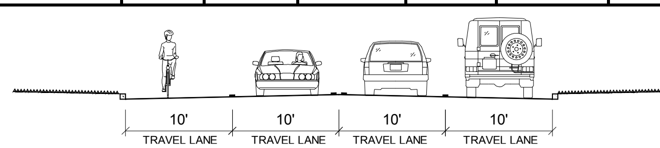
a_1 = 0.507; a_2 = 0.199; a_3 = 7.066; a_4 = -0.005; and C = 0.760,

are the model coefficients and constant.

BLOS Application Examples

Based on the BLOS model, the factors that most significantly affect the comfort level of bicyclists on shared roadways are the lane widths, the motor vehicle traffic volume and the pavement surface condition. The presence of a bicycle lane is a major factor in the BLOS model, indicating that bicyclists who participated in the BLOS study generally felt more comfortable on roadways with space designated for their use. Table 5 provides several examples of the BLOS methodology applied to actual Louisville Metro road segments to provide some familiarity with the BLOS model and grading system.

Table 5: The Bicycle Level of Service is computed for three Louisville Metro road segments to demonstrate how it is applied.

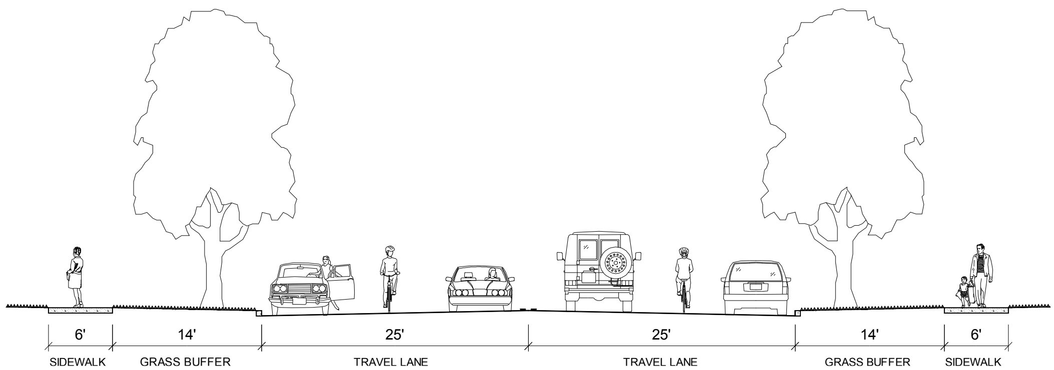
	Traffic Data			Width of Pavement					BLOS	
Number of Through Lanes	Average Daily Traffic (veh./day)	Estimated Percentage of Trucks (%)	Posted Speed Limit (mph)	Outside Lane Width (ft)	Shoulder or Bicycle Lane Width (ft)	Parking Lane Width (ft)	Occupied On-Street Parking (%)	Pavement Condition (1-5)	Score (1-7)	Grade (A-F)
 *Example 1: South Park Rd (Lampton Ave to Old South Park Rd)*										
2	8150	1.5	35	11	10	0	0	3	1.79	B
 *Example 2: W Chestnut St (S 3rd St to S 4th St)*										
4	18430	2	25	9	0	0	0	3	4.3	D
 *Example 3: Brownsboro Rd (Hillcrest Ave to Country Ln)*										
4	21400	3.5	35	10	0	0	0	2	5.93	F

Example 1 in Table 5 shows a short segment of South Park Rd that crosses I-65 just north of I-265. This road segment has generous 10-foot paved shoulders and moderate motor vehicle traffic volumes and speeds resulting in a BLOS rating of B. W Chestnut St in downtown Louisville is shown in Example 2. The narrow travel lanes with relatively high traffic volumes gives this road a moderately low BLOS rating of D. Finally, Example 3 shows a portion of Brownsboro Rd with relatively high traffic volumes, narrow travel lanes, and poor pavement surface condition resulting in an extremely low BLOS rating of F.

Table 6 demonstrates how the BLOS model can be used to consider different design options with a focus on alternative treatments for W Broadway from S 36th St to Southwestern Pkwy. The two alternatives show the addition of a striped bicycle lane either shared with or separated from a parking lane. In both cases the BLOS is improved dramatically to a rating of A by the addition of roadway striping to designate a bicycle lane. Separate bicycle and parking lanes would probably function best in this situation where parking demand is light. A combined lane might be mistaken for a travel lane by some motorists when there are few parked vehicles.

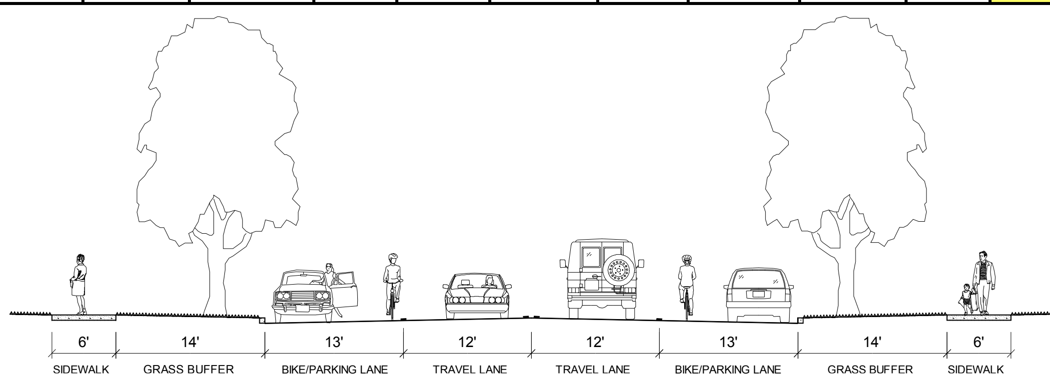
Table 6: The Bicycle Level of Service model can be used to evaluate design alternatives for existing roads.

	Traffic Data			Width of Pavement					BLOS	
Number of Through Lanes	Average Daily Traffic (veh./day)	Estimated Percentage of Trucks (%)	Posted Speed Limit (mph)	Outside Lane Width (ft)	Shoulder or Bicycle Lane Width (ft)	Parking Lane Width (ft)	Occupied On-Street Parking (%)	Pavement Condition (1-5)	Score (1-7)	Grade (A-F)



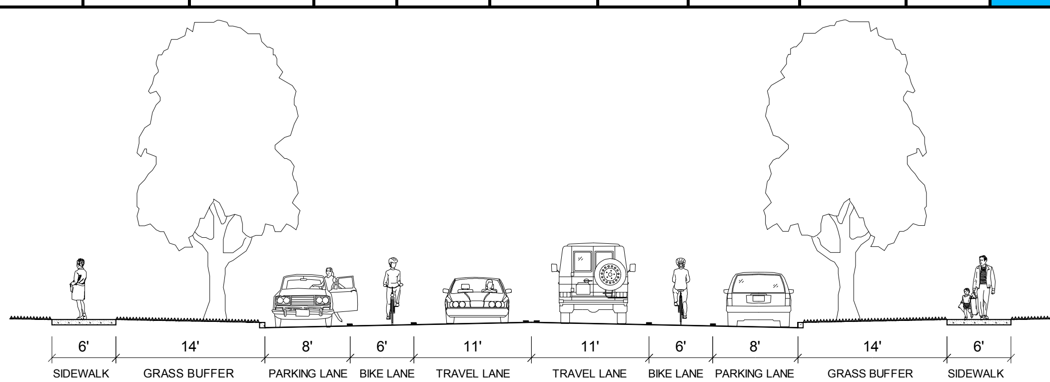
Current configuration: W Broadway (S 36th St to Southwestern Pkwy)

2	9940	2	35	25	0	0	25	3	2.57	**C**



Restriping option 1: combined parking and bicycle lane

2	9940	2	35	12	13	0	25	3	0.14	**A**



Restriping option 2: separate parking and bicycle lanes

2	9940	2	35	11	6	8	25	3	0	**A**

Pedestrian Suitability Measures

Pedestrians represent a broad range of road users with different abilities and needs. Anyone who travels around a metropolitan area is likely to be a pedestrian at some point in their trip. Walking to and from a transit stop or parking lot, or to a lunch meeting brings people out of their vehicles and into a mixed flow of traffic.

Unlike bicyclists, who can often effectively mix with motor vehicles on the same paved roadways, pedestrians are usually served best by sidewalks that are separated from the roadway. Well-designed pedestrian facilities provide a safe, convenient, accessible place to walk along a road and encourage more people to walk. Where no such facilities exist, pedestrians typically use the roadside, shoulders or edge of travel lanes to travel along a road. Pedestrian level-of-service models are helpful for assessing the roadside walking environment and determining how well the road serves pedestrians.

Pedestrian Level of Service Model

Building on their work with the BLOS model, Sprinkle Consulting, Inc., in conjunction with the Florida Department of Transportation, developed the Pedestrian Level of Service (PLOS) model. A 5-mile walking course consisting of 24 distinct road segments was set up in Pensacola, FL. Nearly 75 people participated in the study, and as with the development of the BLOS model, the participants were well distributed across gender, age and level of walking experience in urban and suburban settings. The original PLOS model was published in 2001.[*] The League of Illinois Bicyclists documented some minor modifications to the model after its initial publication. The most recent version of the PLOS model is shown in Table 7.[**,***]

The PLOS model rates the utilitarian function of the roadside walking environment, not its aesthetic, social or cultural aspects; and it does not consider the surrounding context, such as the terrain, landscaping or type of adjacent land use. The model is also intended for use at mid-block locations, not at intersections, where conditions for pedestrians can vary greatly. Despite these limitations, the model does provide a high correlation between several measurable geometric and operational characteristics of a road and a pedestrian's comfort level on that roadside. The model is therefore useful for assessing the basic pedestrian level of service provided by a street network.

The factors that most significantly affect the comfort level of pedestrians are the presence of sidewalks, the lateral separation between motor vehicle and pedestrian traffic, the volume of motor vehicles and the motor vehicle speed. The presence of a sidewalk is a major factor in the PLOS model, especially when the sidewalk is separated from the travel lanes by a buffer (a shoulder, bicycle lane or grass verge) or barrier (trees planted in a buffer or parked cars along the side of the roadway).

* Bruce W. Landis et. al., *Modeling the Roadside Walking Environment: A Pedestrian Level of Service*, Transportation Research Record 1773, Transportation Research Board, Washington DC, 2001. http://www.dot.state.fl.us/planning/systems/sm/los/pdfs/pedlos.pdf

** Ed Barsotti, *BLOS/PLOS Calculator Form*, League of Illinois Bicyclists, http://www.bikelib.org/roads/blos/losform.htm

*** Email correspondence with Ed Barsotti, League of Illinois Bicyclists, March 2004.

Table 7: The Pedestrian Level of Service (PLOS) is computed based on the geometric and operational characteristics of a road.

$$PLOS = a_1 \ln(W_{ol} + W_l + f_p OSPA + f_b W_b + f_s W_s) + a_2\left(\frac{Vol_{15}}{L}\right) + a_3 SPD^2 + C,$$

where:

W_{ol} = width of outside lane (feet)
W_l = width of pavement between the edge stripe and the edge of pavement (feet)
f_p = on-street parking coefficient (= 0.2)
OSPA = percentage of segment with occupied on-street parking

f_b = $1 + (90/T_b)$ = buffer area barrier coefficient,

where:

T_b = spacing between trees in buffer (feet)

W_b = buffer width (feet)

f_s = $6 - 0.3W_s$ = sidewalk presence coefficient

W_s = width of sidewalk (feet)

Vol_{15} = $\frac{ADT \times K_d}{4 \times PHF}$ = volume of traffic in 15 minutes,

where:

ADT = average daily traffic (vehicles/day)
K_d = peak to daily factor (assumed to be 0.1)
PHF = peak hour factor (assumed to be 1.0)

L = total number of through lanes
SPD = average running speed of motor vehicle traffic (miles per hour)

and:

a_1 = -1.227; a_2 = 0.009; a_3 = 0.0004; and C = 6.046,

are the model coefficients and constant.

Note: where sidewalks exist along only a portion of a road segment, the following formula can be used to approximate the PLOS for the entire segment.

$$PLOS = a_1\left[\left(\frac{SWCOV}{100}\right)SW + \left(1 - \frac{SWCOV}{100}\right)NSW\right] + a_2\left(\frac{Vol_{15}}{L}\right) + a_3 SPD^2 + C,$$

where:

SW = $\ln(W_{ol} + W_l + f_p OSPA + f_b W_b + f_s W_s)$ = formula for portion with sidewalk

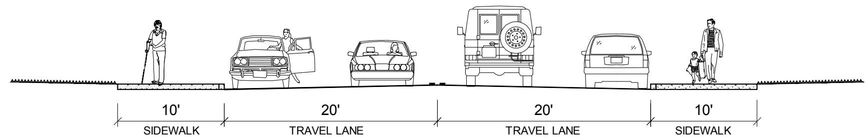
NSW = $\ln(W_{ol} + W_l)$ = formula for portion without sidewalk

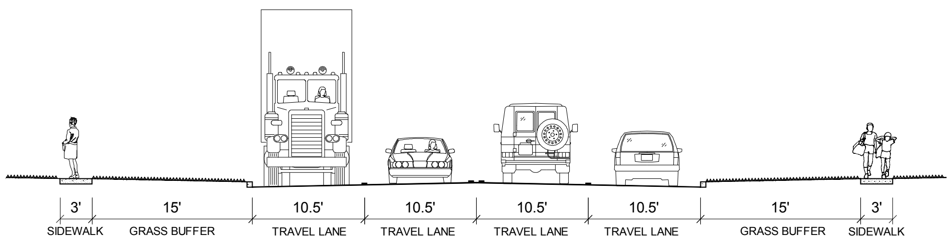
SWCOV = percentage of segment with sidewalks

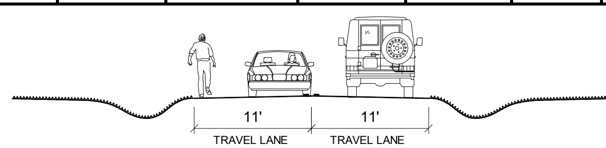
PLOS Application Examples

Table 8 provides several examples of the PLOS methodology applied to actual Louisville Metro road segments to provide some familiarity with the PLOS model and grading system. As with the BLOS model, the PLOS is evaluated based on the geometric and operational conditions of a road and the score is converted to a PLOS grade using Table 3.

Table 8: The Pedestrian Level of Service is computed for three Louisville Metro road segments to demonstrate how it is applied.

<table>
<tr><th rowspan="2">Number of Through Lanes</th><th rowspan="2">Average Daily Traffic (veh./day)</th><th rowspan="2">Posted Speed Limit (mph)</th><th colspan="2">Width of Pavement</th><th rowspan="2">Occupied On-Street Parking (%)</th><th colspan="3">Sidewalk Configuration</th><th colspan="2">PLOS</th></tr>
<tr><th>Outside Lane Width (ft)</th><th>Shoulder or Bicycle Lane Width (ft)</th><th>Width of Sidewalk (ft)</th><th>Buffer Width (ft)</th><th>Tree Spacing (ft)</th><th>Score (1-7)</th><th>Grade (A-F)</th></tr>
<tr><td colspan="11">

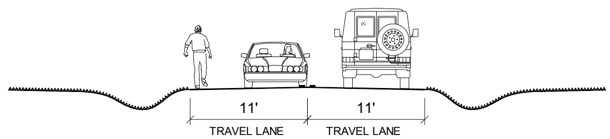
Example 1: E Gray St (Hancock St to Clay St)</td></tr>
<tr><td>2</td><td>880</td><td>25</td><td>20</td><td>0</td><td>100</td><td>10</td><td>0</td><td>0</td><td>1.18</td><td>A</td></tr>
<tr><td colspan="11">

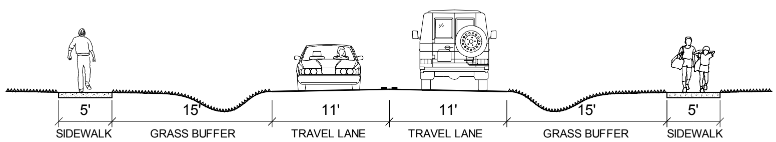
Example 2: Algonquin Pkwy (S 22nd St to Wilson Ave)</td></tr>
<tr><td>4</td><td>9880</td><td>35</td><td>10.5</td><td>0</td><td>0</td><td>3</td><td>15</td><td>0</td><td>2.54</td><td>C</td></tr>
<tr><td colspan="11">

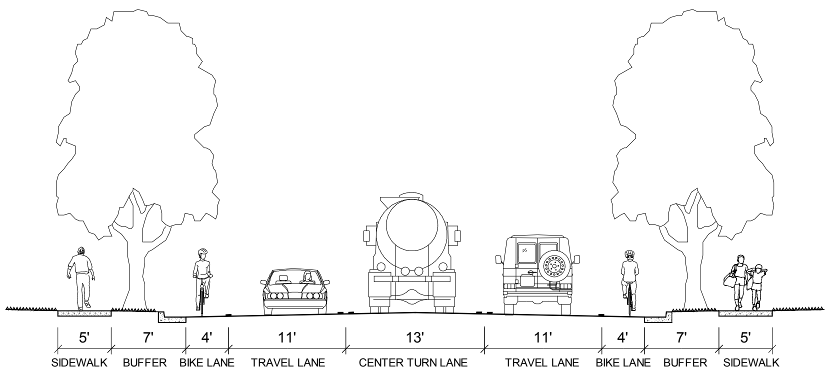
Example 3: 3rd Street Rd (Royal Gardens Ct to Outer Loop)</td></tr>
<tr><td>2</td><td>15900</td><td>45</td><td>11</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>5.70</td><td>F</td></tr>
</table>

Example 1 in Table 8 shows a one-block segment of E Gray St. This block has low motor vehicle traffic volumes and speeds with wide sidewalks and parked cars acting as barriers resulting in a PLOS rating of A. A portion of Algonquin Pkwy is shown in Example 2. This segment has moderate traffic volumes and speeds and a grass buffer between the sidewalk and road giving a moderately high PLOS rating of C. Finally, Example 3 shows a portion of 3rd Street Rd, which has moderately high traffic volumes and speeds, narrow travel lanes and no sidewalks, resulting in an extremely low PLOS rating of F.

Table 9 demonstrates how the PLOS model can be used to consider different design options with a focus on alternative treatments for 3rd Street Rd from Royal Gardens Ct to Outer Loop. Option 1 shows the addition of sidewalks on both sides of the road with a grass buffer between the sidewalk and roadway, resulting in a PLOS rating of D. Option 2 shows a completely reconstructed road including bicycle and pedestrian facilities with a moderately high PLOS rating of C.

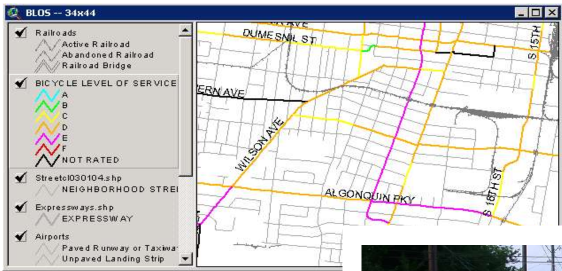
<table>
<tr><th rowspan="2">Number of Through Lanes</th><th rowspan="2">Average Daily Traffic (veh./day)</th><th rowspan="2">Posted Speed Limit (mph)</th><th colspan="2">Width of Pavement</th><th rowspan="2">Occupied On-Street Parking (%)</th><th colspan="3">Sidewalk Configuration</th><th colspan="2">PLOS</th></tr>
<tr><th>Outside Lane Width (ft)</th><th>Shoulder or Bicycle Lane Width (ft)</th><th>Width of Sidewalk (ft)</th><th>Buffer Width (ft)</th><th>Tree Spacing (ft)</th><th>Score (1-7)</th><th>Grade (A-F)</th></tr>
<tr><td colspan="11">

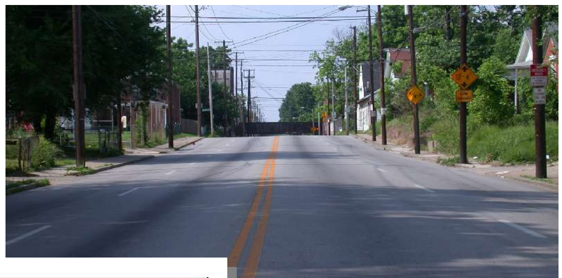
Current configuration: 3rd Street Rd</td></tr>
<tr><td>2</td><td>15900</td><td>45</td><td>11</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>5.7</td><td>F</td></tr>
<tr><td colspan="11">

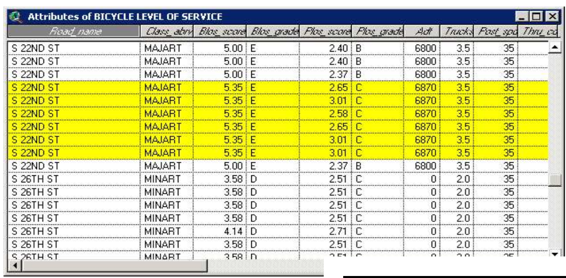
Option 1: sidewalk constructed with 15-foot buffer</td></tr>
<tr><td>2</td><td>15900</td><td>45</td><td>11</td><td>0</td><td>0</td><td>5</td><td>15</td><td>0</td><td>3.88</td><td>D</td></tr>
<tr><td colspan="11">

Option 2: road reconstructed with bicycle and pedestrian facilities</td></tr>
<tr><td>2</td><td>15900</td><td>35</td><td>11</td><td>4</td><td>0</td><td>5</td><td>7</td><td>40</td><td>3.30</td><td>C</td></tr>
</table>

Table 9: The Pedestrian Level of Service model can be used to evaluate design alternatives for existing roads.

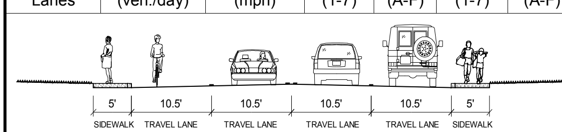






Attributes of BICYCLE LEVEL OF SERVICE

Road_name	Class_abrv	Blos_score	Blos_grade	Plos_score	Plos_grade	Adt	Trucks	Post_spd	Thru_ca
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.58	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	4.14	D	2.71	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D						



Considering Design Alternatives

Number of Through Lanes	Average Daily Traffic (veh./day)	Posted Speed Limit (mph)	BLOS Score (1-7)	BLOS Grade (A-F)	PLOS Score (1-7)	PLOS Grade (A-F)
Existing configuration						
4	6870	35	5.35	E	2.65	C
Resurface and reconfigure to create wide curb lane						
2	6870	35	3.76	D	2.86	C
Resurface and reconfigure to add bicycle lane						
2	6870	35	2.88	C	2.86	C

Chapter 3

Data Collection

Bicycle and Pedestrian Level-of-Service Database

Much of the effort of this study involved the collection and compilation of data for Louisville Metro's arterial and collector roads. For ease of mapping and data analysis, creation of a spatial database using geographic information system (GIS) tools was a natural choice.

Louisville Metro Public Works maintains a GIS database of all streets throughout Jefferson County. This database is available through the Louisville/Jefferson County Information Consortium (LOJIC) as a map layer entitled STREETCL.* This street centerline database includes more than 30,000 polyline segments that represent the centerlines of expressways, arterial and collector roads and neighborhood streets. The endpoints of these segments lie at street intersections. In the downtown area, each segment typically represents one block, where in outlying areas, road segments may be several thousand feet or more than a mile long.

The LOJIC street centerlines database was used as a basis to produce a new bicycle and pedestrian road database. The bicycle and pedestrian database is essentially a duplicate of the LOJIC street centerlines polyline shapefile with several additional attribute fields to record bicycle- and pedestrian-related data. Information was collected for more than 6,200 segments representing all of the arterial and collector roads.

