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MEMORANDUM

Date:	July 31, 2013
To:	Todd Girdler, Jessica Mortinger
From:	Tom Huber & Bill Schultheiss, PE
Re:	Lane Widths

On June 4 through 6 of 2013, Toole Design Group (TDG) conducted field visits by bicycle of streets and bikeways recommended for improvement within the Lawrence and Douglas County bicycle plan. As observed and measured, a number of street segments will require removal of parking (if present), widening the roadway, or narrowing travel lanes to provide the recommended bike lanes. For purposes of this memorandum it is presumed that widening the street and removing parking may not be financially or politically feasible on some or most segments, therefore, the use of narrower travel lanes will be required to provide the bicycle lanes recommended. Should narrower travel lanes not be acceptable in many of these cases, the alternative may be the provision of a wide outside lane which will not provide the same comfort, safety, or operational benefits as bicycle lanes.

Most of the subject streets observed are either 2-lane collectors or 2-lane minor arterials with and without parking lanes. This memorandum presents design and safety considerations for the use of 10 and 11 foot travel lanes. The width of travel lanes is an important consideration as the cities of Lawrence, Eudora, Baldwin City, and Lecompton and Douglas County seek to balance the safety needs of all street users while at the same time ensuring that public rights-of-way in the cities and county are used to the utmost efficiency. To inform this discussion, a review of current lane width guidance and research is provided below.

Overview of Policy Guidance

National highway design policy allows a flexible approach to selecting lane widths. The AASHTO *Policy on Geometric Design of Highways and Streets* recommends that lane widths on major roads should range from 10-12 feet.[1] The selection of the appropriate lane width is a context-based decision. For example, 12-foot lanes are generally more appropriate on higher speed, free flowing, principal arterials. On roads with signals operating at lower speeds (45 mph or less), narrower lane widths are normally adequate and have some advantages as outlined in this memo (e.g., safety, separation of users, capacity). The determination of lane widths should incorporate factors such as a road's crash history, speed limit, the volume of heavy trucks, and whether a shoulder is provided.

The Federal Highway Administration allows flexibility and notes that while wider lane widths may be attainable on new construction; projects that seek to retrofit the built environment should consider minimum values where appropriate.[2] Flexibility in lane widths is particularly important in cities and towns, where there is often a concentration of multiple modes in constrained conditions. In recognition of the need to provide additional guidance for roadway design in urban areas, the Institute of Transportation Engineers (ITE) published the *Urban Street Geometric Design Handbook.*[3]

The *Geometric Design Handbook* addresses the importance of context when selecting travel lane width and provides specific lane width recommendations based on roadway type and cross section. For example, it provides

[1] AASHTO. *A Policy on Geometric Design of Highways and Streets.* Washington, D.C. : American Association of State Highway and Transportation Officials, 2004.

[2] Federal Highway Administration. *Flexibility in Highway Design.* Washington, DC : United States Department of Transporation, 1997.

[3] Institute of Transportation Engineers . *Urban Street Geometric Design Handbook.* Washington, DC : ITE, 2008.

minimum recommended lane width dimensions for urban collector streets, which take into account context-based factors such as land use, motor vehicle volumes, speed, and whether there is existing on-street parking and/or bike lanes.

Overview of Research

Traditionally, 12 feet is the desired standard for motor vehicle travel lanes. Narrower lane widths have been avoided in the past due to concerns about vehicle occupant safety and congestion, especially on arterial roadways. The only substantial research effort published which documented safety benefits were attributable to 12-foot lanes on rural two-lane highways.[4] New research on suburban and urban arterials, however, has shown that 12 feet is not always needed for safety and capacity and lane widths between 10 feet and 11 feet on arterials and collectors do not negatively impact overall motor vehicle safety or operations. A summary of safety and capacity-related research is provided below.

Safety

A study by the Midwest Research Institute entitled *Relationship of Lane Width to Safety for Urban and Suburban Arterials* concluded "That there is no indication that crash frequencies increase as lane width decreases for arterial roadway segments or arterial intersection approaches."[5] The study compared 408 miles of urban and suburban arterials under state and local jurisdictions in two states. The types of roads in the analysis included the following arterial roadway types:

- Two-lane undivided arterials
- Three-lane arterials (one lane each direction + center turn lane)
- Four-lane undivided arterials
- Four-lane divided arterials
- Five-lane arterials (two lanes each direction + center turn lane).

According to the study, "A safety evaluation of lane widths for arterial roadway segments found no indication, except in limited cases, that the use of narrower lanes increases crash frequencies." Further, the study found that, "The lane width effects in the analyses conducted were generally either not statistically significant or indicated that narrower lanes were associated with lower rather than higher crash frequencies." Similarly, the study found no indication, except in limited cases, that the use of narrower lanes for arterial intersection approaches increases crash frequencies.

It is important to note that this study highlighted three situations in which the observed lane width effect was inconsistent including: lane widths of 10 feet or less on four-lane undivided arterials; lane widths of 9 feet or less on four-lane divided arterials; and lane widths of 10 feet or less on approaches to four-leg STOP-controlled arterial intersections. According to the study, these inconsistent findings do not mean that the use of narrower lanes must be avoided in these situations, but rather that, "It is recommended that narrower lane widths be used cautiously in these situations unless local experience indicates otherwise."