In general, the street centerline database provided more than enough resolution to study the varying conditions for bicyclists and pedestrians on Louisville Metro's arterial and collector roads. In most cases, the geometric and operating conditions for the studied segments were approximately constant for the entire length of the segment, but some conditions such as shoulder width, presence of sidewalks or number of travel lanes changed along the segment. Generally, these mid-segment changes could be accounted for by noting the percentage of a segment with certain conditions or assigning the segment a value that best approximated the conditions over the entire segment.

Table 10: Louisville Metro arterial and collector roads are broken into four classifications.

Functional Classification	Mileage	Segments
Major Arterial	174.3	1469
Minor Arterial	258.8	2361
Primary Collector	301.4	2004
Secondary Collector	142.7	431
Total	**877.2**	**6265**

The arterial and collector roads are broken into four functional classifications: major arterials, minor arterials, primary collectors and secondary collectors. The approximate total mileage for each functional classification is shown in Table 10. These mileages are estimated based on the segment lengths in the street centerlines database; they do not account for the topography of the roads and are generally underestimates of the actual road miles. This network of arterial and collector roads is shown graphically in Map 1 in Appendix A.

* The STREETCL layer is available in the $LOJICDATA directory under the Transportation index. For more information on this database, visit: http://www.lojic.org/datahelp/index.htm

Metro Public Works frequently updates the street centerlines database and posts the changes to the LOJIC server. Over time, the current street centerlines database and the bicycle and pedestrian database will differ. Typically, the discrepancies occur where there is new road construction or where road segments are deleted, subdivided, moved to new alignments or reclassified. These changes are fairly easy to track and update in the bicycle and pedestrian database by simply joining the two databases and looking for differences in the number of road segments, new or deleted polyline segments and segments that have changed length. Using this approach, the bicycle and pedestrian spatial database was updated twice during its creation to more accurately reflect the current street centerlines database.

Road Data Related to Bicycling and Walking

In Chapter 2, the bicycle and pedestrian LOS models were presented. The information required for these models represents geometric and operational characteristics of a road, such as lanes widths, traffic volumes, traffic speeds, presence of sidewalks and pavement conditions. In addition to these parameters, other useful information was identified that could be collected in tandem and provide a more complete picture of the road, especially what opportunities may exist to improve conditions for bicycling and walking.

Some of the information, such as traffic volumes, traffic speeds and pavement conditions, was collected from existing databases supplied by Metro Public Works, the Kentucky Transportation Cabinet (KYTC), the Kentuckiana Regional Planning and Development Agency (KIPDA) and Metro Planning and Design Services. Much of the information, such as pavement widths, lane configurations and sidewalk data, was collected by viewing the Louisville/Jefferson County Information Consortium (LOJIC) aerial imagery and taking measurements directly from the images (see Figure 6). The remaining information was acquired through field assessments or estimated where appropriate. Table 11 provides a brief description of the 31 attribute fields included in the bicycle and pedestrian LOS (BP-LOS) database. A more detailed explanation of these fields is included in Appendix B.

Figure 6: The LOJIC color aerial imagery was used extensively to record geometric and operational data for road segments.

Table 11: Several attribute fields were created to store bicycle- and pedestrian-related information.

ADT	Average daily traffic along road segment.
VOL60	Peak hour traffic volume during 12-hour count.
VOL15	Peak traffic volume in 15-minute period during 12-hour count.
TRUCKS	Percentage of heavy vehicles out of total motor vehicle volume.
POST_SPD	Posted speed limit along road segment.
THRU_CD	Number of through travel lanes in cardinal (North/East) direction.
THRU_NN	Number of through travel lanes in non-cardinal (South/West) direction.
ONEWAY	Indicates if road is designated for one-way operation.
DIVIDED	Indicates if road is divided into two roadways with center median.
MED_TYP	Indicates what type of median strip divides two roadways.
CLT	Indicates if roadway has continuous center-left-turn lane.
EDG_COND	Describes edge condition of the paved roadway (curb and gutter, curb only or open shoulder).
STR_CEN	Indicates whether two-lane, undivided road has center stripe.
PV_WID	Total width of paved roadway between curb faces or pavement edges.
OL_WID	Width of outside through lane, excluding gutter pan width.
SH_WID	Width of paved shoulder beyond edge stripe.
CLT_WID	Width of continuous center-left-turn lane.
MED_WID	Width of median separating two adjacent roadways.
BKLN_WID	Width of pavement marked and striped as dedicated bicycle lane.
PK_WID	Width of striped on-street parking adjacent to striped bicycle lane.
SDWK_WID	Width of sidewalk present along roadside.
BUF_WID	Width of space between outside lane and edge of sidewalk, including grass verge, drainage ditch, shoulders, gutters and bicycle lanes.
TREE_SP	Distance between trees planted in sidewalk buffer.
SDWK_CD	Percentage of segment with sidewalks in cardinal (North/East) direction.
SDWK_NN	Percentage of segment with sidewalks in non-cardinal (South/West) direction.
SDWK_SUM	Indicates whether the segment has complete sidewalks on both sides, a complete sidewalk on one side, partial sidewalks or no sidewalks.
PV_COND	Rating of pavement surface condition based on FHWA 5-point scale.
P_ALLOW	Indicates if on-street parallel parking is allowed.
P_OCC	Indicates percentage of road segment with occupied on-street parking excluding driveways, alleys and bus stops.
B_FC_POS	Code identifying road segments with potential for improving bicycling accommodations through cost-effective changes like restriping or reconfiguring lanes (see Appendix C).
NOTES	Notes about unusual conditions that require special attention.

Additional Road Data

This section highlights some additional information that may be useful for assessing bicycling and walking conditions and identifying opportunities to make improvements to the existing road network. Although this information was not collected for this study, it could be added to the BP-LOS database for future use.

Data Requirements for the Bicycle Compatibility Index

Three additional attribute fields, shown in Table 12, are needed to compute the Bicycle Compatibility Index (BCI). BCI is another nationally recognized level-of-service model for evaluating the suitability of roads for bicycle travel.* In general, BCI and BLOS results agree closely. An online calculator is available from the League of Illinois Bicyclists that compares BLOS and BCI and presents the results side-by-side.**

Table 12: Three additional attribute fields are required to compute the Bicycle Compatibility Index.

Type of Adjacent Development	BCI accounts for the type of development adjacent to the road segment. The BCI score is better for residential areas than for commercial districts.
Right-turning vehicle volumes	A correction factor in the BCI model accounts for high numbers of right-turning motor vehicles. High right-turn volumes worsen the BCI score due to conflicts with bicyclists.
Parking Turnover	On-street parking can pose a number of dangers for bicyclists by narrowing the roadway width and creating potential conflicts with drivers and passengers entering and exiting their vehicles. These conflicts are more severe in commercial corridors, where parking turnover can be high. The BCI model has a correction factor based on the parking time limit to account for parking turnover.

Presence of Shoulder Rumble Strips

Rumble strips are used on the shoulders of rural highways to alert inattentive or sleepy motorists that they are deviating from the travel lane. Research has shown that rumble strips are effective in some cases at reducing the rate of motor vehicle crashes; however, shoulder rumble strips are problematic for bicyclists.*** Riding on or crossing over rumble strips is extremely uncomfortable and potentially hazardous to bicyclists. On narrow shoulders, rumble strips force bicyclists into the travel lanes and on wider shoulders, bicyclists are often left to ride through assorted debris between the rumble strip and the edge of the pavement. Shoulders that would otherwise provide welcomed space for bicyclists to operate and allow motorists to pass more easily and at a greater distance from bicyclists are frequently rendered useless for bicycling when rumble strips are applied.

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* The Bicycle Compatibility Index was developed by the University of North Carolina Highway Safety Research Center with support from the Federal Highway Administration. An online manual is available: http://www.hsrc.unc.edu/research/pedbike/bci/

** *BLOS/BCI Calculator Form*, League of Illinois Bicyclists, http://www.bikelib.org/roads/blos/blosform.htm

*** *Roadway Shoulder Rumble Strips*, Federal Highway Administration, Technical Advisory, T 5040.35 December 20, 2001. http://www.fhwa.dot.gov/legsregs/directives/techadvs/t504035.htm

Figure 7: Shoulder rumble strips are found throughout Louisville Metro. On some wide paved shoulders, there is enough space to accommodate bicyclists despite the presence of rumble strips (upper middle); however, in many cases rumble strips are not bicycle friendly (upper and lower right). In other cases, rumble strips are applied to narrow shoulders or to the extreme edge of the shoulder, providing little, if any, useful warning for motorists deviating from their lane (lower middle, upper and lower far right).

Louisville Metro has several miles of roads with shoulder rumble strips that are not bicycle friendly, as shown in Figure 7. Even the narrow shoulders on Westport Rd and Terry Rd (upper and lower left) would provide much needed breathing room for bicyclists if the rumble strips were removed. In some cases, rumble strips are applied to the edge of the shoulder where they are very unlikely to have any benefit for motor vehicle users. By the time the rumble strips on Manslick Rd (upper right), Palatka Rd (lower right) or Lower Hunters Trace (lower middle) provide feedback to a motorist, their wheels would already have left the pavement.

Question-able use of shoulder rumble strips needs to be addressed throughout Louisville Metro.

According to the Federal Highway Administration, shoulder rumble strips are not recommended for roads with speeds less than 50 mph, in urban or suburban areas, or where there is not a relatively wide clear shoulder beyond the rumble strip to provide space for motorists to recover before running off the road.* Emerging bicycle-friendly design standards state that shoulder rumble strips should not be used unless a minimum of 5 feet of clear space is provided between the rumble strip and edge of pavement or 6 feet next to a curb of other obstacle.** Given these design standards, many Louisville Metro roads with shoulder rumble strips simply should not have them. This questionable use of shoulder rumble strips needs to be addressed throughout Louisville Metro. The location of shoulder rumble strips could be recorded in the BP-LOS database to identify roads that do not meet accepted highway and bicycle-friendly design standards. The data could then be used to prioritize rumble strip removal where appropriate.

* *Roadway Shoulder Rumble Strips*, Federal Highway Administration, Technical Advisory, T 5040.35 December 20, 2001. http://www.fhwa.dot.gov/legsregs/directives/techadvs/t504035.htm

** *Comments on Draft Technical Advisory for Roadway Shoulder Rumble Strips*, League of American Bicyclists, August 31, 2001. http://www.bikeleague.org/educenter/lab-rumblestrips_tech-comments.htm

Intersection Information

Neither of the LOS models used in this study address the conditions for bicyclists and pedestrians at intersections. Research to extend the LOS concept to intersections is currently under way; however, there is already a large knowledge base for designing intersections to better accommodate all road users including pedestrians, bicyclists, motorists and large vehicles. A number of simple factors such as the presence of crosswalks and crossing signals, the sensitivity of signal loop detectors to bicycles, lane configurations and other information could be collected for intersections to begin to identify and prioritize intersections in need of improvement.

Road Crossings and Barriers

Pedestrians often have few safe crossing opportunities, especially on high-speed, multi-lane highways. Information related to the locations and accessibility of road crossings would be very helpful to identify weak links for pedestrian travel.

Barriers such as interstate highways, waterways, and railroads are also important considerations that need special attention for both bicycle and pedestrian travel. Many modern freeway interchange designs with free-flowing merge lanes provide no safe crossing opportunities for bicyclists or pedestrians. In addition, bridges that span interstates, waterways or railroads may not have adequate pavement width to facilitate safe bicycling or sidewalks to facilitate walking. Railroad tracks that cross the road at an acute angle can also pose a serious threat to bicyclists by catching their front tire (see Figure 8). Identifying these barriers or hazards to bicycle and pedestrian travel could be part of the BP-LOS spatial database.

Figure 8: The railroad crossing on Wilson Ave intersects the road at a very sharp angle, making crossing by bicycle potentially hazardous.

Condition of Sidewalks

Although sidewalks along a roadside are taken into account in the PLOS model, their condition is not considered. Sidewalks that are in a poor state of repair or that have discontinuities can present a number of hazards and impediments to their users. Information related to sidewalk condition could be added to the BP-LOS database to prioritize improvement projects.

Figure 9: Sidewalks may become hazardous or inaccessible if not properly constructed and maintained. The sidewalk on Muhammad Ali Blvd at Southwestern Pkwy is cracked and becoming overgrown (right). New and old sections of sidewalk along Algonquin Pkwy do not line up (far right).

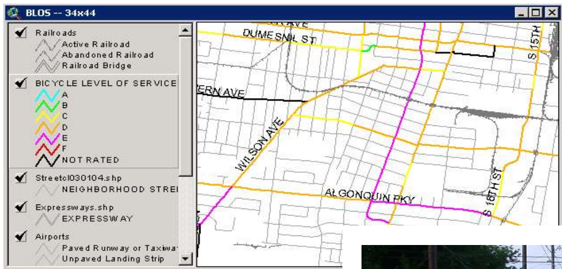
Roadside Profile

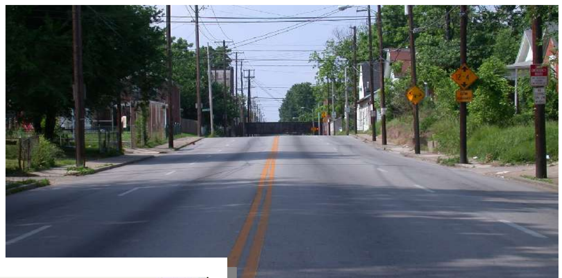
Information about the roadside profile is very helpful in determining the initial feasibility of minor road widening to incorporate sidewalks, paved shoulders, bicycle lanes or wide curb lanes into the existing right-of-way. Some studies have used a simple three-category rating to assess the roadside profile.* The ratings are illustrated in Table 13 with examples of Louisville Metro roads that fit each category.

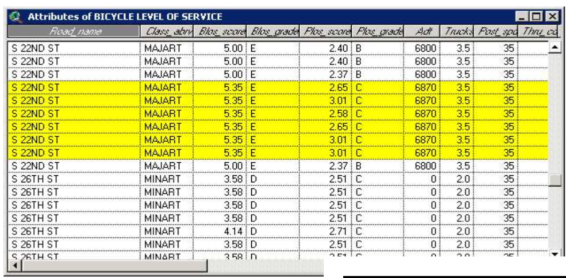
Table 13: A roadside profile rating can be used to quickly assess the initial feasibility of minor widening to improve bicycling or walking conditions.

		
Category 1: An unpaved shoulder already exists with few or no obstacles such as utility poles.	*Category 2: A narrow unpaved shoulder or gently sloping area exists with some obstacles present in the roadside.*	*Category 3: Severe constraints such as ditches, steep slopes and existing utilities would require a major construction effort for even minor widening.*

* *A Summary of the Bicycle Level of Service Model*, Toole Design Group, Roanoke Valley-Alleghany Regional Commission Bicycle Suitability Analysis Training, May 2003. http://www.rvarc.org/bike/blosdescription.pdf

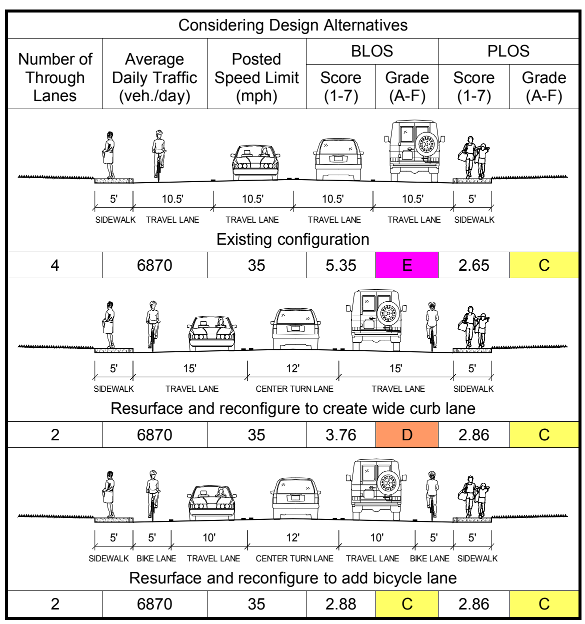






Attributes of BICYCLE LEVEL OF SERVICE

Road_name	Class_abrv	Blos_score	Blos_grade	Plos_score	Plos_grade	Adt	Trucks	Post_spd	Thru_ca
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.58	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	4.14	D	2.71	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	



Considering Design Alternatives

Number of Through Lanes	Average Daily Traffic (veh./day)	Posted Speed Limit (mph)	BLOS Score (1-7)	BLOS Grade (A-F)	PLOS Score (1-7)	PLOS Grade (A-F)
Existing configuration						
4	6870	35	5.35	E	2.65	C
Resurface and reconfigure to create wide curb lane						
2	6870	35	3.76	D	2.86	C
Resurface and reconfigure to add bicycle lane						
2	6870	35	2.88	C	2.86	C

Chapter 4

Data Analysis and Results

Computation and Mapping of Bicycle and Pedestrian LOS

To facilitate the computation of the bicycle and pedestrian LOS from the entries in the BP-LOS database, scripts were written for ArcView GIS software. The scripts were designed to handle the many different road configurations such as those with on-street parking, paved shoulders, curb and gutter, sidewalks or bicycle lanes with a single computation. Two buttons were added to the tool bar in the BP-LOS ArcView project to access these computational functions. More details on the computation of the bicycle and pedestrian LOS is presented in Appendix B.

Several intermediate calculations were performed for both the BLOS and PLOS computations to improve the clarity of the process. These intermediate calculations represent specific terms of the LOS models and are stored in their own attribute fields in the BP-LOS database. The database also contains a field to store the final computation of the BLOS and PLOS and to convert the calculated scores to the LOS grades A-F.

Approximately 16.4 percent of the total miles of arterial and collector roads in Louisville Metro were not rated due to missing traffic volume data. Most of the unrated roads are minor arterial and collector roads throughout the former Jefferson County jurisdiction. Many of the unrated roads pass through areas that are experiencing land development that may significantly increase motor vehicle volumes on roads that were constructed to serve primarily rural user's needs. Without question, development along such roads adversely affects both bicycling and walking conditions if no improvements are made to the road network. These unrated roads should be added to the database as traffic volume records become available.

The continuity of roads rated C or better is extremely poor making it difficult for bicyclists to find a comfortable route to many destinations.

The overall results of the bicycle and pedestrian LOS computations are shown in Figures 10 and 12. The percentage of road miles (out of a total of 877.2 arterial and collector road miles) in each LOS grade is shown in the charts along with the percentage of roads that were not rated. Figures 11 and 13 show the bicycle and pedestrian LOS results broken down by the four road classifications.

The BLOS and PLOS results were also mapped and are included in Appendix A as Maps 2 and 3. These maps show the arterial and collector road network and the expressway system for reference. Each road segment is color coded on the map based on its level of service rating from A-F. Larger maps with more detail, such as neighborhood streets, railroads and waterways, were also created in the BP-LOS ArcView project.

The maps are helpful for assessing the level of service on the road network as a whole. The BLOS map reveals that the continuity of roads rated C or better is extremely poor making it difficult for bicyclists to find a comfortable route to many destinations. The PLOS map reveals that the continuity of roads rated C or above is quite good in the urban core, but is very poor in the suburban and outlying areas, where many people are now living and working. This graphical representation of the LOS results helps identify weak links in the road network, where bicyclists and pedestrians may not have suitable options for reaching their destinations.

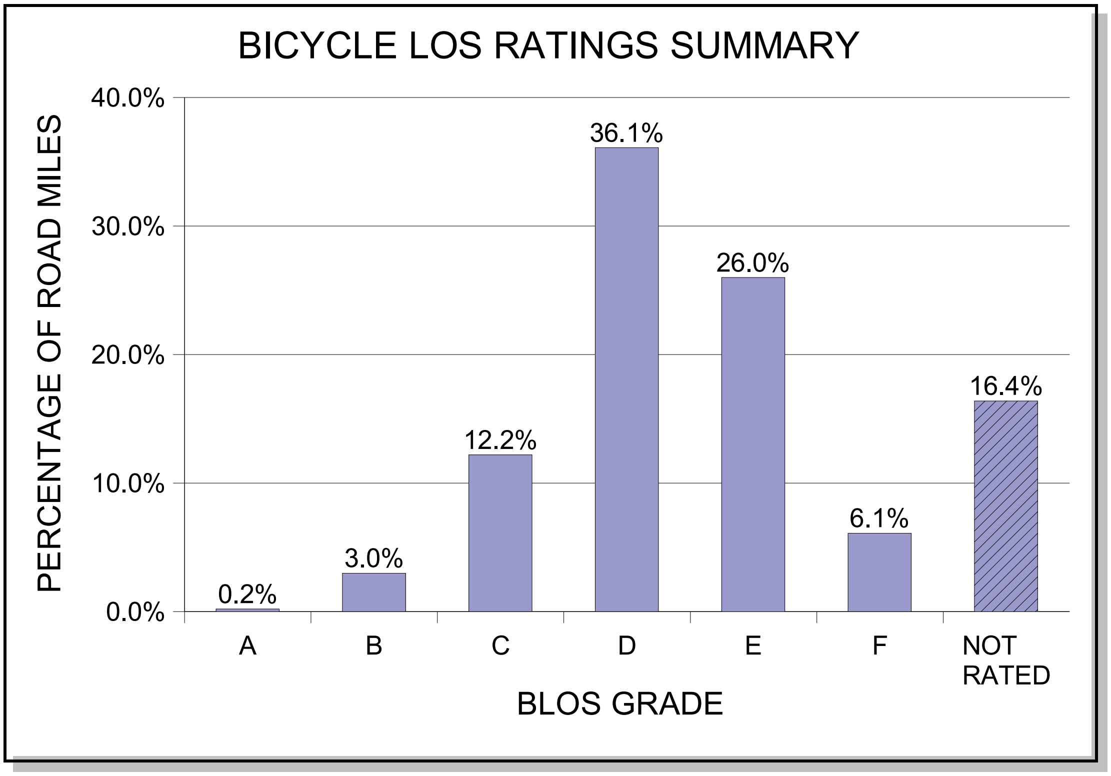


Figure 10: The Bicycle LOS ratings for Louisville Metro arterial and collector roads are summarized.

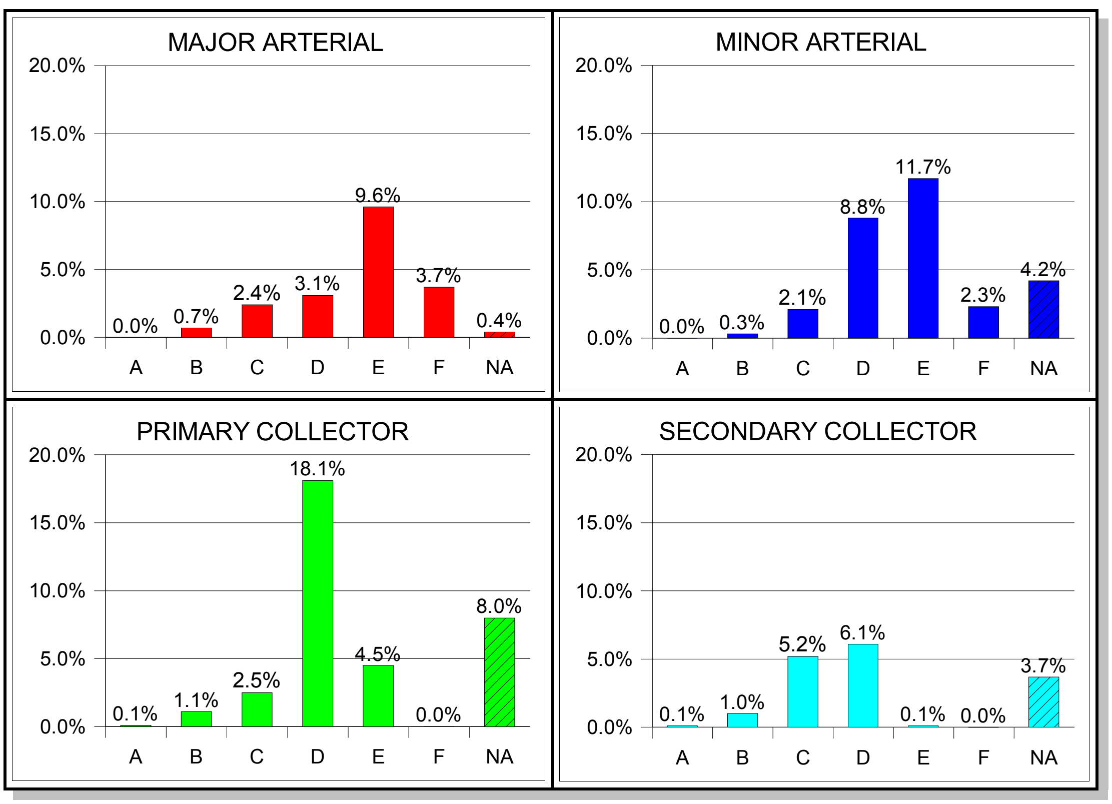


Figure 11: The Bicycle LOS results are broken down by road classification. The percentage of each BLOS grade for each road class out of the total road miles studied is shown in this series of charts.

Figure 12: The Pedestrian LOS ratings for Louisville Metro arterial and collector roads are summarized.

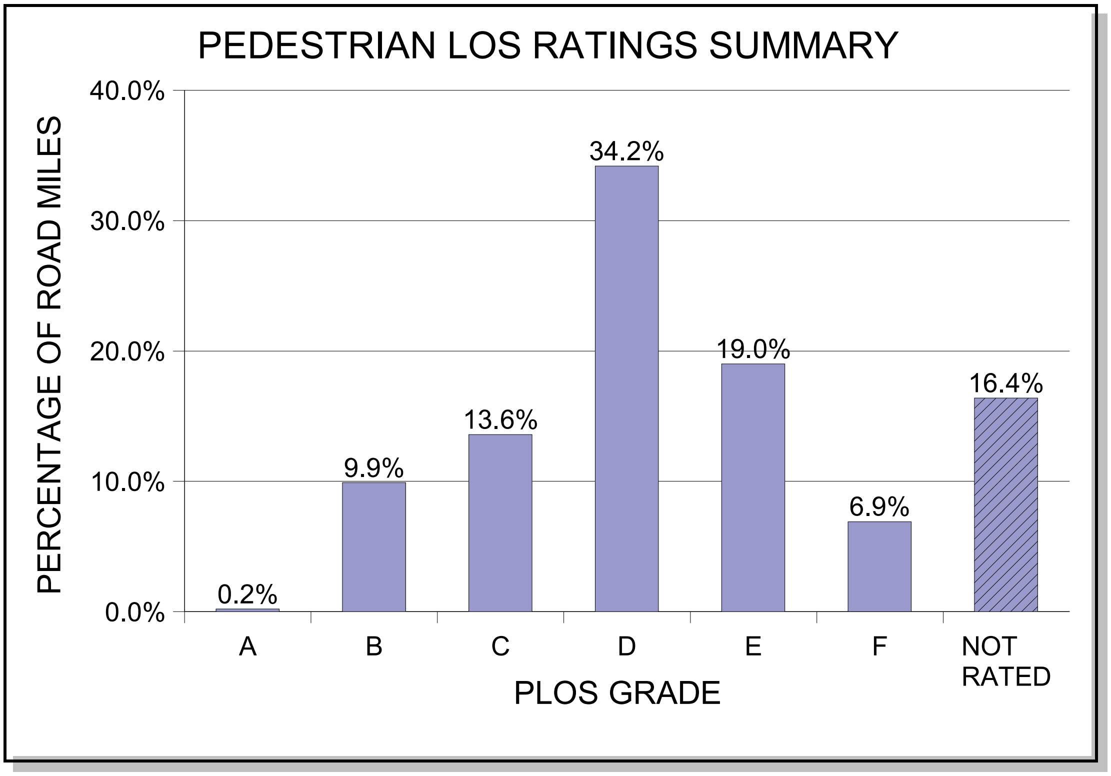
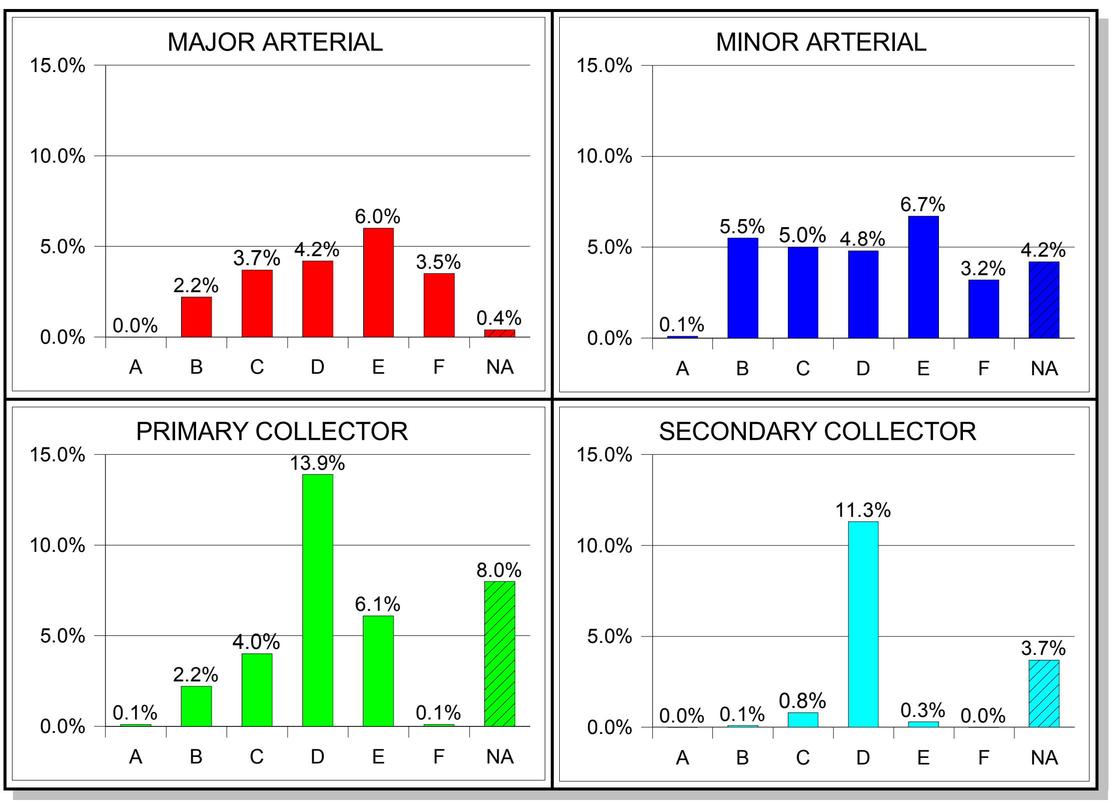


Figure 13: The Pedestrian LOS results are broken down by road classification. The percentage of each PLOS grade for each road class out of the total road miles studied is shown in this series of charts.



Discussion of Bicycle Level of Service Results

The BLOS results show that only about 15 percent of the rated road miles score C or better. The majority of road miles score D and E. These low ratings are generally a result of high traffic volumes and speeds on narrow travel lanes—conditions that create conflicts between bicyclists and motorists and result in an unnecessarily inconvenient and stressful bicycling experience. At peak travel times, only experienced bicyclists are likely to use these low-rated roads. Many of the lowest rated roads will be avoided entirely by bicyclists because of uncomfortable, stressful conditions and perceived risks. Table 14 shows several examples of Louisville Metro roads with their BLOS rating.

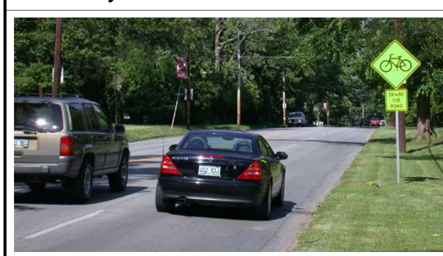
The BLOS results for each road functional classification (see Figure 11) demonstrate that arterial roads rate worse for bicycling than collector roads. Collector roads have very few F ratings and are centered on BLOS rating D, while arterial roads have a fair number of F ratings and are centered on BLOS rating E. This trend can be explained by the higher traffic volumes and speeds on arterial roads. In addition, the scale of multi-lane major arterial roads and barriers such as expressway interchanges and major intersections often create a daunting environment that make these roads particularly bad for bicycling. Unfortunately, many major arterial roads provide the only access to commercial, retail and employment centers, essentially cutting off much of the bicycle travel to those destinations. Table 14 shows a busy commercial segment of Dixie Hwy at Lower Hunters Trace, which received a BLOS rating of E.

The scale of multi-lane major arterial roads and barriers such as expressway inter-changes and major inter-sections often create a daunting environ-ment that make these roads particularly bad for bicycling.

Many collector roads were once quiet rural roads that have been adapted to serve growing suburban developments with few or no road improvements. This development pattern is a key factor in deteriorating conditions for bicycling throughout the outlying areas of Louisville Metro and tends to cut off bicyclists' access to the surrounding countryside. It is clear that land-use planning and transportation planning were not well coordinated in many cases and that everyone who travels in these areas suffers with the unsafe and inconvenient service the roads sometimes provide. Conditions for bicycling and walking become dramatically worse when narrow roads become heavily used by motor vehicles.

Beulah Church Rd just south of I-265 (see Table 14) provides access to a growing number of housing developments. Walking on this road is extremely challenging due to the uneven roadside, ditches and vegetation. At peak travel times, the steady stream of speeding vehicles passing through this area also makes walking very dangerous. Bicycling on this road is equally difficult. The nine-foot travel lanes and hilly topography make passing bicyclists at peak travel times nearly impossible. Bicyclists become obstacles to faster-moving motor vehicles and are subject to harassment. Just one mile east of Beulah Church Rd is Cedar Creek Rd, where housing developments are beginning to spring up. Cedar Creek Rd has even narrower eight-foot lanes but currently carries far less traffic, making it at least tolerable for bicycling and walking. If the intensity of land development continues increasing in this area, Cedar Creek Rd may become as difficult to navigate for bicyclists and pedestrians as Beulah Church Rd.

Table 14: Several examples of Louisville Metro roads with their corresponding BLOS ratings are shown.

 *S 6th St near W Woodlawn Ave*	 *N Chadwick Rd near Whipps Mill Rd*	**BLOS A**
 *S Floyd St near E Market St*	 *Browns Ln near Dutchmans Ln*	**BLOS B**
 *Dixie Hwy at Oak Park Dr*	 *Medora Rd at Blevins Gap Rd*	**BLOS C**
 *Baxter Ave near Goddard Ave*	 *Manslick Rd near Yakima St*	**BLOS D**
 *Dixie Hwy at Lower Hunters Trace*	 *Beulah Church Rd near Rocky Ln*	**BLOS E**
 *Brownsboro Rd near Zorn Ave*	 *Palatka Rd near Manslick Rd*	**BLOS F**

Discussion of Pedestrian Level of Service Results

The PLOS results are slightly better than the BLOS results with nearly 24 percent of road miles scoring C or better. As with the BLOS results, the majority of road miles score PLOS ratings of D and E. In general, only roads with pedestrian facilities and moderate traffic volumes and speeds score well. The central business district and many of the roads within the boundaries of the former City of Louisville score the highest PLOS ratings, while the suburban and outlying areas typically rate very poorly. It seems clear that the denser urban areas have more pedestrian-friendly design standards and road construction practices than the outlying areas and that the intensive suburban development throughout Louisville Metro has not generally provided suitable roads for walking. Table 15 shows several examples of Louisville Metro roads with their PLOS ratings.

The PLOS results for arterial roads (see Figure 13) show a fairly flat distribution of ratings while the collector road scores are centered on PLOS rating D. This trend can be explained by the widely varying conditions for pedestrians on arterial roads, from downtown streets with wide sidewalks to suburban highways with high-speed traffic and no sidewalks. Collectors generally do not have sidewalks and have lower traffic speeds and volumes resulting in a typical rating of D. Arterial roads in suburban and outlying areas of Louisville Metro generally rate much worse for walking than collector roads. The high traffic volumes and speeds and lack of sidewalks result in very poor PLOS ratings for many suburban arterials. These roads are also particularly dangerous and difficult to cross because of their large scale and high-speed traffic. Many of these roads provide the only access to major commercial, retail and employment centers. Even pedestrians who arrive by public transportation are forced to walk in unsafe or inconvenient places, where no connections are provided from bus stops to their destinations (see Figure 5).

Suburban development throughout Louisville Metro has not generally provided suitable roads for walking.

As housing and commercial developments have sprung up along roads intended to serve rural areas, pedestrian facilities such as sidewalks have not been added resulting in poor walking conditions. The commercial development along corridors such as Preston Hwy, Shelbyville Rd and Dixie Hwy often does not connect well to adjacent residential areas. For instance, some sections of Dixie Hwy were built with sidewalks, but few of the surrounding roads have sidewalks extending into residential areas, making walking to these destinations unnecessarily difficult. Figure 14 shows a segment of Lower Hunters Trace just a short distance from Dixie Hwy, where a sidewalk does not exist and pedestrians must walk on the roadside.

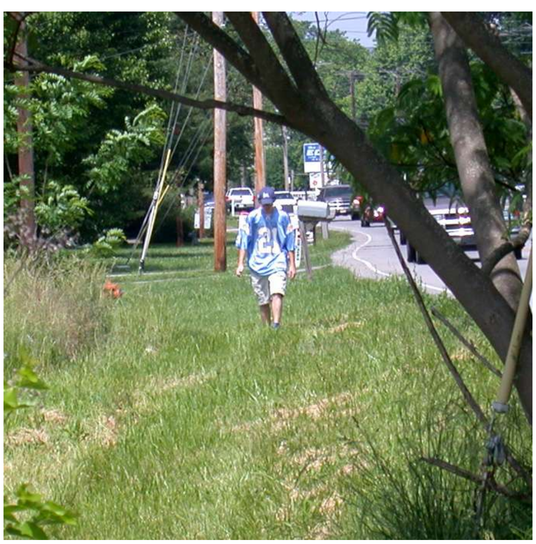
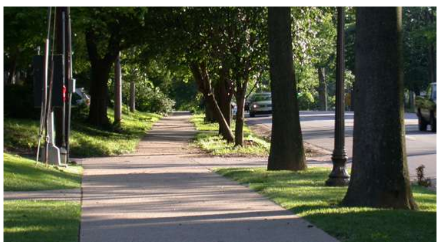


Figure 14: This segment of Lower Hunters Trace near Dixie Hwy does not have a sidewalk, forcing pedestrians to walk on the uneven roadside.

Table 15: Several examples of Louisville Metro roads with their corresponding PLOS ratings are shown.

 *N Shelby St at E Washington St*	 *Stony Brook Dr near Wooded Glen Rd*	**PLOS A**
 *W Muhammad Ali St near S 5th St*	 *Baxter Ave at Hepburn Ave*	**PLOS B**
 *Eastern Pkwy near Bardstown Rd*	 *Chenoweth Ln near Massie Ave*	**PLOS C**
 *Dixie Hwy at Lower Hunters Trace*	 *Cedar Creek Rd near Long Rifle Rd*	**PLOS D**
 *Lexington Rd near Spring St*	 *Brownsboro Rd at Country Ln*	**PLOS E**
 *Shelbyville Rd near Sage Rd*	 *3rd Street Rd near Wisertown Rd*	**PLOS F**

Sidewalk Coverage Analysis

A major factor in the PLOS model is the presence of a sidewalk. Information indicating the location of sidewalks along arterial and collector roads is needed for the PLOS computation, but this information can also be examined directly to see where there are gaps in pedestrian facilities and to help prioritize the retrofitting of suburban roads that were unfortunately not constructed with adequate facilities before the adjacent land was developed. The sidewalk coverage (see Map 4 in Appendix A) shows where sidewalks exist on Louisville Metro's arterial and collector roads. The records are sorted into four categories to show where there are complete sidewalks covering both sides of the entire road segment, a complete sidewalk on one side, partial sidewalks on one or both sides and no sidewalks on either side. The map clearly shows that the urban core has the greatest number of existing sidewalks. This map can be used to identify gaps in the existing sidewalk network and prioritize projects that will improve the continuity of walking facilities to provide better connections to the places people want to walk. Figure 15 summarizes these results revealing that roughly 61 percent of Louisville Metro arterial and collector roads are without sidewalks or have only partially constructed sidewalks, mostly in suburban and outlying areas. The sidewalks coverage results are also broken down by road classification as shown in Figure 16. These results clearly demonstrate that collector roads have a lower proportion of sidewalk coverage compared with arterial roads.

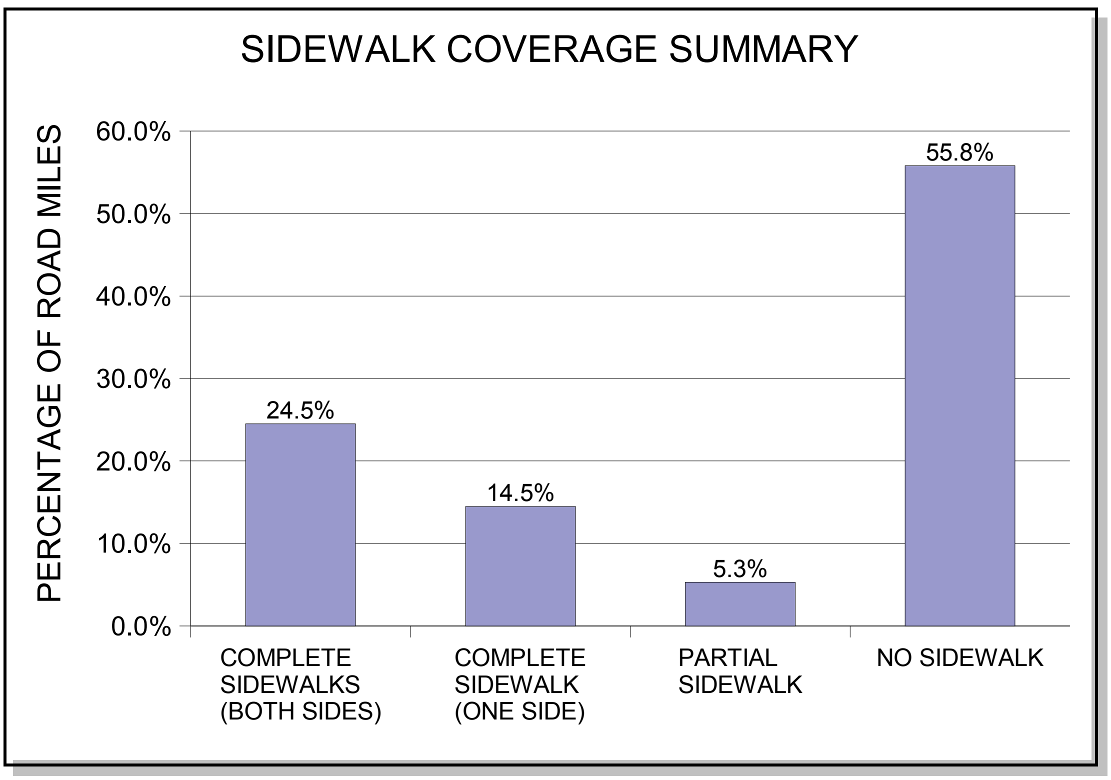
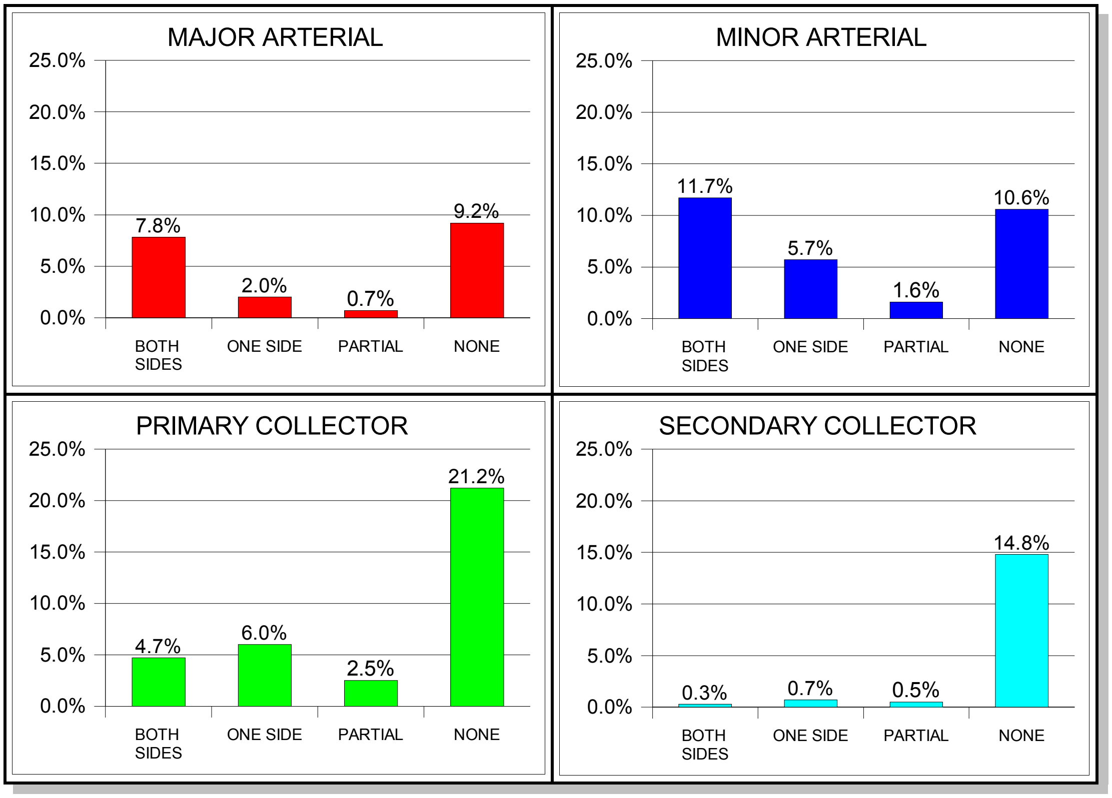


Figure 15: Approximately 39 percent of arterial and collector road miles are covered by sidewalks on one or both sides of the road.

Figure 16: The sidewalk coverage results are broken down by road classification.



Barriers Analysis

The level-of-service models provide a good overall snapshot of the conditions for bicycling and walking on the road network, but these analysis techniques do not take into account many of the barriers and hazards that affect an individual's choice to use non-motorized modes of travel. Freeways, bridges, railroads and other physical impediments can divide regions of a metropolitan area and make travel between them difficult or impossible for bicyclists and pedestrians. Creative solutions must be found to bridge these barriers and improve the continuity of non-motorized travel.

The barriers that exist throughout the Louisville Metro road network should be carefully inventoried and considered in the overall assessment of conditions for bicycling and walking. To begin this process, an analysis of locations where expressways intersect the road network was conducted. Some of these crossings and interchanges are difficult or impossible to traverse outside of a motor vehicle, such as the I-264 and Shelbyville Rd interchange, which has a number of free-flowing merge lanes.

Map 6 in Appendix A highlights the locations of all the expressway crossings and interchanges and indicates whether the crossings have pedestrian facilities and how many merge lanes are present. Merge lanes are particularly hazardous for bicyclists and pedestrians attempting to navigate an interchange when traffic volumes and speeds are high. Figure 17 shows the interchange at Shelbyville Rd, where multiple free-flowing lanes enter and exit from I-264. There is absolutely no safe crossing for pedestrians and bicycling through this interchange is treacherous with almost any level of traffic. The only feasible alternative for most people who do not have access to a motor vehicle is to catch a bus through this interchange. The nearest alternative crossings at Westport Rd and Browns Ln are both two miles or more away.