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[4] Harwood, D. W., F. M. Council, E. Hauer, W. E. Hughes, A. Vogt, Prediction of the
Expected Safety Performance of Rural Two-Lane Highways, Report FHWA-RD-99-207,Federal Highway Administration, December 2000.

[5] Potts, Ingrid B, Harwood, Douglas W and Richard, Karen R. *Relationship of Lane width to Safety for Urban and Suburban Arterials.* Washington, D.C. : Transporation Research Board, 2007.

The study also provides a caveat that "Lane widths less than 12 feet should be used cautiously where substantial volumes of bicyclists share the road with motor vehicles, unless an alternative facility for bicycles such as a wider curb lane or paved shoulder is provided." This statement is intended to suggest that bicyclists comfort and safety should be accommodated on projects where lanes are narrowed to add additional roadway capacity for motorists.

The safety study described above included roads with buses and heavy vehicles. However, it bears mentioning that these vehicles are wider than single-occupancy vehicles (10.5 feet inclusive of mirrors on buses and trucks compared to 8 feet for smaller motor vehicles). Providing a bike lane or paved shoulder adjacent to a lane that carries higher volumes of heavy vehicles is beneficial to both users as it potentially increases the total effective width of the space that would otherwise function as a shared wide lane.

Finally, a report of the National Cooperative Highway Research Program report titled *Effective Utilization of Street Width on Urban Arterials* reached a similar conclusion.[6] This report considered the effectiveness of various strategies to re-allocate widths on urban arterials. The report surveys a wide range of crash data and finds no consistent relationship between 10 foot lanes and increased crash rates. The report recommends that narrower lanes should be considered as a strategy to implement other geometric improvements.

Capacity

Research has also been done to determine the effect of reducing lane widths on motor vehicle capacity. NCHRP Project 3-72 entitled *Lane Widths, Channelized Right Turns, and Right-turn Deceleration Lanes in Urban and Suburban Areas* studied saturation flow rates for various lane widths, and found only a negligible difference (less than 5%) between the saturation flow rate of a 12' travel lane versus a 9.5' travel lane.[7] Therefore, reducing a travel lane width from 12' to 10' has been found to have little adverse effects on motor vehicle capacity in urban and suburban locations.

The Highway Capacity Manual (HCM) is the standard reference document for determining the capacity of roadways and intersections. It was updated in 2010 and reflects the research findings discussed above.[8]

Comfort and Preference for Bicyclist Separation

The Florida Department of Transportation sponsored research to develop a "Bicycle Level of Service" model to measure the comfort of various bicycle facilities for bicyclists.[9] The research concluded bicyclist comfort increased with additional separation from motorized traffic on roadways and decreased with increasing speed and/or volume of traffic (i.e. LOS A = very comfortable, LOS F = very uncomfortable). Generally speaking, the provision of separate bicycle lanes provides bicyclists a substantially higher degree of comfort than a shared wide travel lane. This research has been thoroughly evaluated and calibrated through its application in bicycle master plans throughout the United States. The procedure is now included in the 2010 Highway Capacity Manual.

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[6] Harwood, D.W. *Effective Utilization of Street Width on Urban Arterials* . Washington, D.C. : Transportation Research Board, 1990. NCHRP 330.

[7] *Lane Widths, Channelized Right Turns, and Right-turn Deceleration Lanes in Urban and Suburban Areas* citation.

[8] Transportation Research Board. *Highway Capacity Manual*. Washington, DC: TRB, 2010.

[9] Petritsch, T. A., B. W. Landis, et al. (2006). *Bicycle Level of Service for Arterials*, Florida Department of Transportation

The following example illustrates an application of the model to compare a wide outside lane to a bicycle lane:

Example roadway characteristics: 4 undivided travel lanes, 16,000 ADT, 6% heavy vehicles, 35 mph speed limit, good pavement condition, no parking, 15 foot outside lane.

Scenario	*Lane Width Combination (assuming 16 feet of space available)*	*Bicycle Level of Service Score*	*Bicycle Level of Service Grade*
1	*15 Foot Wide Outside Lane*	*3.86*	*D*
2	*10 Foot Travel Lane, 5 Foot Bicycle Lane*	*2.99*	*C*

A 2013 TRB paper documents findings that motorists prefer the presence of bicycle lanes when interacting with bicyclists. [10] Evidence of this is also found in a recent survey of Bay Area drivers, who overwhelmingly agreed that bicycle lanes "make bicyclists more predictable" and "give bicyclists their own space." Finally, bicycle lanes have been shown to encourage more bicyclists to ride on the roadway instead of the sidewalk, improving safety for pedestrians using the sidewalk.

Conclusion

Based on the most recent research the TDG team will include recommendations in its draft bikeway plan for Lawrence and Douglas County that feature 10' travel lanes for urban streets (none for rural areas). These recommendations will be informed by traffic volumes, anticipated bicycle usage, posted speeds, and functional classification of the roadway. This information will be presented to support the recommendations. Finally, the TDG team will be conservative in its recommendations involving the use of 10' travel lanes, selecting the best combination of factors for their application.

[10] Sanders, Rebecca, Cooper, Jill. *Do All Roadway Users Want the Same Things? Results from a Roadway Design Survey of Pedestrians, Drivers, Bicyclists, and Transit Users in the Bay Area.* Washington, DC. TRB, 2013. http://safetrec.berkeley.edu/trb2013/13-4475.pdf