Figure 17: The interchange at Shelbyville Rd and I-264 has several free-flowing merge lanes that make walking and bicycling through it very dangerous. A barbed-wire fence is an added deterrent to pedestrians.

Roads with Potential to Improve Bicycling Conditions

Most of the existing urban and suburban roads throughout Louisville Metro were not designed with bicyclists in mind. In general, the arterial and collector roads with high traffic volumes are poorly suited for bicycle travel due to narrow lane widths. The inability of motorists to pass bicyclists safely while sharing the same lane causes conflicts that discourage many cyclists from using the roadway and creates an unnecessarily stressful environment for those experienced cyclists who do make use of arterial and collector roads. Providing wide curb lanes, paved shoulders or bicycle lanes helps facilitate passing of slower-moving vehicles while providing a much more welcoming space for cyclists to operate on the roadway.

Many communities have developed strategies for retrofitting existing roads to improve bicycling conditions. These strategies are listed in Table 16. Marking existing shoulders and restriping the roadway are the easiest and least expensive options. In many cases restriping to create wide curb lanes or bicycle lanes can be accomplished at almost no additional cost if done at the time of road resurfacing.

Table 16: There are three basic strategies for improving bicycling accommodations on existing roads.

- ✔ Mark and sign existing shoulders as bicycle lanes
- ✔ Physically widen roadways to create wide curb lanes, paved shoulders or bicycle lanes
- ✔ Restripe the existing roadway to create wide curb lanes or bicycle lanes

Three methods for reconfiguring a roadway to provide additional space for bicyclists are discussed in the following sections.

Method 1: Reduce the Lane Widths

Where space is available, it is sometimes possible to incorporate wide curb lanes or bicycle lanes into a roadway by reducing existing lane widths. Common design standards for lane widths are shown in Table 17.

Table 17: Road design standards generally dictate the preferred lane widths.

Lane Type	Lane Width (feet)
Travel Lane	12
Center Turn Lane	14
Bicycle Lane	6
Parking Lane	8

To better accommodate bicyclists on the roadway, most design guidance documents recommend a minimum width of 14 feet for wide curb lanes, 5 feet for bicycle lanes next to curbs or parking lanes and 4 feet for bicycle lanes on roads with open shoulders without parking. Many jurisdictions are now using striped parking lanes or Ts as narrow as 7 feet to further increase the amount of space on the roadway for bicyclists. Given these minimum widths for bicycle and parking accommodations, opportunities to squeeze wide curb lanes and bicycle lanes into existing roadways by reducing the width of travel lanes and center turn lanes or medians can be identified. The state of Oregon uses the guidelines shown in Table 18 to reduce travel lane widths to incorporate a wide curb lane or bicycle lane.* Chicago's Bike Lane Design Guide also uses 10-foot travel lanes, but the guide does not specify a design speed or maximum speed for these configurations.**

Speed Range (mph)	Travel Lane Width (feet)	Center Turn Lane Width (feet)
< 25	10-10.5	-
30-40	11	12
> 45	12†	14†

†General standards should be maintained if high volumes of truck traffic exist

Table 18: The state of Oregon has developed guidelines for reducing lane widths to provide more space for bicyclists on the roadway.

Figure 18 shows an example of how an existing road could better accommodate bicyclists by reducing some of the lanes widths to either create wide curb lanes or add bicycle lanes.

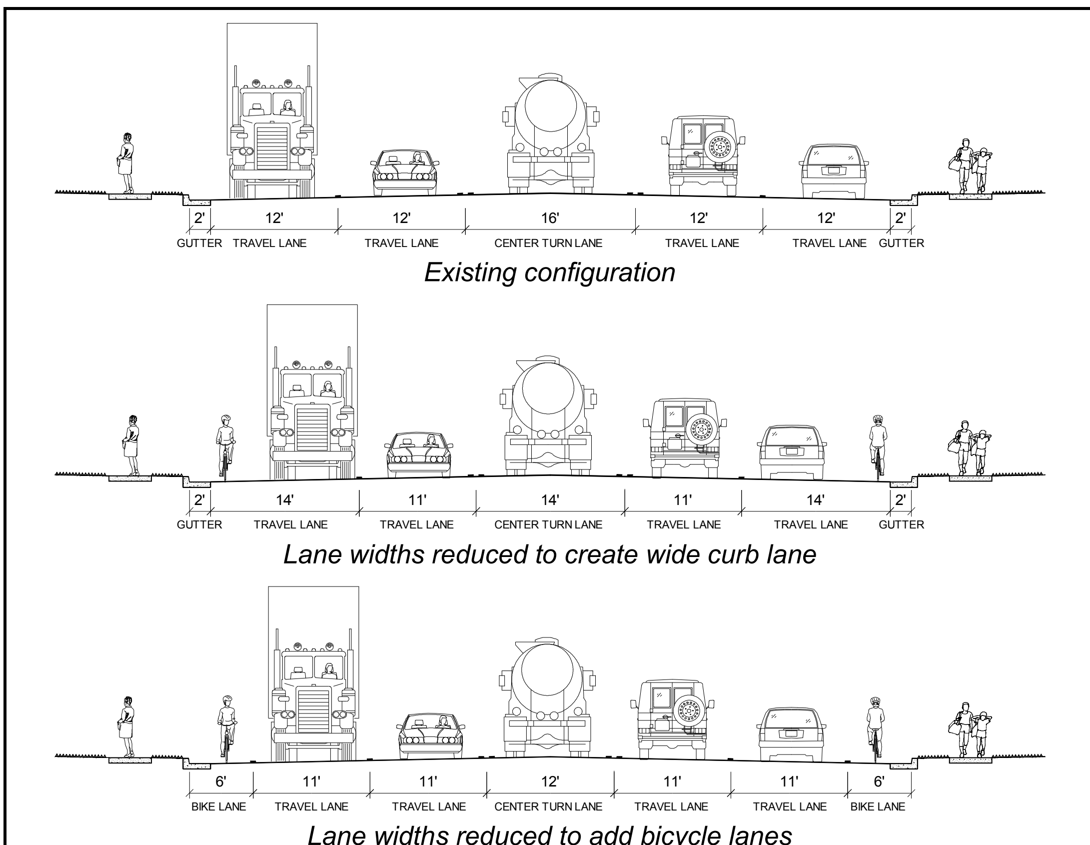


Figure 18: Turning and travel lane widths can often be reduced to provide more space for bicyclists on busy roadways. An existing five-lane road with a continuous center-left-turn lane is shown along with options for reducing lane widths to create 14-foot wide curb lanes or bicycle lanes.

* *Restriping Existing Roads with Bike Lanes*, Oregon Department of Transportation. http://www.odot.state.or.us/techserv/bikewalk/planimag/restripn.htm

** *Bike Lane Design Guide*, Pedestrian and Bicycle Information Center, City of Chicago, Chicagoland Bicycle Federation, 2002. http://www.bicyclinginfo.org/de/bikelaneguide.htm

Method 2: Reduce the Number of Travel Lanes

There may be circumstances where extra travel lanes exist or where reconfiguring the roadway may provide equal or greater service for motor vehicle users. Some one-way streets, for instance, were originally designed for two-way travel and may have excess travel lanes. Four-lane roads with significant left-turn volumes may be better suited to a two-lane configuration with a continuous center-left-turn lane. In both cases, the elimination of one or more travel lanes provides an opportunity to better accommodate bicyclists and pedestrians. Figure 19 illustrates how an existing one-way street with four narrow travel lanes could be converted to a three-lane street with a bicycle lane.

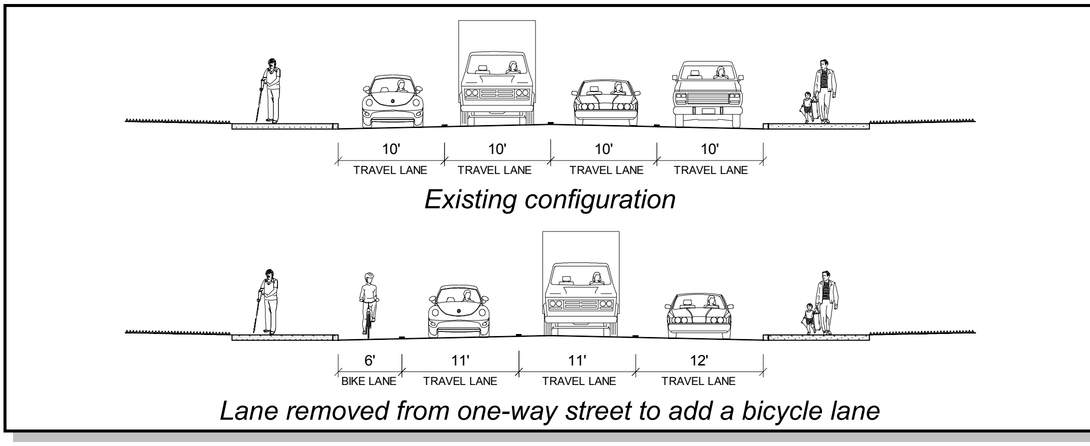


Figure 19: Excess travel lanes can sometimes be used to better accommodate bicyclists without a loss in motor vehicle level of service. One-way streets are often good candidates for conversion.

Some communities have converted four-lane roads with average daily traffic (ADT) volumes as high as 25,000 to three-lane roads with improved bicycle and pedestrian accommodations. Proponents of this strategy say that for ADTs up to 20,000 or even higher in some cases, the road can handle the same volume of traffic with fewer lanes and at lower speeds, improving safety and accessibility for all road users.* Figures 20 and 21 demonstrate how narrow four-lane roads can be converted to three-lane roads with a continuous center-left-turn lane and improved bicycling accommodations.

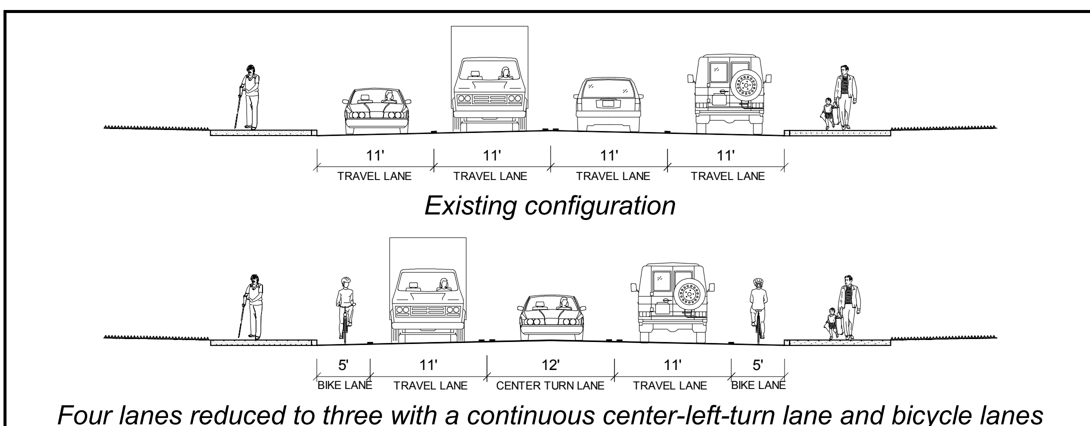
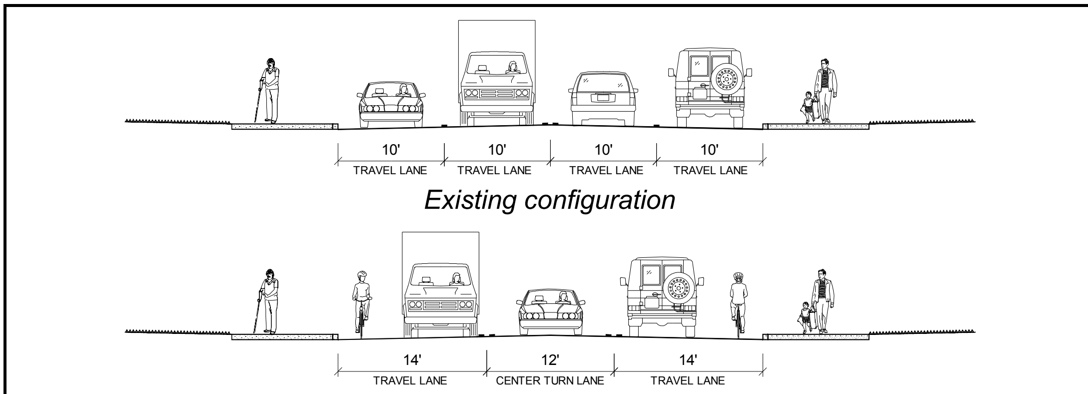


Figure 20: Converting four-lane roads to three lanes with a continuous center-left-turn lane can sometimes improve the conditions for motor vehicle traffic and provides space to better accommodate bicyclists.

* Dan Burden, Peter Lagerwey, *Road Diets: Fixing the Big Roads*, Walkable Communities, Inc., March 1999. http://www.walkable.org/download/rdiets.pdf

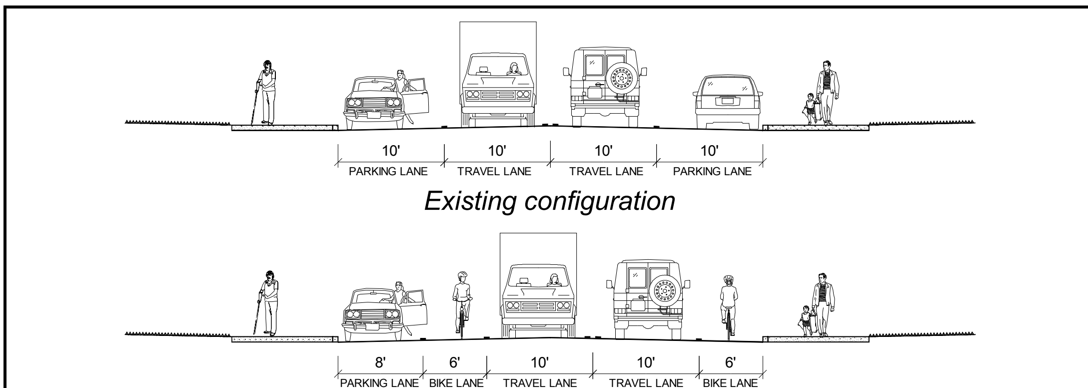


Four lanes reduced to three with a continuous center-left-turn lane and wide curb lanes

Figure 21: Even roads as narrow as 40 feet may benefit from conversion to three lanes, providing wide curb lanes that can better accommodate bicyclists.

Method 3: Reconsider the Need for On-Street Parking

On some roads, the on-street parking demand is quite small, and it may be possible to eliminate parking on one or both sides. If parking is localized near a particular business, it may also be possible to create parking bays outside the existing road width to accommodate the small demand for on-street parking. Figure 22 demonstrates how on-street parking can be adapted to better accommodate bicyclists on the roadway.



Parking removed from one side of street to add bicycle lanes

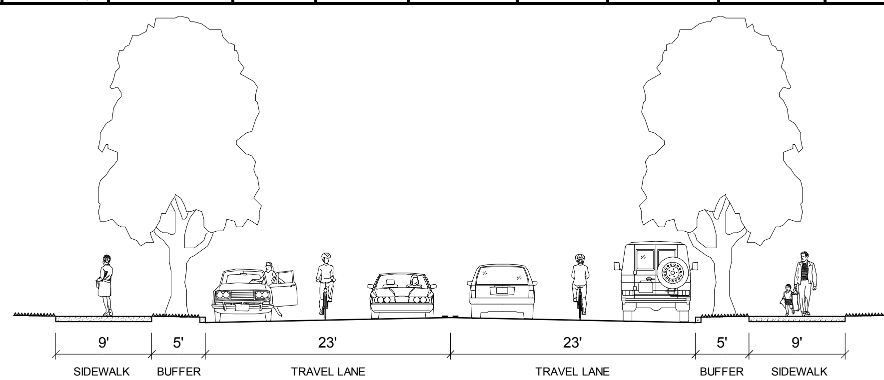
Figure 22: Where on-street parking demand is light, it may be possible to eliminate parking on one or both sides of the street.

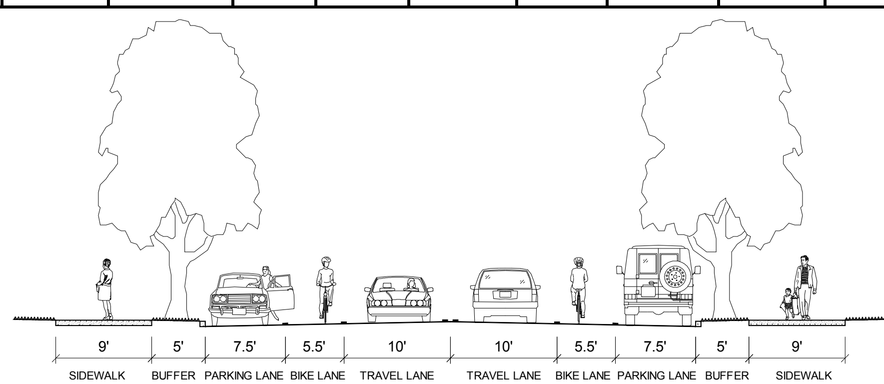
Identifying Louisville Metro Roads with Potential for Improvements

The information gathered in the BP-LOS database can be used to identify what opportunities exist to better accommodate bicyclists on existing Louisville Metro roads. Appendix C contains an extensive list of road segments that show some potential for improved bicycling accommodations through restriping, minor shoulder widening or marking existing shoulders. These road segments were identified by querying the BP-LOS database for roadways with sufficient pavement width to be reconfigured or with existing paved shoulders. The results of this analysis are represented graphically in Map 5 in Appendix A. This map shows 12 categories of road conditions in five groupings that have potential for improved bicycling accommodations. These categories are fully explained in Appendix C. All of the examples listed in Appendix C require more detailed study to determine the feasibility of improvements. Every effort was made to collect accurate geometric and operational information for the studied road segments using the LOJIC aerial imagery; however, accurate field measurements would be required for a more detailed study.

A number of illustrative examples of Louisville Metro roads that may benefit from restriping are shown in Tables 19 through 23. These examples are meant to illustrate how the restriping methods described above could be implemented on actual Louisville Metro roads, but they are not complete road designs. Wherever restriping is being considered as a method to improve bicycling accommodations, a thorough engineering study should be performed, public involvement should be sought (especially when considering the need for on-street parking) and the project should be carefully considered as part of a continuous bicycling network. In addition, if bicycle lanes will be added as part of a restriping project, efforts should be made to educate motor vehicle operators, bicyclists and local officials about where the lanes will be installed and how they are intended to function.

Table 19: This segment of Frankfort Ave may benefit from restriping to add bicycle lanes.

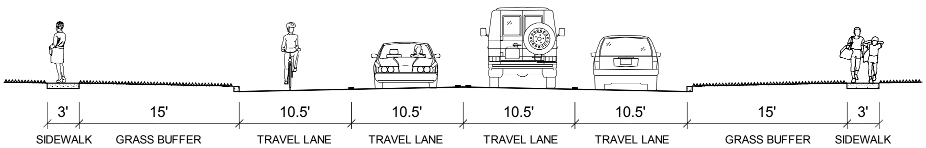
<table>
<tr><th rowspan="2">Number of Through Lanes</th><th colspan="2">Traffic Data</th><th rowspan="2">Posted Speed Limit (mph)</th><th colspan="3">Width of Pavement</th><th rowspan="2">Occupied On-Street Parking (%)</th><th rowspan="2">Pavement Condition (1-5)</th><th colspan="2">BLOS</th></tr>
<tr><th>Average Daily Traffic (veh./day)</th><th>Estimated Percentage of Trucks (%)</th><th>Outside Lane Width (ft)</th><th>Shoulder or Bicycle Lane Width (ft)</th><th>Parking Lane Width (ft)</th><th>Score (1-7)</th><th>Grade (A-F)</th></tr>
<tr><td colspan="11">

Frankfort Ave (Mellwood Ave to Haldeman Ave): current configuration</td></tr>
<tr><td>2</td><td>9470</td><td>3.5</td><td>35</td><td>23</td><td>0</td><td>0</td><td>75</td><td>3</td><td>4.19</td><td>D</td></tr>
<tr><td colspan="11">

Improvement example: add separate parking and bicycle lanes to roadway</td></tr>
<tr><td>2</td><td>9470</td><td>3.5</td><td>35</td><td>10</td><td>5.5</td><td>7.5</td><td>75</td><td>3</td><td>3.18</td><td>C</td></tr>
</table>

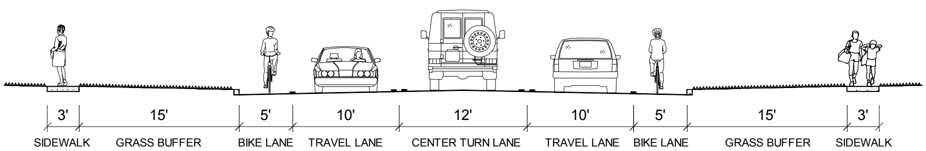
Table 20: Reconfiguring this segment of Algonquin Pkwy could provide space for bicycle lanes.

Number of Through Lanes	Traffic Data		Posted Speed Limit (mph)	Width of Pavement			Occupied On-Street Parking (%)	Pavement Condition (1-5)	BLOS	
	Average Daily Traffic (veh./day)	Estimated Percentage of Trucks (%)		Outside Lane Width (ft)	Shoulder or Bicycle Lane Width (ft)	Parking Lane Width (ft)			Score (1-7)	Grade (A-F)



Algonquin Pkwy (Dixie Hwy to S 39th St): current configuration

4	9880	2	35	10.5	0	0	0	3	4.20	D

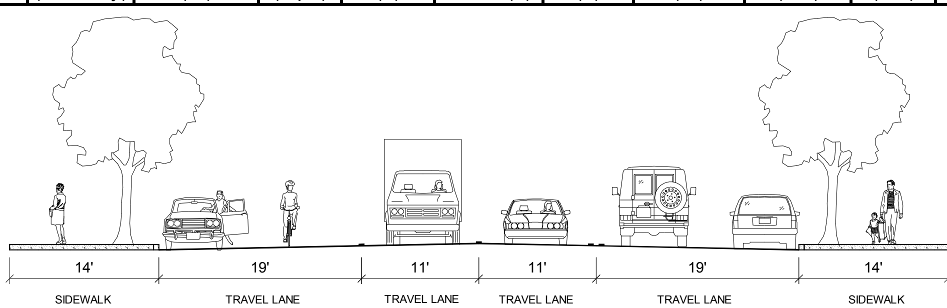


Improvement example: reconfigure from four to three lanes to add bicycle lanes

2	9880	2	35	10	5	0	0	3	3.10	C

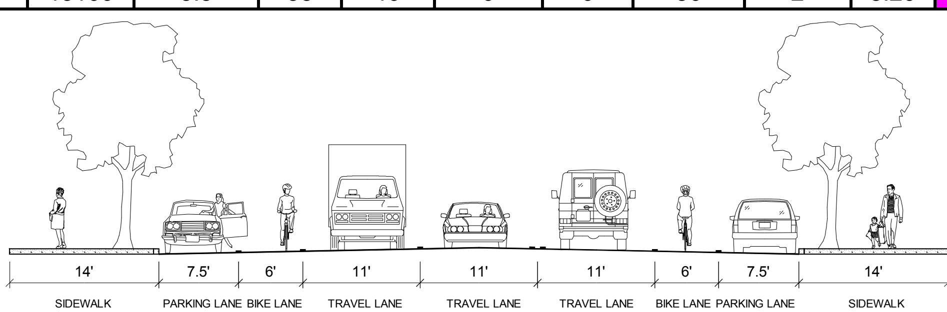
Table 21: Removing one eastbound travel lane from E Market St could provide space for provide space for bicycle lanes.

Number of Through Lanes	Traffic Data		Posted Speed Limit (mph)	Width of Pavement			Occupied On-Street Parking (%)	Pavement Condition (1-5)	BLOS	
	Average Daily Traffic (veh./day)	Estimated Percentage of Trucks (%)		Outside Lane Width (ft)	Shoulder or Bicycle Lane Width (ft)	Parking Lane Width (ft)			Score (1-7)	Grade (A-F)



E Market St (S Hancock St to S Shelby St): current configuration

4	13100	3.5	35	19	0	0	50	2	5.20	E



Improvement example: remove one eastbound travel lane to add bicycle lanes

3	13100	3.5	35	11	6	7.5	50	2	2.41	B

Table 22: Minor widening of Pee Wee Reese Rd could provide 5-foot paved shoulders to better accommodate bicyclists.

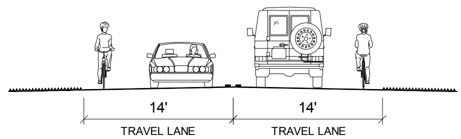
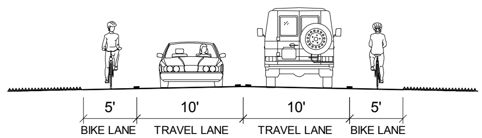
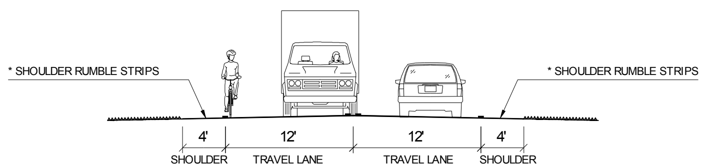
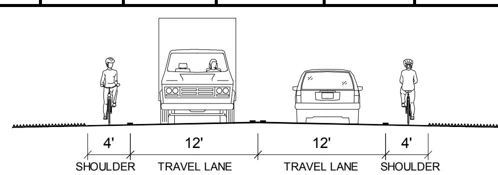
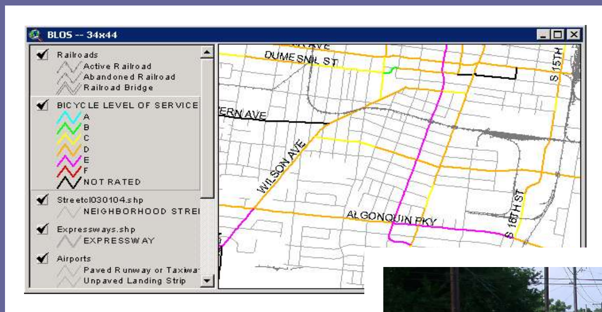
Number of Through Lanes	Traffic Data: Average Daily Traffic (veh./day)	Traffic Data: Estimated Percentage of Trucks (%)	Posted Speed Limit (mph)	Width of Pavement: Outside Lane Width (ft)	Width of Pavement: Shoulder or Bicycle Lane Width (ft)	Width of Pavement: Parking Lane Width (ft)	Occupied On-Street Parking (%)	Pavement Condition (1-5)	BLOS: Score (1-7)	BLOS: Grade (A-F)
 *Pee Wee Reese Rd (Taylorsville Rd to Seneca Park Rd): current configuration*										
2	5850	1.5	25	14	0	0	0	3	3.44	C
 *Improvement example: minor road widening to create paved shoulder/bicycle lanes*										
2	5850	1.5	25	10	5	0	0	3	2.42	B

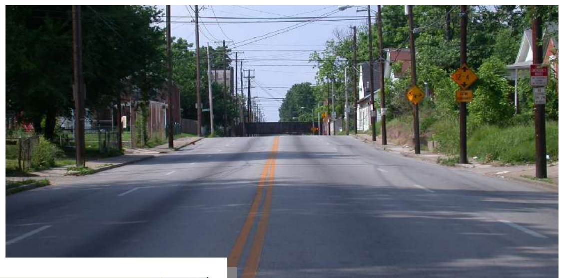
Table 23: Removal of shoulder rumble strips from Terry Rd would create a useable 4-foot shoulder to accommodate bicyclists.

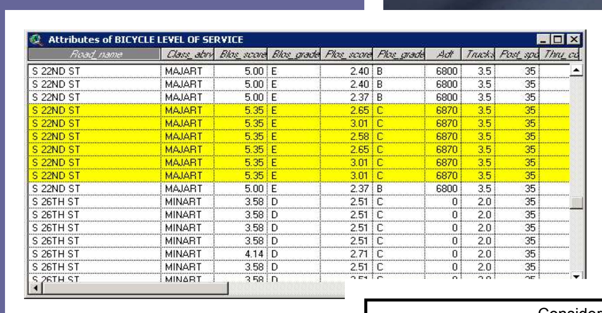
Number of Through Lanes	Traffic Data: Average Daily Traffic (veh./day)	Traffic Data: Estimated Percentage of Trucks (%)	Posted Speed Limit (mph)	Width of Pavement: Outside Lane Width (ft)	Width of Pavement: Shoulder or Bicycle Lane Width (ft)	Width of Pavement: Parking Lane Width (ft)	Occupied On-Street Parking (%)	Pavement Condition (1-5)	BLOS: Score (1-7)	BLOS: Grade (A-F)
 *Terry Rd (Cane Run Rd to Greenwood Rd): current configuration*										
2	13200	2	45	12	4*	0	0	3	4.70	E
 *Improvement example: resurface and eliminate shoulder rumble strips*										
2	13200	2	45	12	4	0	0	5	2.91	C

Limitations of Bicycle and Pedestrian LOS Models

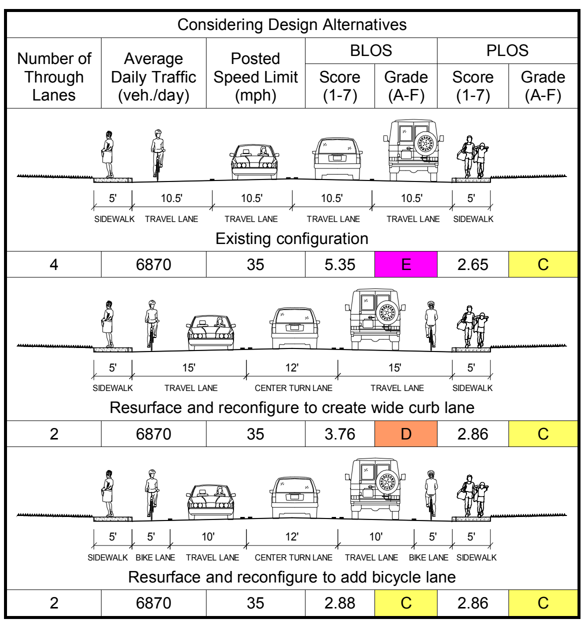
Although the bicycle and pedestrian level-of-service models are a useful tool for understanding the bicycling and walking conditions on Louisville Metro roads, they have limitations that should be noted. In general, these LOS methodologies are useful as a system-wide indicator of conditions for bicycling and walking and can be used to consider design alternatives for specific road projects, but they do not provide a complete assessment of the walking and bicycling environment. In particular, the models do not consider conditions at intersections, where many of the potential conflicts between different road users occur. The models also do not incorporate information about the context of the surrounding land, safety issues or public input about desired facilities. Public involvement and careful, detailed design and planning work for any proposed roadway project are essential to address these important issues. The LOS models are most effective when incorporated into a comprehensive planning and design effort that also considers the adjacent land uses, the long-term mobility goals of the community and input from citizens.






Attributes of BICYCLE LEVEL OF SERVICE

Road_name	Class_abrv	Blos_score	Blos_grade	Plos_score	Plos_grade	Adt	Trucks	Post_spd	Thru_ca
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.40	B	6800	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.58	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	2.65	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.35	E	3.01	C	6870	3.5	35	
S 22ND ST	MAJART	5.00	E	2.37	B	6800	3.5	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	4.14	D	2.71	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	2.51	C	0	2.0	35	
S 26TH ST	MINART	3.58	D	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	



Chapter 5

Recommendations

Uses and Outcomes of Study

The data collected for this study and the resulting maps and analyses have a number of potential uses for planning and implementing improvements to the existing road network to better accommodate bicyclists and pedestrians. The following section highlights a few of the possibilities for building on the results of this study.

Bicycle and Pedestrian Planning

Comprehensive bicycle and pedestrian planning to improve the bicycling and walking conditions throughout a community is a complex, evolving process. Many tools and approaches have been developed in recent years to support and promote bicycling and walking at a level that captures the many benefits of these travel modes at the local level. This study focuses on the suitability of the existing road network for bicycling and walking. With an overall picture of road suitability, planners, engineers, advocates, citizens and public officials have an additional tool to identify and prioritize roads in need of improvement for non-motorized travel. The level-of-service results and maps produced in this study can be combined with other tools and techniques such as bicycle and pedestrian counts, demand forecasts, crash statistics, land-use plans and neighborhood plans to develop comprehensive strategies to improve bicycle and pedestrian facilities on Louisville Metro roads.

Benchmarking and Tracking Progress

The results of this study can be used as a benchmark to track improvements to bicycling and walking conditions on the road network as a whole. The goals could be to shift the average level of service for bicyclists and pedestrians from D to C and to prevent worsening of conditions where land development is resulting in increased volumes of motor vehicle traffic. The charts in Figures 10 through 13 show a current snapshot of the suitability of arterial and collector roads for bicycle and pedestrian travel. Charting the progress of Louisville Metro road improvements could be accomplished by periodically updating the bicycle and pedestrian database as changes to the road network are made.

Updating and Maintaining the Bicycle and Pedestrian Information Database

It is highly recommended that the bicycle and pedestrian database be adopted by a local agency to be maintained and updated periodically for use in long-term planning and for tracking the progress toward road improvements. Records for road construction, resurfacing and sidewalk construction could be used to periodically update the database to better reflect the current geometric conditions of the studied roadways. Updated traffic volume, speed limit and pavement surface condition records could also be incorporated into the database as they become available. Mapping and analyzing the updated information every few years will provide a means to track changes and trends in the suitability of the road network for bicycle and pedestrian travel. This information can help shape transportation planning and policy to allocate limited bicycle and pedestrian resources where they are needed most.

There are a number of arterial and collector road segments that could not be assigned an LOS score due to missing traffic volume data. Many of these roads are in outlying areas of the county, where land development is increasing and is sure to worsen conditions for walking and bicycling due to increased volumes of motor vehicle traffic. Missing traffic volumes should be added to the database as they become available to track the changing conditions for non-motorized travel where new suburban growth is occurring.

Incorporating crash statistics, bicycle and pedestrian counts, destination and origin data and other information into the bicycle and pedestrian database will also allow for a more complete understanding of how the overall multi-modal transportation network functions. Much of this information can be quickly and effectively searched and analyzed using GIS tools and maps. By merging and building on the existing databases, it will be easier to prioritize projects that have the greatest potential benefit for the community.

Actions for Improving Bicycle and Pedestrian Facilities

Many components go into improving the overall safety, convenience and accessibility of the road network for bicyclists and pedestrians. As discussed in Chapter 1, educating all users on their roles and responsibilities to safely share a road is one of the most important actions that must be taken. Equitable enforcement of traffic laws and promotion of bicycling and walking as healthful, viable modes of transportation and recreation are also important pieces of the overall picture. This study focuses on the suitability of existing roads for facilitating bicycling and walking—the engineering aspect of non-motorized travel. The results indicate that much improvement is needed on many Louisville Metro roads to provide accommodations that people will consider as real options for bicycling and walking. Many communities have begun the challenging work of retrofitting their road network to create a more complete and inclusive transportation system that serves all users no matter how they choose to travel. By bringing together citizens, engineers, planners, advocacy groups and public officials to address these challenging issues, everyone is beginning to understand the mutual benefits of a safe, convenient, accessible, multi-modal transportation network. The following sections describe some of the specific actions that are necessary for better bicycling and walking facilities on Louisville Metro roads.

Improve the Existing Road Network

Chapter 4 discusses a number of opportunities to improve bicycling accommodations by restriping existing roadways, through minor shoulder widening and by marking existing roads and shoulders for bicycle use. Appendix C contains an extensive listing of roads that are potential candidates for these cost effective strategies (see also Map 5 in Appendix A). The sidewalk coverage analysis (see Map 4 in Appendix A) provides an additional tool to identify gaps in sidewalks that could be filled as resources become available. These are good starting points for improvements to bicycling and walking accommodations on arterial and collector roads, but many roads have constraints that will require more creative solutions and compromises to better accommodate all users. Some busy Louisville Metro roads are already highly congested at times and have physical constraints such as existing structures that would prohibit widening to provide better bicycling and walking accommodations. Meeting these challenging constraints with a coordinated planning effort involving citizens, planners, engineers and public officials, and matching this planning effort with substantial funding to construct the needed bicycle and pedestrian facilities is the only way Louisville Metro will make significant progress toward improving bicycling and walking accommodations on its road network.

Routinely Accommodate Bicyclists and Pedestrians on New Roads and in Road Reconstruction Projects

When new roads are designed or when existing roads undergo redesign and reconstruction, bicyclists and pedestrians must be routinely considered in the planning, design, construction and maintenance of the road. The Kentucky Transportation Cabinet instituted a bicycle and pedestrian policy in July 2002 that recognizes the importance of bicycling and walking and the need to construct the necessary facilities as part of road projects.* The policy states that with few exceptions:

> The Kentucky Transportation Cabinet (KYTC) will consider the incorporation of pedestrian facilities on all new or reconstructed state-maintained roadways in existing and planned urban and suburban areas.

and that:

> The Kentucky Transportation Cabinet (KYTC) will consider the accommodation of bicycles on all new or reconstructed state-maintained roadways. KYTC will also consider accommodating bicycle transportation when planning the resurfacing of roadways, including shoulders.

This state policy is a very important step toward supporting bicycle and pedestrian travel through construction of needed facilities. Although a fair number of roads in Jefferson County are state-maintained, the majority of roads are maintained by local agencies. Louisville Metro needs to institute its own policy to ensure that bicycle and pedestrian accommodations are routinely considered as part of road projects.

Even though some progress is being made through policy changes, bicycle and pedestrian issues may remain in the margins of the design and planning process by being considered as separate plans, and having separate design standards and procedures. This separation allows the plans to be overlooked when policy makers decide how to allocate limited funding and when engineers and designers begin their effort of designing roads. According to a report published by the Federal Highway Administration, jurisdictions that fully incorporate bicycle and pedestrian planning into their overall transportation planning efforts and include bicycle and pedestrian design standards within their road design manuals will have the greatest success at implementing their plans and constructing the needed bicycle and pedestrian facilities.** Changes in transportation policy that promote and support bicycle and pedestrian travel need to be met with changes in road design, construction and maintenance practice.

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* *Pedestrian and Bicycle Travel Policy*, Commonwealth of Kentucky Transportation Cabinet, July 2002.

** Bicycle and Pedestrian Planning Under the Intermodal Surface Transportation Efficiency Act (ISTEA): A Synthesis of the State of the Practice, Federal Highway Administration, FHWA-PD-97-053, July 1997.

Follow Appropriate Design Guidance

In the past few decades, a wealth of practical design guidance has been developed for on-road bicycle and pedestrian facilities. This information is readily available from federal and state agencies and national organizations such as the Pedestrian and Bicycle Information Center and the National Center for Walking and Bicycling. These tools can help Louisville Metro build local expertise in bicycle and pedestrian facility design, operation and maintenance.

The Metropolitan Louisville Bicycle and Pedestrian Advisory Committee (BPAC) currently has a standing subcommittee that reviews design guidance documents for on-road bicycle facilities. This committee has amassed a wealth of useful information on appropriate design guidance. The committee is currently waiting to examine the revised highway design manual that is under development by the Kentucky Transportation Cabinet before making its final recommendations on design guidance to Louisville Metro.

After adopting suitable on-road bicycle and pedestrian facility design standards, Louisville Metro must make its standards clear to the engineering firms that design new roads and hold these firms accountable for incorporating bicycle and pedestrian accommodations as a routine element of road projects.

Concluding Remarks

Despite the challenges and risks, there are many Louisvillians who frequently choose bicycling and walking for recreation and transportation. These citizens experience the benefits and joy of non-motorized travel in a city dominated by automobile transportation. Their choices result in tangible benefits for the entire community and must be routinely supported, promoted and celebrated to encourage more people to discover the benefits for themselves. Adequately funding improvements for bicycling and walking accommodations on Louisville Metro roads must be part of this support to capture the greatest benefit for the community.

Bicycling and walking are just one aspect of a much broader issue of how we choose to inhabit the land. A long-term strategy for living sustainably and restoring the living systems that are critical to all human activity will almost certainly involve major changes in the way people use land and travel in cities. Much of this effort may involve retrofitting existing developed areas to reduce our dependence on costly modes of transportation and to create healthful, vibrant communities and town centers. Bicycling and walking for transportation and recreation will play important roles in this redevelopment of our cities. Louisville Metro, like many other American cities, is poised ready to reinvent itself over the next several decades. This study is one small step toward a positive vision of the future for all Louisvillians, no matter how they choose to travel.

Appendix A: Maps

The following table describes 6 maps contained in this Appendix. The maps are printed in 11 inch by 17 inch format to be included directly in this report. Additional maps in 34 inch by 44 inch format were also created and can be found as ArcView layouts in the included data files.

MAP 1	***LOUISVILLE METRO ARTERIAL AND COLLECTOR ROADS (CLASS DESIGNATIONS)***
	This map shows the arterial and collector road network. Each functional class (major arterial, minor arterial, primary collector and secondary collector) is shown with a different color. These roads represent the studied road network.
MAP 2	***LOUISVILLE METRO SUITABILITY INDEX FOR BICYCLE TRAVEL (ARTERIAL AND COLLECTOR ROADS)***
	This map shows the results of the Bicycle Level of Service (BLOS) computation. Each arterial and collector road segment in the bicycle and pedestrian level-of-service (BP-LOS) database is shown with a color representing its BLOS grade A-F. The road segments that could not be rated due to missing traffic volume data are shown in gray.
MAP 3	***LOUISVILLE METRO SUITABILITY INDEX FOR PEDESTRIAN TRAVEL (ARTERIAL AND COLLECTOR ROADS)***
	This map shows the results of the Pedestrian Level of Service (PLOS) computation. Each arterial and collector road segment in the bicycle and pedestrian level-of-service (BP-LOS) database is shown with a color representing its PLOS grade A-F. The road segments that could not be rated due to missing traffic volume data are shown in gray.
MAP 4	***LOUISVILLE METRO SIDEWALK COVERAGE (ARTERIAL AND COLLECTOR ROADS)***
	This map shows where sidewalks exist on the arterial and collector road network. Each road segment is represented with a different color depending on whether it has complete sidewalks covering both sides of the road, a complete sidewalk on one side, partial sidewalks on either side of the road, or no sidewalks.
MAP 5	***OPPORTUNITIES TO IMPROVE BICYCING ACCOMMODATIONS (ARTERIAL AND COLLECTOR ROADS)***
	This map shows several categories of roads that may have potential for improved bicycling accommodations through restriping the roadway, minor shoulder widening or marking existing shoulders for bicycle use. These categories are explained further in Appendix C.
MAP 6	***LOUISVILLE METRO BICYCLE AND PEDESTRIAN BARRIERS (EXPRESSWAY CROSSINGS)***
	This map shows all of the crossing opportunities along the expressway system, including pedestrian, road and trail crossings. The map also shows whether a pedestrian facility (sidewalk or path) is present. For roads with expressway interchanges, the number of merge lanes entering and exiting the road are shown as an indicator of how challenging the crossing is for bicyclists and pedestrians.

Appendix B: Bicycle and Pedestrian Database

The BP-LOS database is a polyline shapefile created in ArcView GIS software to store spatial data related to bicycling and walking on Louisville Metro's arterial and collector road network. The database was created from the street centerlines database maintained by Metro Public Works. Of the more than 30,000 road segments in the STREETCL database, 6,265 segments representing the arterial and collector roads were selected for inclusion in the BP-LOS database. Map 1 in Appendix A shows these road segments and their four classifications (major arterial, minor arterial, primary collector and secondary collector). There were a few changes made to the base entries carried over from the LOJIC STREETCL database. Some road segments were likely designated with the wrong functional classification or had geometry that did not agree with the current aerial imagery. In most cases, it was apparent that road changes had been made recently that were still not reflected in the street centerlines database. By joining the BP-LOS and STREETCL attribute tables, these discrepancies become clear.

BP-LOS Attribute Fields

The following list provides a detailed description of each of the 31 attribute fields that were added to the STREETCL database to create the BP-LOS database.

ADT

<u>Description</u>: Average daily traffic along road segment.

<u>Format</u>: number <u>Range</u>: 80 - 67,800 (ADT)

<u>Data Source</u>: The KYTC Highway Information System (HIS) contained traffic volume counts for most of the state-maintained roads. Most of these counts were fairly recent at the time of the study. Metro Public Works also had some ADT records available for the urban streets that were part of the former City of Louisville and for Jefferson County roads. The counts for the county and city were often older than the state data, but very few were dated before 1998. After incorporating this information, there were still no ADT records available for over 20% of the arterial and collector road miles. The spatial databases from KYTC and Metro Public Works did not have the same road segments as the STREETCL database that was used as a basis for this study. This difference made the incorporation of the data somewhat challenging. In order to perform a spatial join of the ADT and BP-LOS databases, the ADT polyline shapefiles were converted to polygon shapefiles with 100-foot buffers around the original polyline geometry. These polygon buffers provided a much greater tolerance for the spatial join operation. After the join was performed, a number of segments that did not match or that received erroneous matches were manually adjusted.

<u>Uses</u>: The volume of motor vehicle traffic along a road is a significant factor in how bicyclists and pedestrians perceive the roadway. Both the BLOS and PLOS models use the traffic volume in the outside travel lane to assess the suitability of the road for bicycling and walking (see *ADT* in Tables 4 and 7).

<u>Data Accuracy</u>: The accuracy of the traffic volume information from KYTC and Metro Public Works depends on the age of the data, the collection and reporting procedure and how the records from specific count stations were converted to data for entire road segments. These traffic volume records are rough assessments of the relative levels of motor vehicle traffic on Louisville Metro roads. They are not highly accurate numbers, but they are well suited for rating and comparing the level of service for bicyclists and pedestrians on various roads.

<u>Notes</u>: Any road segment for which no traffic volume records exist is designated in the BP-LOS database by a -1 entry in the ADT field.

VOL60

Description: Peak hour traffic volume during 12-hour count.

Format: number Range: 36 - 2636 (vehicles per hour)

Data Source: Some of the traffic volume records available from Metro Public Works were reported as peak hour volumes rather than ADT. For the purposes of the BLOS and PLOS models, the peak hour volume counts are actually closer to the desired format than the ADT values (see BLOS and PLOS models in Tables 4 and 7 respectively).

Uses: The volume of motor vehicle traffic along a road is a significant factor in how bicyclists and pedestrians perceive the roadway. Both the BLOS and PLOS models use the traffic volume in the outside travel lane to assess the suitability of the road for bicycling and walking.

Data Accuracy: The accuracy of the traffic volume information from Metro Public Works depends on the age of the data, the collection and reporting procedure and how the records from specific count stations were converted to data for entire road segments. These traffic volume records are rough assessments of the relative levels of motor vehicle traffic on Louisville Metro roads. They are not highly accurate numbers, but they are well suited for rating and comparing the level of service for bicyclists and pedestrians on various roads.

VOL15

Description: Peak traffic volume in a 15-minute period during a 12-hour count.

Format: number Range: 18 - 456 (vehicles per 15 minutes)

Data Source: To fill in some of the gaps where no traffic volume information was available, raw counts were requested from KIPDA and supplied as 12-hour turning-movement counts at urban intersections. Using these 12-hour counts the peak traffic volume in 15 minutes was estimated over the adjacent road segments. For the purposes of the BLOS and PLOS models, the peak 15-minute volume counts are actually closer to the desired format than the ADT values (see BLOS and PLOS models in Tables 4 and 7 respectively). These additional records brought the total road miles with traffic volume data to 83.6%. Although 16.4% of the arterial and collector road miles were not evaluated using the BLOS and PLOS methodologies, all of the other available road information for these segments was collected, making it possible to query the data for specific conditions that may be desirable to improve bicycling and walking accommodations.

Uses: The volume of motor vehicle traffic along a road is a significant factor in how bicyclists and pedestrians perceive the roadway. Both the BLOS and PLOS models use the traffic volume in the outside travel lane to assess the suitability of the road for bicycling and walking.

Data Accuracy: The accuracy of the traffic volume information from Metro Public Works depends on the age of the data, the collection and reporting procedure and how the records from specific count stations were converted to data for entire road segments. These traffic volume records are rough assessments of the relative levels of motor vehicle traffic on Louisville Metro roads. They are not highly accurate numbers, but they are well suited for rating and comparing the level of service for bicyclists and pedestrians on various roads.

TRUCKS

Description: Percentage of heavy vehicles out of the total motor vehicle volume.

Format: number Range: 1.5 – 3.5%

Data Source: Very little information on heavy vehicle percentages was available for this study. KYTC provided a point dataset of heavy vehicle percentages for a small portion of the state road network. The values were found to vary widely, and often exceeded the three percent maximum that was used to create the BLOS model. Given the uncertain accuracy of these records and their limited coverage, estimates of heavy vehicle percentages were used instead. The guidelines for the Bicycle Compatibility

Index use measurements of average truck percentages from FHWA to arrive at the following recommended truck percentages:*

Functional Classification (Type of Street)	Recommended Truck Percentage
Principle Arterial (Non-Freeway)	3.5%
Minor Arterial	2.0%
Collector Street	1.5%
Local Street	0.0%

Uses: The percentage of heavy vehicles is used directly in the BLOS model (see variable *HV* in Table 4). The BLOS model shows a strong correlation between the percentage of trucks present and a bicyclist's perception of the service provided by the road. Large trucks, buses and other heavy vehicles can deter bicyclists, especially on roads with narrow travel lanes. In addition, large vehicles create wind blasts and throw debris that can endanger bicyclists if there is not enough separation between the bicyclist and the passing truck.

POST_SPD

Description: Posted speed limit along road segment.

Format: number Range: 25 - 55 miles/hour

Data Source: The street centerlines database has speed limit listings for the roads maintained by Louisville Metro; however, many of these listings were not up to date at the time of data collection. Metro Public Works provided an additional spatial database entitled *strspeed5* that contained more up-to-date speed limit data. The *strspeed5* database was joined to the BP-LOS database using the *rwcompkey* field, and the outdated speed limit records were replaced. Speed limit records for the state roads were requested from the Kentucky Transportation Cabinet, District 5. The information was supplied as a polyline shapefile, which did not match the geometry of the BP-LOS database. To perform a spatial join of the state speed limit and BP-LOS databases, the speed limit polyline shapefile was converted to a polygon shapefile with 100-foot buffers around the original polyline geometry. These polygon buffers provided a much greater tolerance for the spatial join operation. After the join was performed, a number of segments that did not match or that received erroneous matches were manually adjusted.

Uses: Speed limit records are necessary for both the bicycle and pedestrian LOS models. The BLOS model uses this information directly (see SP_p in Table 4), but the PLOS model uses the average running speed of motor vehicles (see *SPD* in Table 7). The average running speed is often higher than the posted speed limit. Despite this discrepancy, the posted speed limit was used directly for the PLOS model. To account for generally higher traffic speeds than the posted speed limit, speed values could be increased by 5 mph or by a percentage of the posted speed limit to arrive at a better estimate of the average running speed on Louisville Metro roads.

Data Accuracy: The accuracy of the posted speed limit data is fairly high. The database provided by Metro Public Works had been recently updated. KYTC noted that a few of the entries in their records were quite old and may not reflect the actual posted speed limit.

Notes: Speed limit records were available for all the road segments studied. In some cases, conflicting data existed from both Louisville Metro and KYTC for the same road segments. For this handful of cases, quick field checks were performed to verify the actual posted speed limit.

* *Data Requirements and Assumptions*, The Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual, FHWA-RD-98-095, http://www.hsrc.unc.edu/research/pedbike/98095/data/body_data.html

THRU_CD/THRU_NN

Description: Number of through travel lanes in the cardinal (North/East) or non-cardinal (South/West) directions, excluding turn lanes, shoulders or other lanes that are not for through travel. Two attribute fields exist—one for each direction.

Format: number Range: 1 - 5 lanes

Data Source: Some through lane information was available for the state routes from the KYTC Highway Information System (HIS); however, the records were not always accurate. This information was instead collected by observing the LOJIC aerial imagery and manually counting the number of lanes in each direction.

Uses: This information is necessary for both the bicycle and pedestrian LOS models to determine an estimated traffic volume in the outside travel lane (See variables L_n and L in the BLOS and PLOS models in Tables 4 and 7, respectively). Information about numbers of lanes is also helpful in combination with other geometric information about a road to determine if road improvements to better accommodate bicyclists and pedestrians are feasible.

Data Accuracy: This information is quite easy to determine from the aerial imagery. Any errors relate to incorrect data recording.

Notes: In some cases, the lane configuration changes through a road segment. In this case, the number of lanes through the major part of the segment was recorded.

ONEWAY

Description: Indicates if a road is designated for one-way operation.

Format: string Range: Y = one-way; N = bi-directional

Data Source: Most of this information came directly from the STREETCL database, which has an attribute field for one-way streets.

Uses: Knowledge about one-way streets is helpful for the BLOS and PLOS models to accurately calculate the traffic volume in the outside lane and when looking for opportunities to improve bicycling accommodations.

Data Accuracy: A few of the one-way designations were found to be incorrect when compared with the aerial imagery. These discrepancies were corrected in the BP-LOS database.

Notes: Clues from road striping and parked cars viewed in the aerial imagery were used to determine if a street was one-way. The lane striping and parking often were not enough to verify one-way operation, but a stop line that extended across the entire paved width of the road at an intersection was usually a tell-tale sign of one-way streets. This attribute field along with the number of lanes in the cardinal and non-cardinal direction provide redundancy in determining the directional operation of the roadway, but they are both useful for different types of querying tasks.

DIVIDED

Description: Indicates if a road is divided into two roadways with a center median.

Format: string Range: Y = divided; N = undivided

Data Source: Some information on medians and divided roads exists in the KYTC HIS databases, but the records were incomplete. For better accuracy, this information was collected by viewing the aerial imagery.

Uses: Divided roads must be treated differently when considering roadway improvements for bicyclists and pedestrians, and it is helpful to know which roads are divided.

Notes: Very short sections of divided roads were often encountered at intersections and freeway interchanges These conditions were ignored unless they existed along the majority of a road segment.

In cases where the road was divided along only part of a segment, the segment was assigned a value that best approximated its overall character.

MED_TYP

Description: Indicates what type of median strip divides two roadways.

Format: string   Range: F = flush with roadway pavement; D = depressed, median falls below the grade of the roadway; G = guardrail divides two roadways; N = raised median with a non-mountable curb; M = raised median with a mountable curb intended to allow turning movements.

Data Source: Some information on medians and divided roads exists in the KYTC HIS databases, but the records were incomplete. For better accuracy, this information was collected by viewing the aerial imagery.

Uses: Knowledge about the median can be helpful for identifying potential opportunities for road improvements. For instance a flush median may allow the travel lanes to be shifted toward the center of the road to create a wide curb lane or bicycle lane and to help buffer the sidewalk from high-speed motor vehicle traffic.

Notes: In most cases, the type of median could be easily confirmed from the aerial imagery. In a few cases mountable and non-mountable medians were difficult to distinguish resulting in possible errors in the database.

CLT

Description: Indicates if a roadway has a continuous center-left-turn lane.

Format: string   Range: Y = CLT lane exists; N = no CLT lane

Data Source: This information came entirely from viewing the LOJIC aerial imagery.

Uses: Knowing whether a continuous center-left-turn lane exists is important for understanding the overall operation of the roadway and identifying ways to reconfigure or restripe the roadway to better serve all users.

Notes: Continuous center-left-turn lanes were easy to spot in the aerial imagery. In cases where a center-left-turn lane existed along only part of a road segment, the segment was assigned a value that best approximated its overall character.

EDG_COND

Description: Describes the edge condition of the paved roadway.

Format: string   Range: C = curb and gutter exist; N = curb exists without a gutter (pavement extends right to curb face); O = open shoulder

Data Source: This information came from observations of the aerial imagery.

Uses: The edge condition of a roadway affects the calculation of the BLOS and PLOS results. Generally, bicyclists cannot consider gutter pans to be useable riding space, thus the gutter pan must be excluded from the outside lane width. For the PLOS calculation however, the gutter pan is included as part of the lateral separation between motor vehicles and pedestrians.

Data Accuracy: Because so little of this information was available from other databases, many of the records came from observations of the aerial imagery. In some cases it was very difficult to judge the difference between the three edge conditions, especially where the pavement was worn and faded and image sharpness was poor; however, the functional classification of the road; it's location in urban, suburban or rural areas; and the surrounding land uses gave strong clues about the likely edge condition when the aerial imagery was otherwise difficult to interpret. In general, the entries in the BP-LOS database are fairly accurate, but field assessments would be required for confirmation.

Notes: For the purpose of classification, any gutter pan that was 18" or wider was considered to be a 2-foot gutter pan and was classified as curb and gutter. Roads with 1-foot gutter pans or no gutter pans were classified as curbed without gutter.

STR_CEN

Description: Indicates whether a two-lane, undivided road has a center stripe defining the two directions of travel.

Format: string Range: Y = center stripe present; N = no stripe

Data Source: This information was collected by observing the LOJIC aerial imagery.

Uses: There is a correction factor for two-lane, unstriped, undivided roads with low traffic volume in the BLOS model (see W_v in Table 4). Generally these roads have a wider effective outside lane width than half of the road width.

Data Accuracy: In most cases the road striping was clearly visible in the aerial imagery.

PV_WID

Description: Total width of paved roadway between curb faces or pavement edges.

Format: number Range: 12 - 180 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery.

Uses: The total pavement width is useful to get a complete picture of the road configuration and to help identify opportunities to improve bicycling and walking conditions.

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1-foot accuracy on the pavement width was achieved. The measured values from the database were spot checked against actual measurements on several road segments with very close agreement.

OL_WID

Description: Width of outside through lane, excluding gutter pan width.

Format: number Range: 6 - 26 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery. In many cases, the lane width was best approximated by measuring the full width of the road and dividing the pavement width by the number of travel lanes. In the cases where the lanes were not of equal width, then the outside lane width was measured directly.

Uses: The outside travel lane width is used directly in both the BLOS and PLOS models (see W_t and W_{ol} in the BLOS and PLOS models in Tables 4 and 7, respectively).

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1-foot accuracy on the outside lane width was achieved. The lane widths were entered in 0.5-foot increments because measuring the entire roadway width and dividing by the number of travel lanes sometimes yielded fractional values.

SH_WID

Description: Width of paved shoulder beyond edge stripe.

Format: number Range: 0 - 12 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery. The shoulder width was best approximated by measuring the entire pavement width and subtracting the width of pavement between the outside travel lane edge stripes.

Uses: The shoulder width is used directly in both the BLOS and PLOS models (see variable W_l in the BLOS and PLOS models in Tables 4 and 7).

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1 foot accuracy of the shoulder width was achieved.

Notes: Few roads throughout Louisville Metro have paved shoulders. For those with shoulders over 2 feet wide, most were easily recognized and measured by observing the aerial imagery. Narrower shoulders (< 2 feet) were less accurately identified, but represent a small fraction of road miles covered in this study. It was also difficult to distinguish between paved and unpaved shoulders in some cases. The use of shoulder rumble strips renders what little shoulder exists, unuseable for bicycling. The width occupied by shoulder rumble strips must be subtracted from the shoulder width. The presence of rumble strips was noted in the NOTES field and the shoulder width was adjusted accordingly for the BLOS computation. Note, however, that the full width of the shoulder should be considered for the PLOS computation. Shoulder rumble strips were usually not detectable in the aerial imagery, so field assessments would be necessary for an accurate account of shoulder conditions. In many cases, shoulders are present along a road at an expressway interchange. These shoulders were recorded in the *NOTES* field but were not counted as shoulders for the purpose of computing LOS because of the number of merge lanes and crossings that interrupt the shoulder.

CLT_WID

Description: Width of continuous center-left-turn lane.

Format: number Range: 10 - 20 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery. The measurement was made between the yellow pavement striping used to designate center-left-turn lanes.

Uses: Although this measurement is not used directly in either the BLOS or PLOS models, it provides a more complete picture of the operational characteristics of the road to determine the feasibility of roadway improvements.

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1-foot accuracy was achieved.

MED_WID

Description: Width of median separating two adjacent roadways.

Format: number Range: 2 - 80 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery.

Uses: Although this measurement is not used directly in either the BLOS or PLOS models, it provides a more complete picture of the operational characteristics of the road to determine the feasibility of roadway improvements.

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1-foot accuracy was achieved.

Notes: The median was often adjacent to a small shoulder or gutter pan that was included in its width measurement since this space is not part of the paved surface that facilitates vehicle travel.

BKLN_WID

Description: Width of pavement marked and striped as a dedicated bicycle lane.

Format: number   Range: 0 - 4 feet

Data Source: Louisville Metro currently only has dedicated bicycle lanes along stretches of Adams St and Spring St. Measurements for these short segments were made using the LOJIC aerial imagery and were verified with field measurements.

Uses: Dedicated bicycle lanes are perceived by many road users to provide better service for cyclists than streets designed without them. In the BLOS model, this public perception is represented by the significant influence that a bike lane has in improving the BLOS rating. The PLOS rating is also improved with the addition of a bicycle lane because the lane provides additional buffer space between pedestrians and motor vehicles.

Data Accuracy: The accuracy of these measurements is high because field measurements were taken; however, the width of the bicycle lane does vary along the road segment, so the recorded width should be considered a good approximation.

PK_WID

Description: Width of striped on-street parking adjacent to a striped bicycle lane.

Format: number   Range: 0 feet

Uses: This value is only recorded if a parking lane exists adjacent to a striped bicycle lane. This condition only occurs on a very short segment of Spring St., which was not included in this study because it is classified as a neighborhood street. Thus, this attribute field is currently empty but would be needed if adjacent parking and bicycle lanes are incorporated on Louisville Metro streets in the future.

SDWK_WID

Description: Width of sidewalk present along a roadside.

Format: number   Range: 3 - 25 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery.

Uses: This measurement is used directly in the PLOS model (see W_s in Table 7) and affects a pedestrian's perception of how well the road serves their walking needs.

Data Accuracy: The LOJIC aerial imagery has 1-foot pixel resolution. With careful measurements in high-contrast, sharply focused areas of the image, ± 1-foot accuracy was achieved.

Notes: Because the sidewalk width was often less than 5 feet, it has a higher percentage of measurement error than measurements of wider features. In addition, the sidewalks are sometimes not clearly defined where grass has overgrow the edges, effectively narrowing the walkway. It was impossible to identify these situations from aerial imagery alone. Where the sidewalk width varied from one side of the road to the other and along the road segment, a representative value that best described the sidewalk width for the entire segment was used. The PLOS model is limited to sidewalk widths of 10 feet. For wider sidewalks, the model gives erroneous results. Therefore, any values over 10 feet were recorded but are limited to 10 feet during the PLOS computation.

BUF_WID

Description: Width of space between outside lane and edge of sidewalk, including grass verge, drainage ditch, shoulders, gutters and bicycle lanes.

Format: number   Range: 0 - 45 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery.

Uses: This measurement is used directly in the PLOS model (see W_b in Table 7) and affects a pedestrian's percept of how well the road serves their walking needs.

Notes: Because the buffer often varied greatly from one side of the road to the other and throughout a road segment, a representative value for each road segment was selected.

TREE_SP

Description: Distance between trees planted in a buffer between the roadway and sidewalk.

Format: number Range: 20 - 80 feet

Data Source: This information was collected with the measurement tool in ArcView while viewing the LOJIC aerial imagery.

Uses: This measurement is used directly in the PLOS model (see T_b in Table 7) and affects a pedestrian's percept of how well the road serves their walking needs. A buffer area planted with trees or otherwise offering physical protection from adjacent motor vehicle traffic is perceived as a better place to walk by pedestrians.

Notes: The tree spacing was sometimes difficult to assess from the aerial imagery. Where fairly uniformly spaced trees were planted in the buffer, along a major portion of both sides of the road segment, this measurement was recorded. More typically, trees that did exist in the buffer were spaced very sporadically. These trees were usually neglected. In the central business district where trees were often located in the sidewalk, the sidewalk was divided into a sidewalk space and a buffer space and the tree spacing was then measured and recorded.

SDWK_CD / SDWK_NN

Description: Percentage of road segment covered by sidewalks in the cardinal (North/East) and non-cardinal (South/West) directions.

Format: number Range: 0-100% in 5% increments

Data Source: The LOJIC aerial imagery was observed to estimate the percentage of sidewalk coverage to the nearest 5% for each road segment.

Uses: The average sidewalk coverage for both sides of the road is used directly in the PLOS model (see *SWCOV* in Table 7). The presence of a sidewalk is a major factor in how well pedestrians rate their experience walking along a roadside.

Notes: These sidewalk coverages are simple estimates of sidewalks that were viewable in the LOJIC aerial imagery. The condition or safety of the sidewalk was not addressed. Some sidewalk segments may not be represented in the database where new construction has occurred.

SDWK_SUM

Description: Indicates whether the road segment has complete sidewalks on both sides, a complete sidewalk on one side, partial sidewalks or no sidewalks.

Format: string Range: COM = complete sidewalks (both sides); ONE = complete sidewalk (one side); PAR = partial sidewalks; NON = no sidewalks on either side

Data Source: This information was deduced from the *SDWK_CD* and SDWK_NN fields that show the estimated percentage of the road segment covered by sidewalks in the cardinal and non-cardinal directions.

Notes: This attribute field is a summarized representation of the *SDWK_CD* and *SDWK_NN* attribute fields and was created to map the sidewalk coverage for Louisville Metro arterial and collector roads (see Map 4 in Appendix A).

PV_COND

Description: Rating of pavement surface condition based on FHWA 5-point scale.

Format: number   Range: 2 - 5

Data Source: KYTC maintains a database of pavement conditions based on the "rideability index," which is a 5-point scale that rates the ride quality. These state records were incorporated into the BP-LOS database by buffering the polyline shapefile and performing a spatial join as discussed above in the *ADT* field description. Metro Public Works also maintains pavement conditions in the form of a 10-point pavement rating scale for the former City of Louisville streets; however this information was not made available in time to be incorporated into the study. Records from the former Jefferson County Public Works Department were difficult to correlate to any actual pavement surface condition rating and were not used. When no information was available, a default value of 3 was used. The following table from FHWA describes the Present Serviceability Rating (PSR) scale used in this study to record the pavement surface condition:[*]

PSR	Description
4.0 - 5.0	Only new (or nearly new) superior pavements are likely to be smooth enough and distress free (sufficiently free of cracks and patches) to qualify for this category. Most pavements constructed or resurfaced during the data year would normally be rated in this category.
3.0 - 4.0	Pavements in this category, although not quite as smooth as those described above, give a first-class ride and exhibit few, if any, visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
2.0 - 3.0	The riding qualities of pavements in this category are noticeably inferior to those of new pavements and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and extensive patching. Rigid pavements in this group may have a few joint fractures, faulting and/or cracking and some pumping.
1.0 - 2.0	Pavements have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement may have large potholes and deep cracks. Distress includes raveling, cracking, and rutting and occurs over 50 percent or more of the surface. Rigid pavement distress includes joint spalling, faulting, patching, cracking, and scaling and may include pumping and faulting.
0.0 - 1.0	Pavements are in extremely deteriorated conditions. The facility is passable only at reduced speeds and considerable ride discomfort. Large potholes and deep cracks exist. Distress occurs over 75 percent or more of the surface.

Uses: The pavement rating is used directly in the BLOS model and has a significant affect on the computed LOS (see PR_5 in Table 4). Pavements with very low surface quality often result in extremely low (F) level-of-service. The pavement surface quality affects the ride comfort for all vehicles on the road and it affects the safety of bicyclists to a larger extent than motorists. Potholes, longitudinal gaps that can catch a tire and other road hazards related to surface condition of the pavement can all affect the safety and rideability of a road for bicyclists.

Notes: Since the measurement of pavement surface condition depends somewhat on the method or person rating the pavement, it is not a highly accurate measure of pavement quality. However, the ratings are still useful to show the relative differences in pavement conditions and to demonstrate how poorly served bicyclists are by deteriorating pavements that rate very low by FHWA's standards. Because of the strong influence of pavement ratings less than 2 on the BLOS computation, the range of allowable ratings was limited to a minimum of 2.

* *1999 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance Report*, Exhibit 3-2, Federal Highway Administration, 1999. http://www.fhwa.dot.gov/policy/1999cpr/chap03.pdf

P_ALLOW

Description: Indicates if on-street parallel parking is allowed.

Format: string   Range: Y = parking allowed; N = no parking

Data Source: This information was collected by observing the roadway in the LOJIC aerial imagery. Based on whether cars were present on the side of the roadway and the context of the surrounding area, a determination was made about on-street parking. A limited number of field assessments were also made to verify some of the information collected from aerial imagery.

Uses: Determining the presence of on-street parking is important because bicyclists generally experience more conflicts along roads with a great deal of parking, either because the useable width of the outside travel lane is narrowed or because passengers and drivers entering and exiting their vehicles introduce potential hazards into bicyclists' paths. For pedestrians, the presence of parked cars along a road can be both a comforting factor and a potential hazard. In the middle of a block, the parked vehicles serve as a protective buffer between pedestrians and motor vehicles. At intersections, however, it is often difficult to see around parked vehicles to safely cross the street, creating a potentially dangerous situation.

Notes: Determining exactly where on-street parking is allowed would require a field study of street signage. In general, the observation of the aerial imagery provided enough information to create a reasonably accurate account of where bicyclists and pedestrians are most likely to encounter roads with on-street parking. Not surprisingly, most of these roads are located in urban areas of Louisville Metro, such as in the Central Business District or town centers like St. Matthews and Jeffersontown.

P_OCC

Description: Indicates percentage of road segment with occupied on-street parking excluding driveways, alleys and bus stops.

Format: number   Range: 0 - 100% in 25% increments

Data Source: This percentage was estimated visually by examining the LOJIC aerial imagery and was verified with field studies for 20% of the road miles where parking was observed.

Uses: Determining the presence of on-street parking is important because bicyclists generally experience more conflicts along roads with a great deal of parking, either because the useable width of the outside travel lane is narrowed or because passengers and drivers entering and exiting their vehicles introduce potential hazards into bicyclists' paths. For pedestrians, the presence of parked cars along a road can be both a comforting factor and a potential hazard. In the middle of a block, the parked vehicles effectively serve as a protective buffer between pedestrians and motor vehicles. At intersections, however, it is often difficult to see around parked vehicles to safely cross the street, creating a potentially dangerous situation. The BLOS and PLOS models use the percentage of occupied on-street parking directly in their computations (see *OSPA* in the BLOS and PLOS models in Tables 4 and 7 respectively).

Notes: On-street parking is a difficult parameter to measure accurately. This parameter is constantly changing, and it depends on the time of day. For instance, in residential areas on-street parking usage usually peaks in the evenings and on weekends when people are home from work. Along commercial corridors, the parking usage is highest during business hours. The amount of time required to accurately assess each road segment's peak or average parking demand was outside the scope of this study. The estimates for this study from both the aerial imagery and field assessments were made for mid-day (9 AM – 4 PM) parking conditions on weekdays. These values provide a snapshot of parking usage, but they may not provide the most accurate assessment of the overall parking useage for the road segment.

B_FC_POS

Description: Code identifying road segments with potential for improving bicycling accommodations through cost-effective changes like restriping or reconfiguring lanes (see Appendix C).

Format: number Range: 1-12

Data Source: These 12 categories of roads may have sufficient pavement width to be reconfigured for better bicycling accommodations. These segments were identified by querying the BP-LOS database for combinations of factors such as pavement width, number of lanes and presence of parking. The categories are fully explored in Appendix C.

NOTES

Description: Notes about unusual conditions along a road segment that require special attention.

Format: string

BLOS and PLOS Computation Scripts

To facilitate the computation of the bicycle and pedestrian LOS, scripts were written for ArcView GIS software. The scripts were designed to handle the many different road configurations such as those with on-street parking, paved shoulders, curb and gutter, sidewalks or bicycle lanes with a single computation. Two buttons were added to the tool bar in the BP-LOS ArcView project to access these computational functions. After selecting records in the BP-LOS attributes table, the BLOS or PLOS button can be clicked to initiate the computation scripts. The results are stored in several intermediate fields to improve the clarity of the process. These intermediate calculations represent specific terms of the LOS models and are labeled *BLOS_term1*, *BLOS_term2*, *BLOS_term3*, *BLOS_term4*, *PLOS_term1*, *PLOS_term2* and *PLOS_term3*. The BP-LOS database also contains attribute fields to store the final computation of the BLOS and PLOS and to convert the calculated scores to the LOS grades A-F. The following scripts were used to perform the LOS computations:

BLOS Script

```
BP_Table = av.GetActiveDoc
BP_VTab  = BP_Table.GetVTab
BP_VTab.SetEditable(true)

'Create reference names for all the fields involved in the BLOS calculation

'Term 1

ADT_Field = BP_VTab.FindField("ADT")
PKHOUR_Field = BP_VTab.FindField("VOL60")
PK15MIN_Field = BP_VTab.FindField("VOL15")
LNCARD_Field = BP_VTab.FindField("THRU_CD")
LNNON_Field = BP_VTab.FindField("THRU_NN")

'Term 2

SPEED_Field = BP_VTab.FindField("POST_SPD")
TRUCKS_Field = BP_VTab.FindField("TRUCKS")

'Term 3

PAVECON_Field = BP_VTab.FindField("PV_COND")

'Term 4

CURBWID_Field = BP_VTab.FindField("OL_WID")
SHWID_Field = BP_VTab.FindField("SH_WID")
BIKEWID_Field = BP_VTab.FindField("BKLN_WID")
PARKWID_Field = BP_VTab.FindField("PK_WID")
EDGECON_Field = BP_VTab.FindField("EDG_COND")
PARKALLOW_Field = BP_VTab.FindField("P_ALLOW")
PARKOCC_Field = BP_VTab.FindField("P_OCC")
STRIPED_Field = BP_VTab.FindField("STR_CEN")

'BLOS Fields

BLOS1_Field = BP_VTab.FindField("BLOS_term1")
BLOS2_Field = BP_VTab.FindField("BLOS_term2")
BLOS3_Field = BP_VTab.FindField("BLOS_term3")
BLOS4_Field = BP_VTab.FindField("BLOS_term4")
BLOSscore_Field = BP_VTab.FindField("BLOS_score")
BLOSgrade_Field = BP_VTab.FindField("BLOS_grade")
```

```
'BLOS constants

a1 = 0.507
a2 = 0.199
a3 = 7.066
a4 = -0.005
C = 0.760

'Computation of BLOS for all selected records in the table

for each record in BP_VTab.GetSelection

'Term 1 -- Traffic volume in 15 minute interval in outside travel lane

  ADT = BP_VTab.ReturnValue(ADT_Field,record)
  PKHOUR = BP_VTab.ReturnValue(PKHOUR_Field,record)
  PK15MIN = BP_VTab.ReturnValue(PK15MIN_Field,record)
  LNCARD = BP_VTab.ReturnValue(LNCARD_Field,record)
  LNNON = BP_VTab.ReturnValue(LNNON_Field,record)

  if (PK15MIN > 0) then
    BLOS1 = a1 * ((PK15MIN / (LNCARD + LNNON)).Ln)
  elseif (PKHOUR > 0) then
    BLOS1 = a1 * (((PKHOUR/4) / (LNCARD + LNNON)).Ln)
  elseif ((ADT = -1).Not) then
    BLOS1 = a1 * (((ADT / 40) / (LNCARD + LNNON)).Ln)
  else
    BLOS1 = 999
  end

  BP_VTab.SetValue(BLOS1_Field, record, BLOS1)

'Term 2 -- Effective traffic speed and percentage of heavy vehicles

  SPEED = BP_VTab.ReturnValue(SPEED_Field,record)
  TRUCKS = BP_VTab.ReturnValue(TRUCKS_Field,record)

  if (SPEED > 0) then
    BLOS2 = a2 * ((1.1199 * ((SPEED - 20).Ln)) + 0.8103) * ((1 + (10.38 * (TRUCKS / 100))) ^ 2)
  else
    BLOS2 = 999
  end

  BP_VTab.SetValue(BLOS2_Field, record, BLOS2)

'Term 3 -- Pavement rating

  PAVECON = BP_VTab.ReturnValue(PAVECON_Field,record)

  'Compensation for excessively low values

  if ((PAVECON < 2) and (PAVECON > 0)) then
    PAVECON = 2
  end

  'Pavement rating computation

  PAVECON = PAVECON.Round
  if (PAVECON > 0) then
    BLOS3 = a3 * ((1 / PAVECON) ^ 2)
```

```
  else
    BLOS3 = a3 * ((1/3)^2) 'If no record is available, a default value of 3 is used
  end

  BP_VTab.SetValue(BLOS3_Field, record, BLOS3)

'Term 4 -- Configuration of outside lane

  CURBWID = BP_VTab.ReturnValue(CURBWID_Field,record)
  SHWID = BP_VTab.ReturnValue(SHWID_Field,record)
  BIKEWID = BP_VTab.ReturnValue(BIKEWID_Field,record)
  PARKWID = BP_VTab.ReturnValue(PARKWID_Field,record)
  EDGECON = BP_VTab.ReturnValue(EDGECON_Field,record)
  PARKALLOW = BP_VTab.ReturnValue(PARKALLOW_Field,record)
  PARKOCC = BP_VTab.ReturnValue(PARKOCC_Field,record)
  STRIPED = BP_VTab.ReturnValue(STRIPED_Field,record)

  'Test for unstriped, undivided, low traffic volume roads

  if ((ADT > 0) and (ADT <= 4000) and (STRIPED = "N")) then
    WID_FACTOR = (2 - (ADT/4000))
  elseif ((PKHOUR > 0) and (PKHOUR <= 400) and (STRIPED = "N")) then
    WID_FACTOR = (2 - (PKHOUR/400))
  elseif ((PK15MIN > 0) and (PK15MIN <= 100) and (STRIPED = "N")) then
    WID_FACTOR = (2 - (PK15MIN/100))
  else
    WID_FACTOR = 1
  end

  'Compensation for extra-wide shoulders

  if (SHWID > 6) then
    SHEXTRA = SHWID - 6
    CORRECTION = (SHEXTRA/1.5).Round
    SHWID = SHWID - CORRECTION
  end

  'Computations

  if ((SHWID = 0) and (BIKEWID = 0) and (PARKWID = 0)) then
    WID_EFF = (CURBWID * WID_FACTOR) - (10 * (PARKOCC/100))
  elseif (((SHWID > 0) or (BIKEWID > 0)) and (PARKWID = 0)) then
    WID_EFF = ((CURBWID + BIKEWID + SHWID) * WID_FACTOR) + ((BIKEWID + SHWID) * (1 - (2 *
(PARKOCC/100))))
  elseif ((BIKEWID > 0) and (PARKWID > 0)) then
    WID_EFF = ((CURBWID + BIKEWID + PARKWID) * WID_FACTOR) + (BIKEWID + PARKWID) - (2 * (10 *
(PARKOCC/100)))
  else
    WID_EFF = 999
  end

  if (Not(WID_EFF = 999)) then
    BLOS4 = a4 * (WID_EFF ^ 2)
  else
    BLOS4 = 999
  end

  BP_VTab.SetValue(BLOS4_Field, record, BLOS4)

'BLOS score
```

```
  if ((Not(BLOS1 = 999)) and (Not(BLOS2 = 999)) and (Not(BLOS3 = 999)) and (Not(BLOS4 = 999))) then
    BLOSscore = BLOS1 + BLOS2 + BLOS3 + BLOS4 + C
  else
    BLOSscore = 999
  end

  BP_VTab.SetValue(BLOSscore_Field, record, BLOSscore)

'BLOS grading

  if (BLOSscore <= 1.500) then
    BLOSgrade = "A"
  elseif ((1.500 < BLOSscore) and (BLOSscore <= 2.500)) then
    BLOSgrade = "B"
  elseif ((2.500 < BLOSscore) and (BLOSscore <= 3.500)) then
    BLOSgrade = "C"
  elseif ((3.500 < BLOSscore) and (BLOSscore <= 4.500)) then
    BLOSgrade = "D"
  elseif ((4.500 < BLOSscore) and (BLOSscore <= 5.500)) then
    BLOSgrade = "E"
  elseif ((BLOSscore > 5.500) and (Not(BLOSscore = 999))) then
    BLOSgrade = "F"
  else
    BLOSgrade = "NA"
  end

'BLOS +/- scoring if desired

'  if (BLOSscore <= 0.500) then
'    BLOSgrade = "A+"
'  elseif ((0.500 < BLOSscore) and (BLOSscore <= 1.000)) then
'    BLOSgrade = "A"
'  elseif ((1.000 < BLOSscore) and (BLOSscore <= 1.500)) then
'    BLOSgrade = "A-"
'  elseif ((1.500 < BLOSscore) and (BLOSscore <= 1.833)) then
'    BLOSgrade = "B+"
'  elseif ((1.833 < BLOSscore) and (BLOSscore <= 2.167)) then
'    BLOSgrade = "B"
'  elseif ((2.167 < BLOSscore) and (BLOSscore <= 2.500)) then
'    BLOSgrade = "B-"
'  elseif ((2.500 < BLOSscore) and (BLOSscore <= 2.833)) then
'    BLOSgrade = "C+"
'  elseif ((2.833 < BLOSscore) and (BLOSscore <= 3.167)) then
'    BLOSgrade = "C"
'  elseif ((3.167 < BLOSscore) and (BLOSscore <= 3.500)) then
'    BLOSgrade = "C-"
'  elseif ((3.500 < BLOSscore) and (BLOSscore <= 3.833)) then
'    BLOSgrade = "D+"
'  elseif ((3.833 < BLOSscore) and (BLOSscore <= 4.167)) then
'    BLOSgrade = "D"
'  elseif ((4.167 < BLOSscore) and (BLOSscore <= 4.500)) then
'    BLOSgrade = "D-"
'  elseif ((4.500 < BLOSscore) and (BLOSscore <= 4.833)) then
'    BLOSgrade = "E+"
'  elseif ((4.833 < BLOSscore) and (BLOSscore <= 5.167)) then
'    BLOSgrade = "E"
'  elseif ((5.167 < BLOSscore) and (BLOSscore <= 5.500)) then
'    BLOSgrade = "E-"
'  elseif ((BLOSscore > 5.500) and (Not(BLOSscore = 999))) then
```

```
'    BLOSgrade = "F"
'  else
'    BLOSgrade = "NA"
'  end

  BP_VTab.SetValue(BLOSgrade_Field, record, BLOSgrade)

end
```

PLOS Scripts

```
BP_Table = av.GetActiveDoc
BP_VTab  = BP_Table.GetVTab
BP_VTab.SetEditable(true)

'Create reference names for all the fields involved in the PLOS calculation

'Term 1 -- Lateral separation

CURBWID_Field = BP_VTab.FindField("OL_WID")
SHWID_Field = BP_VTab.FindField("SH_WID")
BIKEWID_Field = BP_VTab.FindField("BKLN_WID")
PARKWID_Field = BP_VTab.FindField("PK_WID")
EDGECON_Field = BP_VTab.FindField("EDG_COND")
PARKALLOW_Field = BP_VTab.FindField("P_ALLOW")
PARKOCC_Field = BP_VTab.FindField("P_OCC")
SDWKWID_Field = BP_VTab.FindField("SDWK_WID")
BUFFWID_Field = BP_VTab.FindField("BUF_WID")
TREESPACE_Field = BP_VTab.FindField("TREE_SP")
SDWKCARD_Field = BP_VTab.FindField("SDWK_CD")
SDWKNON_Field = BP_VTab.FindField("SDWK_NN")


'Term 2 - Traffic volume

ADT_Field = BP_VTab.FindField("ADT")
PKHOUR_Field = BP_VTab.FindField("VOL60")
PK15MIN_Field = BP_VTab.FindField("VOL15")
LNCARD_Field = BP_VTab.FindField("THRU_CD")
LNNON_Field = BP_VTab.FindField("THRU_NN")

'Term 3 -- Traffic speed

SPEED_Field = BP_VTab.FindField("POST_SPD")

'Term 4

'PLOS Fields

PLOS1_Field = BP_VTab.FindField("PLOS_term1")
PLOS2_Field = BP_VTab.FindField("PLOS_term2")
PLOS3_Field = BP_VTab.FindField("PLOS_term3")
PLOSscore_Field = BP_VTab.FindField("PLOS_score")
PLOSgrade_Field = BP_VTab.FindField("PLOS_grade")

'PLOS constants

a1 = -1.227
a2 = 0.009
```

```
a3 = 0.0004
C = 6.046

'Computation of PLOS for all selected records in the table

for each record in BP_VTab.GetSelection

'Term 1 -- Lateral separation of pedestrian from travel lane

  CURBWID = BP_VTab.ReturnValue(CURBWID_Field,record)
  SHWID = BP_VTab.ReturnValue(SHWID_Field,record)
  BIKEWID = BP_VTab.ReturnValue(BIKEWID_Field,record)
  PARKWID = BP_VTab.ReturnValue(PARKWID_Field,record)
  EDGECON = BP_VTab.ReturnValue(EDGECON_Field,record)
  PARKALLOW = BP_VTab.ReturnValue(PARKALLOW_Field,record)
  PARKOCC = BP_VTab.ReturnValue(PARKOCC_Field,record)
  SDWKWID = BP_VTab.ReturnValue(SDWKWID_Field,record)
  BUFFWID = BP_VTab.ReturnValue(BUFFWID_Field,record)
  TREESPACE = BP_VTab.ReturnValue(TREESPACE_Field,record)
  SDWKCARD = BP_VTab.ReturnValue(SDWKCARD_Field,record)
  SDWKNON = BP_VTab.ReturnValue(SDWKNON_Field,record)

  'Compensation for a curbed road with gutter pans (add 2 feet to buffer width)

  if (EDGECON = "C") then
    BUFFWID = (BUFFWID + 2)
  end

  'Calculation of Buffer Area Barrier Coefficient (Ed Barsotti approximation)

  if(TREESPACE > 0) then
    Fb = 1 + (90 / TREESPACE)
  else
    Fb = 1
  end

  'Average sidewalk coverage for both sides of road

  SDWKCOV = ((SDWKCARD + SDWKNON) / 2)

  'Ensure calculation is within maximum of 10' sidewalk width

  if (SDWKWID > 10) then
    SDWKWID = 10
  end

  'Computations

  PLOS1_SW = (CURBWID + (SHWID + BIKEWID + PARKWID) + (0.2 * PARKOCC) + (Fb * BUFFWID) + ((6
- (0.3 * SDWKWID)) * SDWKWID))
  PLOS1_NSW = (CURBWID + (SHWID + BIKEWID + PARKWID))
  PLOS1 = a1 * ((((SDWKCOV / 100) * PLOS1_SW.Ln) + ((1 - (SDWKCOV / 100)) * PLOS1_NSW.Ln)))

  BP_VTab.SetValue(PLOS1_Field, record, PLOS1)

'Term 2 -- Traffic volume

  ADT = BP_VTab.ReturnValue(ADT_Field,record)
  PKHOUR = BP_VTab.ReturnValue(PKHOUR_Field,record)
  PK15MIN = BP_VTab.ReturnValue(PK15MIN_Field,record)
```

```
  LNCARD = BP_VTab.ReturnValue(LNCARD_Field,record)
  LNNON = BP_VTab.ReturnValue(LNNON_Field,record)

  if (PK15MIN > 0) then
    PLOS2 = a2 * (PK15MIN / (LNCARD + LNNON))
  elseif (PKHOUR > 0) then
    PLOS2 = a2 * ((PKHOUR/4) / (LNCARD + LNNON))
  elseif ((ADT = -1).Not) then
    PLOS2 = a2 * ((ADT / 40) / (LNCARD + LNNON))
  else
    PLOS2 = 999
  end

  BP_VTab.SetValue(PLOS2_Field, record, PLOS2)

'Term 3 -- Traffic Speed

  SPEED = BP_VTab.ReturnValue(SPEED_Field,record)

  if (SPEED > 0) then
    PLOS3 = a3 * (SPEED ^ 2)
  else
    PLOS3 = 999
  end

  BP_VTab.SetValue(PLOS3_Field, record, PLOS3)

'PLOS score

  if ((Not(PLOS1 = 999)) and (Not(PLOS2 = 999)) and (Not(PLOS3 = 999))) then
    PLOSscore = PLOS1 + PLOS2 + PLOS3 + C
  else
    PLOSscore = 999
  end

  BP_VTab.SetValue(PLOSscore_Field, record, PLOSscore)

'PLOS grading

  if (PLOSscore <= 1.500) then
    PLOSgrade = "A"
  elseif ((1.500 < PLOSscore) and (PLOSscore <= 2.500)) then
    PLOSgrade = "B"
  elseif ((2.500 < PLOSscore) and (PLOSscore <= 3.500)) then
    PLOSgrade = "C"
  elseif ((3.500 < PLOSscore) and (PLOSscore <= 4.500)) then
    PLOSgrade = "D"
  elseif ((4.500 < PLOSscore) and (PLOSscore <= 5.500)) then
    PLOSgrade = "E"
  elseif ((PLOSscore > 5.500) and (Not(PLOSscore = 999))) then
    PLOSgrade = "F"
  else
    PLOSgrade = "NA"
  end

'PLOS +/- scoring if desired

'  if (PLOSscore <= 0.500) then
'    PLOSgrade = "A+"
'  elseif ((0.500 < PLOSscore) and (PLOSscore <= 1.000)) then
```

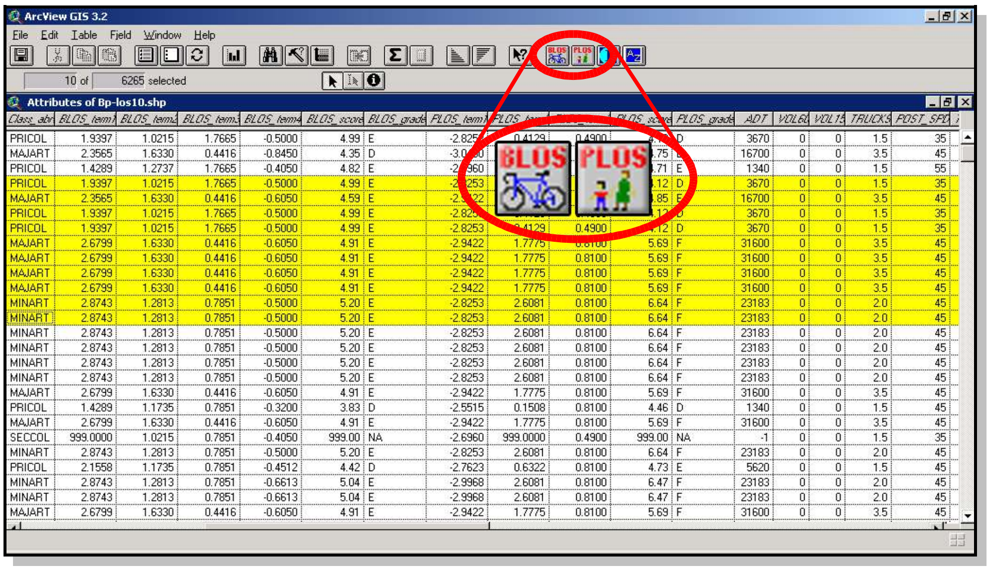
```
'    PLOSgrade = "A"
'  elseif ((1.000 < PLOSscore) and (PLOSscore <= 1.500)) then
'    PLOSgrade = "A-"
'  elseif ((1.500 < PLOSscore) and (PLOSscore <= 1.833)) then
'    PLOSgrade = "B+"
'  elseif ((1.833 < PLOSscore) and (PLOSscore <= 2.167)) then
'    PLOSgrade = "B"
'  elseif ((2.167 < PLOSscore) and (PLOSscore <= 2.500)) then
'    PLOSgrade = "B-"
'  elseif ((2.500 < PLOSscore) and (PLOSscore <= 2.833)) then
'    PLOSgrade = "C+"
'  elseif ((2.833 < PLOSscore) and (PLOSscore <= 3.167)) then
'    PLOSgrade = "C"
'  elseif ((3.167 < PLOSscore) and (PLOSscore <= 3.500)) then
'    PLOSgrade = "C-"
'  elseif ((3.500 < PLOSscore) and (PLOSscore <= 3.833)) then
'    PLOSgrade = "D+"
'  elseif ((3.833 < PLOSscore) and (PLOSscore <= 4.167)) then
'    PLOSgrade = "D"
'  elseif ((4.167 < PLOSscore) and (PLOSscore <= 4.500)) then
'    PLOSgrade = "D-"
'  elseif ((4.500 < PLOSscore) and (PLOSscore <= 4.833)) then
'    PLOSgrade = "E+"
'  elseif ((4.833 < PLOSscore) and (PLOSscore <= 5.167)) then
'    PLOSgrade = "E"
'  elseif ((5.167 < PLOSscore) and (PLOSscore <= 5.500)) then
'    PLOSgrade = "E-"
'  elseif ((PLOSscore > 5.500) and (Not(PLOSscore = 999))) then
'    PLOSgrade = "F"
'  else
'    PLOSgrade = "NA"
'  end

  BP_VTab.SetValue(PLOSgrade_Field, record, PLOSgrade)

end
```

ArcView Project Electronic Files

The attached CD-ROM contains the raw data, BP-LOS database and the ArcView project file. The project file contains several views that were used for data collection and mapping of result, and several layouts that were used to create the maps in Appendix A. The BLOS and PLOS computation scripts are also included. These scripts can be activated by placing buttons on the ArcView tool bar through the customization menu. Two bitmap button images were created to serve this purpose. After adding the buttons and linking them to the scripts, the BLOS and PLOS can be computed for selected records by clicking the buttons. The following figure shows these buttons added to the ArcView tool bar.



BLOS Application Notes

There are a few instances when special care must be taken to accurately account for the bicycling conditions on a roadway. Wide paved shoulders have a significant effect on the BLOS computation with shoulders over 10 feet wide usually resulting in BLOS rating A, even on roads like Dixie Hwy. Because the model was developed for a maximum shoulder width of 6 feet, any widths much beyond that produce questionable results. This problem is typically resolved by reducing the effective width of paved shoulders.* In this study the following scheme was used in the BLOS computation script to adjust the shoulder widths over 6 feet: 7-foot shoulders were reduced to 6 feet; shoulders 8-10 feet wide were reduced to 7 feet; and shoulders 11-12 feet wide were reduced to 8 feet.

Accurately accounting for the various parking conditions can be challenging. In situations where parking is restricted during peak travel times but not during off-peak times, some studies have used two separate calculations to compute the overall BLOS.** During peak times only the width of the outside travel lane is considered with no occupied on-street parking. During off-peak times, the width of the two outside travel lanes combined is considered along with the percentage of occupied parking in the outer-most lane. These considerations were neglected in this study, but a more detailed assessment of parking conditions would allow slightly improved model accuracy for roads with time-of-day parking restrictions.

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* *BLOS/BCI Calculator Form*, League of Illinois Bicyclists, http://www.bikelib.org/roads/blos/blosform.htm

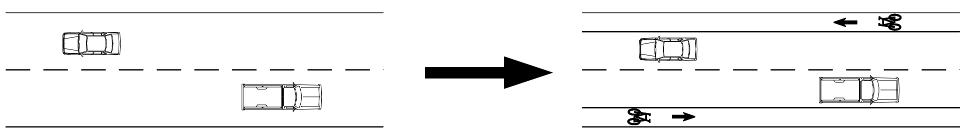
** *A Summary of the Bicycle Level of Service Model*, Toole Design Group, Roanoke Valley-Alleghany Regional Commission Bicycle Suitability Analysis Training, May 2003. http://www.rvarc.org/bike/blosdescription.pdf

Appendix C: Opportunities to Improve Bicycling Conditions on Existing Roads

The following tables show various roadway configurations that may lend themselves to modifications that improve bicycling accommodations. The modifications include restriping the existing pavement to provide wide curb lanes, bicycle lanes or paved shoulders; minor shoulder widening; or marking existing shoulders for bicycle use. A database query was performed for each of these categories to identify roads that may have sufficient pavement width to be reconfigured or restriped. The 12 categories are organized into 5 main groups as shown in Map 5 in Appendix A. The groups are: two-lane roads, multiple-lane roads, one-way streets, roads with potential to reduce the number of travel lanes and roads with existing shoulders. Diagrams illustrate each category with examples of the type of bicycling improvement that may be possible. The information shown in these tables is part of the BP-LOS database and is stored by the category number in the *B_FC_POS* attribute field.

Two-Lane Roads

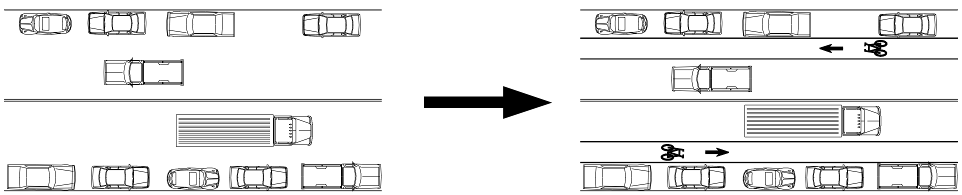
Category 1: Parking prohibited



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	Adams St (E Witherspoon St to Quincy St)	0.66	42	curb & gutter	Existing bike lane segment
2	Bunsen Pkwy (S Hurstbourne Pkwy to Plantside Dr)	0.74	36	curb & gutter	
3	Cherokee Pkwy (Cherokee Rd to Willow Ave)	0.19	40	curb only	
4	E Witherspoon St (N Shelby St to River Rd)	0.22	42	curb only	
5	Plantside Dr (Watterson Tr to Blankenbaker Rd)	0.83	36	open shoulder	
6	S 12th St (W Kentucky St to W Burnett Ave)	0.82	34/36	curb only	Parking in question
7	S 26th St (W Market St to Maple St)	0.70	30	curb only	Cars parked on sidewalk
8	S 4th St (Oakdale Ave to Longfield Ave)	0.45	36	curb only	
9	North/Southwestern Pkwy (Bank St to W Market St)	0.65	34	curb & gutter	Some sections have open shoulder
10	Stony Brook Dr (Taylorsville Rd to S Hurstbourne Pkwy)	0.75	38	curb & gutter	May have center turn lane

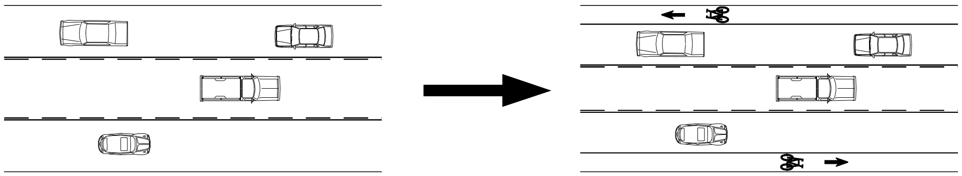
	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
11	Taylorsville Rd (Watterson Tr to Ruckriegel Pkwy)	0.33	40	curb & gutter	
12	Tug Rd (Park Blvd to Nevada Ave)	0.61	42	curb only	Area affected by airport expansion
13	Warnock St (S Floyd St to Crittenden Dr)	0.23	30-52	curb only	Unusual intersection (I-65)
14	Wilson Ave (S 24th St to S 26th St)	0.15	30	curb only	
15	Barret Hill Rd (Cherokee Rd to Park Boundary Rd)	0.25	28	open shoulder	
16	Cherokee Gardens Rd (Beals Branch Dr to Pee Wee Reese Rd)	0.10	28	open shoulder	
17	Cherokee Rd (Barringer Ave to Cherokee Ter)	0.86	28	open shoulder	
18	Pee Wee Reese Rd (Taylorsville Rd to Rock Creek Dr)	1.54	28	open shoulder	

Category 2: Parking allowed



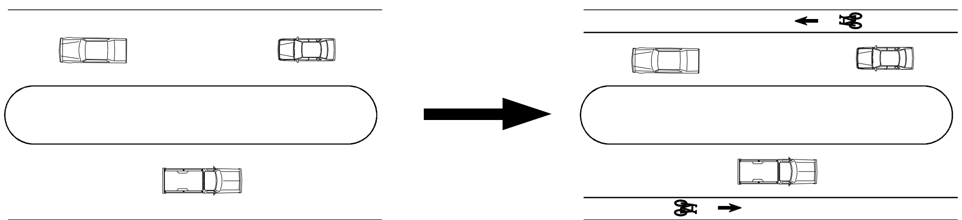
	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	Eastern Pkwy (Bardstown Rd to Cherokee Rd)	0.40	44	curb & gutter	Unusual, wide gutter pans
2	Frankfort Ave (Mellwood Ave to Weist Pl)	0.45	46	curb only	
3	S 11th/12th St (Hill St to S 7th St)	0.38	48/52	curb only	
4	S 15th St (W Broadway to W Kentucky St)	0.48	48	curb only	
5	S Floyd St (Warnock St to Byrne Ave)	0.45	48	curb only	
6	Southwestern Pkwy (W Market St to Shawnee Park Dr)	0.29	48	open shoulder	Shared-use path through park
7	W Broadway (S 36th St to Southwestern Pkwy)	0.88	50	curb only	
8	W Market St (S 23rd St to S 28th St)	0.42	48	curb only	

Category 3: Continuous center-left-turn lane, parking prohibited



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	E Indian Tr (Preston Hwy to Ironwood Rd)	2.03	42	curb and gutter	
2	Park Blvd (Crittenden Dr to Tug Rd)	0.22	44	curb and gutter	
3	Plantside Dr (Bluegrass Pkwy to Watterson Tr)	1.45	46	open shoulder	14’ wide curb lanes already exist

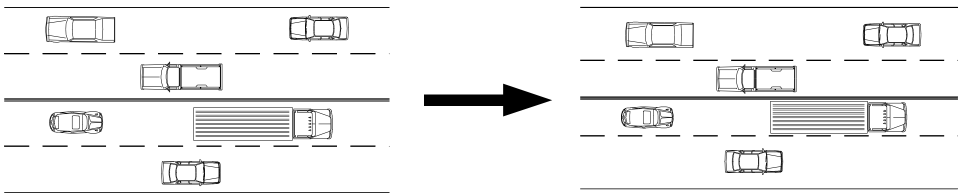
Category 4: Divided, parking prohibited



	Road Segment	Length (miles)	Pavement Width (feet)	Median Width (feet)	Edge Condition	Notes
1	Plantside Dr (Blankenbaker Pkwy to Tucker Station Rd)	0.53	72	20	open shoulder	

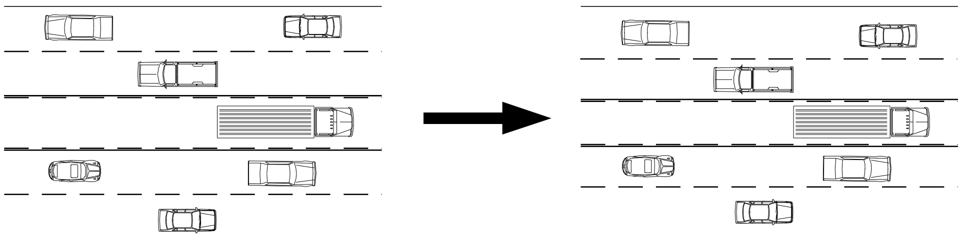
Multiple-Lane Roads

Category 6: Four-lane, parking prohibited



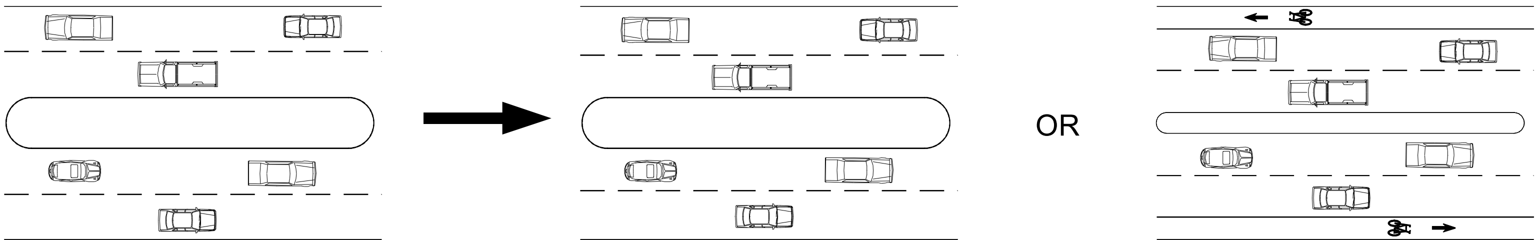
	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	Breckenridge Ln (Bardstown Rd to Six Mile Ln)	1.14	52	curb & gutter	
2	Chamberlain Ln (Westport Rd to La Grange Rd)	2.10	48	open shoulder	Minor widening may be possible
3	Crittenden Dr (Maclean Ave to Grade Ln)	2.26	52	curb & gutter	
4	Crums Ln (Cane Run Rd to Hartlage Ct)	0.63	48	curb only	
5	E Chestnut St (Chestnut St Connector to Baxter Ave)	0.47	48	curb only	
6	Eastern Pkwy (S 3rd St to S Floyd St)	0.48	50	curb only	
7	New Cut Rd (Southern Pkwy to Palatka Rd)	1.34	52	curb & gutter	
8	New La Grange Rd (Shelbyville Rd to Camelia Ave)	1.17	48	curb only	
9	Plantside Dr (Blankenbaker Rd to Blankenbaker Pkwy)	0.32	52	curb & gutter	
10	River Rd (N Preston St to Frankfort Ave)	1.24	48-52	curb only/ curb & gutter	
11	Taylorsville Rd (Tree Ln to Grand Ave)	0.27	56	curb & gutter	

Category 7: Four-lane, continuous center-left-turn lane, parking prohibited



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	Bardstown Rd (Fegenbush Rd to S Watterson Tr)	1.01	66	open shoulder	Narrow shoulder may already exist
2	Bardstown Rd (Ferndale Rd to Beulah Church Rd)	0.41	66	open shoulder	Narrow shoulder may already exist
3	National Tpke (Outer Loop to Cheri Way)	0.45	72	curb & gutter	
4	Newburg Rd (Larkmoor Ln to Bluegrass Park Dr)	0.47	66	open shoulder	
5	Preston Hwy (KFEC Gate6 Dr to Canal St)	4.33	60-78	open shoulder & curb only	Various configurations may allow for a wide curb lane
6	Sheperdsville Rd (Hikes Ln to Outer Loop)	4.08	66	curb & gutter	

Category 8: Multiple-lane, divided, parking prohibited

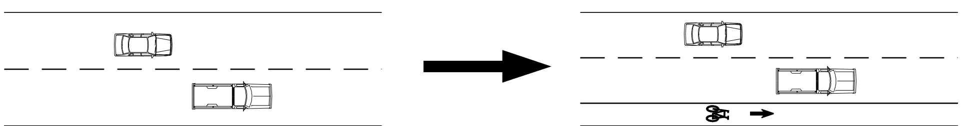


	Road Segment	Length (miles)	Pavement Width (feet)	Median Width (feet)	Total Through Lanes	Edge Condition	Notes
1	12th St Connector (W Chestnut St to W Broadway)	0.23	60	12	4	curb Only	
2	Hikes Ln (Buechel Bypass to Taylorsville Rd)	2.43	62/64	14/16	4	curb Only	
3	Newburg Rd (Sheperdsville Rd to Bluegrass Park Dr)	1.31	68	20	4	open shoulder	
4	Newburg Rd (Bishop Ln to Larkmoor Ln)	0.32	68/96	20/20	4/6	open / curb & gutter	
5	Poplar Level Rd (Eastern Pkwy to Hess Ln)	1.00	68	16	4	curb only	
6	Roy Wilkins Ave (W Market St to W Muhammad Ali Blvd	0.29	130	58	6	curb only	
7	S 9th St (W Broadway to W Kentucky St)	0.45	70	16	4	curb only	
8	S Hurstbourne Pkwy (Bunsen Pkwy to Wittington Pkwy)	1.74	108	36	6	open shoulder	Through lanes, median width and edge condition vary
9	Shelbyville Rd (Bircham Rd to Eastwood Cut Off Rd)	1.16	60	12	4	open shoulder	
10	Taylorsville Rd (Hikes Ln to McMahan Blvd)	0.34	62	14	4	open shoulder	
11	W Broadway (S 27th St to S 29th St)	0.18	60	12	4	open shoulder	
12	Bardstown Rd (Wadsworth Ave to Goldsmith Ln)	0.52	104	28	6	curb & gutter	I-264 interchange
13	Cane Run Rd (Richelle Dr to Lions Arms Dr)	2.66	72	20	4	curb & gutter	
14	Central Ave (Crittenden Dr to Taylor Blvd)	1.42	70/72	18/20	4	curb & gutter	
15	Dixie Hwy (Seibel Ct to Heaton Rd)	3.17	94	18	6	curb & gutter	Gutter pan may not exist
16	Greenbelt Hwy (Dover Ave to Lions Arms Dr)	0.27	72	20	4	curb & gutter	

	Road Segment	Length (miles)	Pavement Width (feet)	Median Width (feet)	Total Through Lanes	Edge Condition	Notes
17	Hikes Ln (Buechel Bypass to Bashford Ave)	0.41	70/82	18/30	4	curb & gutter	
18	Outer Loop (Sheperdsville Rd to Preston Hwy)	1.60	72	20	4	curb & gutter	
19	Outer Loop (National Tpke to Grade Ln)	0.68	72	20	4	curb & gutter	
20	Poplar Level Rd (Hess Ln to Poplar Tree Ct)	5.59	70/72	18/20	4	curb & gutter	
21	Produce Rd (Campisano Dr to Petersburg Rd)	0.47	64	12	4	curb & gutter	
22	S 9th St (W Kentucky St to S 7th St)	0.69	72	20	4	curb & gutter	
23	Taylorsville Rd (Cawein Way to Hikes Ln)	1.04	68/92	16	4/6	curb & gutter	

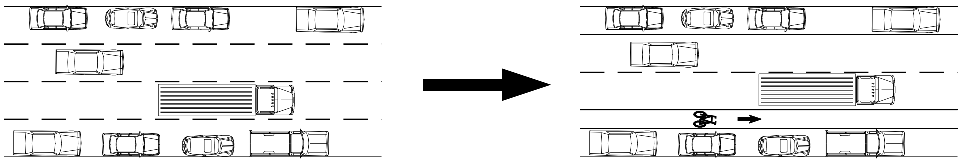
One-Way Streets

Category 9: Parking prohibited



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	Arthur St (E Gaulbert Ave to Warnock St)	0.64	30	curb only	

Category 10: Parking allowed

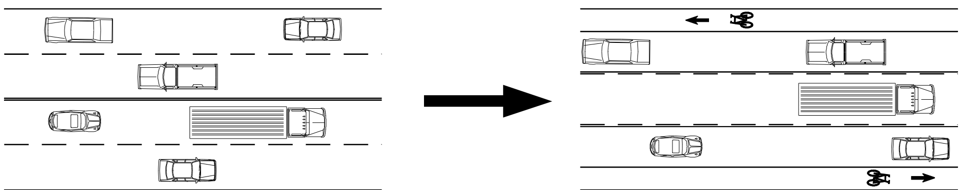


	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	E Chestnut St (S Brook St to S Campbell St)	0.87	40/42	curb only	
2	W Chestnut St (S 15th St to S 8th St)	0.64	42	curb only	
3	E Jefferson St (Baxter Ave to S 1st St)	0.94	60	curb only	
4	E Main St (Mellwood Ave to N 1st St)	1.50	40/60	curb only	
5	W Main St (N 9th St to N 22nd St)	1.18	60	curb only	
6	E Muhammad Ali Blvd (S Campbell St to S Preston St)	0.55	40/42	curb only	
7	W Muhammad Ali Blvd (S 5th St to S 15th St)	0.91	42	curb only	
8	Northwestern Pkwy (N 33rd St to N 39th St)	0.49	64	curb only	
9	Portland Ave (N 15th St to N 26th St)	1.07	40	curb only	
10	15th St (W Broadway to W Market St)	0.63	42	curb only	
11	S 1st St (W Main St to E Magnolia Ave)	1.91	42	curb only	
12	S Jackson St (E Broadway to E Jefferson St)	0.51	40	curb only	
13	Story Ave (Adams St to E Main St)	0.48	40	curb only	
14	Mellwood Ave (Brownsboro Rd to E Main St)	0.57	40	curb only	
15	S 2nd St (W Oak St to W Broadway)	0.77	42	curb only	
16	S 3rd St (W Main St to W Brandeis Ave)	2.49	42	curb only	
17	S 6th St (W Main St to York St)	0.87	40	curb only	
18	S 7th St (W Broadway to W Market St)	0.65	42	curb only	
19	S Preston St (E Main St to E Broadway)	0.71	40/42	curb only	

	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
20	S Brook St (Woodbine St to E Jacob St)	1.03	40/42	curb only	
21	S 3rd St (Breckenridge to 2nd St)	1.60	42	curb only	

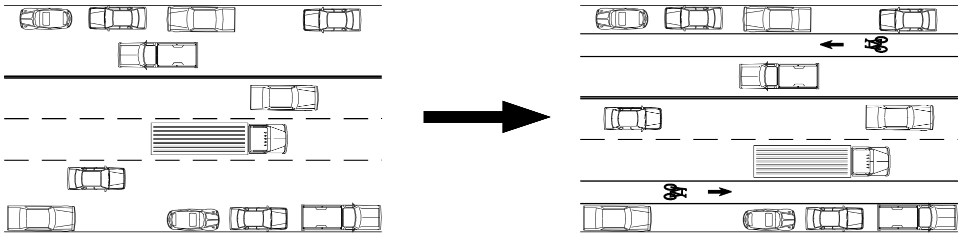
Roads with Potential to Reduce the Number of Travel Lanes

Category 11: Four-lane, bi-directional, parking prohibited (consider for conversion to two-lane with continuous center-left-turn lane)



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	7th Street Rd/S 7th St (W Hill St to Wathen Ln)	1.30	42	curb only	
2	Algonquin Pkwy (S 16th St to S 39th St)	2.11	42	curb only	
3	Fegenbush Ln (Bardstown Rd to Fern Valley Rd)	1.76	44	open shoulder	
4	S 22nd St (Dumesnil St to Dixdale Ave)	1.02	42	curb only	
5	Southwestern Pkwy (W Broadway to Virginia Ave)	0.69	42	curb only	
6	Taylorsville Rd (Bardstown Rd to Seneca Blvd)	1.31	42	curb only	
7	Winkler (S 3rd St to Taylor Blvd)	0.42	46	curb only	

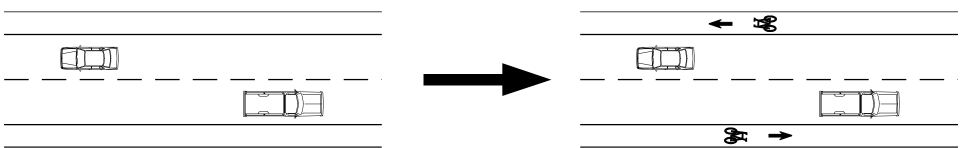
Category 12: Consider elimination of one travel lane



	Road Segment	Length (miles)	Pavement Width (feet)	Edge Condition	Notes
1	E Market St (Baxter Ave to S Brook St)	0.97	60	curb only	3 lanes cardinal direction, 1 non-cardinal
2	W Market St (S 22nd St to Roy Wilkins Ave)	1.09	60	curb only	3 lanes cardinal direction, 1 non-cardinal

Roads with Existing Shoulders

Category 5



	Road Segment	Length (miles)	Shoulder Width (feet)	Notes
1	Bardstown Rd (S Watterson Tr to Ferndale Rd)	2.45	2-3	Minor widening may be possible
2	Bardstown Rd (County line to I-265)	5.59	10	Rumble strips present
3	Dixie Hwy (County line to Seibel Ct)	11.37	6-10	
4	Dixie Hwy (Bernheim Ln to LeRoy Ave)	1.92	5	

	Road Segment	Length (miles)	Shoulder Width (feet)	Notes
5	Flowervale Ln (Dixie Hwy to Lewis Way)	0.61	9	
6	Greenbelt Hwy (Dover Ave to Dixie Hwy)	7.09	6-10	Rumble strips likely present
7	Manslick Rd (Crums Ln to Lance Dr)	0.40	9	Crosses I-264
8	New La Grange Rd (Camelia Ave to Whipps Mill Rd)	1.42	4	
9	Old Henry Rd (N. English Station Rd to Arnold Palmer Blvd)	1.93	8-10	
10	Outer Loop (3rd Street Rd to National Tpke)	2.51	3	Minor widening may be possible
11	Outer Loop (Grade Ln to Lone Oak Ave)	2.70	10	I-65 interchange
12	Pee Wee Reese Rd (Seneca Park Rd to Cannons Ln)	1.21	4	Shoulder present on one side only
13	Preston Hwy (County line to I-265)	2.17	9-11	
14	Produce Rd (Poplar Level Rd to Jennings Ln)	0.65	4+	Unimproved shoulder may exist
15	Seneca Park Rd (Park Boundary Rd to Pee Wee Reese Rd)	0.33	4	Shoulder present on one side only
16	Shelbyville Rd (Wildwood Ln to Blankenbaker Pkwy)	1.42	3	Minor widening may be possible
17	Shelbyville Rd (N Watterson Tr to Bircham Rd)	3.88	2-12	Minor widening may be possible
18	South Park Rd (Lampton Ave to Old South Park Rd)	0.66	10	Crosses I-65 near I-265
19	Stone Street Rd (Dixie Hwy to 3rd Street Rd)	1.21	5	
20	Taylorsville Lake Rd (Taylorsville Rd to County line)	4.25	10	Rumble strips present
21	Taylorsville Rd (Ruckriegel Pkwy to Taylorsville Lake Rd)	4.79	2	Minor widening may be possible
22	Taylorsville Rd (McMahan Blvd to Tucker Rd)	2.41	5-10	
23	Terry Rd (Cane Run Rd to Greenwood Rd)	2.47	4	
24	Watterson Tr (Plantside Dr to Ruckriegel Pkwy)	0.70	7-10	
25	Whipps Mill Rd (La Grange Rd to Keeneland Blvd)	0.21	3	Minor widening may be possible
26	Woodridge Dr (Woodridge Lake Blvd to Deering Heights Dr)	0.29	8	Crosses I-265
27	Browns Ln (Dutchmans Ln to Sherburn Ln)	0.32	10	Crosses I-64