

# Chapter 12

## Literature Review

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### ***QUALITY-OF-LIFE STUDY OF THE 7<sup>th</sup> AVENUE AND 7<sup>th</sup> STREET REVERSE LANES***

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## Introduction

A literature review was conducted of 16 different cases to analyze if any contained relevant information for the Phoenix study regarding reverse lanes and/or citizen participation. A series of questions were asked of each article to determine their relevance to the Phoenix study. The few most relevant articles are reviewed in this chapter. Appendix 5 contains the three most relevant documents.

The following articles were reviewed:

1. Bonneson, J. and McCoy, P. *Capacity and Operation Effects of Midblock Left Turn Lanes* (1997). National Cooperative Highway Research Program.
2. Day Wilburn Associates. *Northside Drive Reversible Traffic Analysis*. Prepared for the Georgia State Department of Transportation (2001).
3. DMJM + Harris, Inc. *Connecticut Avenue Transportation Study*. Prepared for District Department of Transportation, District of Columbia (2003) (Main report and Appendices J and K).
4. Iowa Department of Transportation. *Guidelines for the Conversion of Urban Four-lane Undivided Roadways to Three-lane Two-Way Left Turn Lane Facilities*. Iowa State University, Sponsored by the Office of Traffic and Safety of the Iowa Department of Transportation (2001).
5. Lamber, L. and Wolshon, B. *Convertible Roadways and Lanes: A Synthesis of Highway Practice*. National Cooperative Highway Research Program (2004).
6. Lambert, Laurence and Wolshon, Brian (2006). *Planning and Operational Practices for Reversible Roadways*. ITE Journal, 2006.
7. Machemehl, R., O'Shea, J, and Rioux, T. *Design of Medians for Principal Arterials*. Center for Transportation Research, University of Texas at Austin (2001).
8. *Mid-Block Crossings*. United States Department of Transportation.
9. Pernia, J., Lu, J.J., Peng, H. *Safety Issues Related to Two-Way Left-Turn Lanes*. University of South Florida, Prepared for the Florida Department of Transportation (2004).
10. Poole, Robert Jr. and Orski, C. Kenneth. *HOT Networks: A New Plan for Congestion Relief and Better Transit*. Reason Foundation (2003).
11. Research Results Digest. *Crash Reduction Factors for Traffic Engineering and Intelligent Transportation System Improvements: State-of-Knowledge Report*. National Cooperative Highways Research Program (2005).
12. Texas Transportation Institute. *Houston's Travel Rate improvement Program*. Prepared for the Greater Houston Partnership (2001).
13. Squires, C A. and Parsonson, P S. *Accident Comparison of Raised Median and Two-way Left turn Lane Median Treatments*. Transportation Research Record, 1239 (1989).

14. Wolshon, B. and Lambert, L. *Reversible Lane Systems: Synthesis of Practice*. Journal of Transportation Engineering (2006).
15. Transcore. *Grant Road Reversible Lane Traffic Flow and Crash Analysis with an Update of Broadway Boulevard Reversible Lane Study*. Prepared for City of Tucson, Arizona (2005).
16. Transcore. *Before and After Study of Traffic Conditions for the Trial Removal of Reversible Lanes on Broadway Boulevard*. Prepared for City of Tucson, Arizona (2001).

Each article was initially selected based on its potential significance to the Phoenix study. To determine relevance, nine questions were asked of each article. These questions related to reverse lanes and public opinions and satisfaction, as well as to reverse lanes in general. The questions follow below.

1. Public process for removing the lanes?
2. Implementation for removing the lanes?
3. Public Satisfaction Identified?
4. Any focus groups done regarding lanes?
5. Any surveys on public opinion done regarding lanes?
6. Any lanes which were removed, and why?
7. Any public controversies in removing the r lanes?
8. Entities responsible for the process for creating the r. lanes?
9. General Problems with R. Lanes
10. Purpose for creating R. Lanes:

Based on this research, several cases were determined not to be of particular relevance to the Phoenix Reverse Lane study. Those articles and reports that were significant were then studied further for this project. Rarely was public opinion cited in any way regarding traffic studies or implementation. Only a few articles mentioned gathering public opinion, and most were evaluative, and not meant to influence a decision to remove a reverse lane. The more relevant articles are reviewed below.

## Most Significant Cases

Through the literature review, it was found that several cases were relevant to the Phoenix Reverse Lane study. Overall, the most relevant cases were the Tucson Grant Avenue and Broadway Avenue Studies, and the Connecticut Avenue report by DMJM + Harris for Washington DC DOT. These cases include a reverse lane study and gathering public opinion on traffic issues in the study area.

The next most relevant report was from the Iowa Department of Transportation titled Guidelines for the Conversion of Urban Four-lane Undivided Roadways to Three-lane Two-Way Left Turn Lane Facilities had a considerable amount of information relevant to the Phoenix study in regards to public opinion, albeit nothing about reverse lanes specifically. The HOT Networks article also has mention of focus groups in studying public opinion regarding traffic, but also does not make specific mention to reverse lanes.

A few articles also made reference to information that while not entirely relevant independently, as a whole, contribute significantly. The Convertible Roadways report included a survey which questioned if public opinion surveys had been done. The results indicated that of all the 16 respondents, only three agencies had sought out public opinion regarding reverse lanes (Texas Department of Transportation, Virginia Department of Transportation, and Washington DC Department of Transportation). The two former surveys were concerning freeway median reverse lanes, and the latter was referring to the Connecticut Avenue report by DMJM + Harris for Washington DC. The Reversible Lane Systems: Synthesis of Practice article included some information relevant to reverse lanes in general, and did mention that typically, the only public opinion gathered on reverse lanes or traffic in general was in the form of complaints, and thus, a lack of complaints was an indicator of a project's success.

Provided below is more detailed information regarding those reports determined to be most relevant to the Phoenix Reverse Lanes study.

### ***Featured Literature #1***

#### **Transcore. Grant Road Reversible Lane Traffic Flow and Crash Analysis with an Update of Broadway Boulevard Reversible Lane Study. Prepared for City of Tucson, Arizona (2005).**

This study analyses the before and after impacts of removing the reverse lanes from both Grant Road and Broadway Boulevard in Tucson, Arizona, with greater emphasis on the former street. Various methods were utilized to identify possible changes in traffic volumes, traffic delays, use of alternate modes of travel, and accidents following the removal of the reverse lane operations. The study results and references to public opinion are all pertinent to the Phoenix reverse lane study.

Traffic impacts were analyzed before and after the Grant Road reverse lane functions were removed in June of 2004. The findings reveal that traffic volumes decreased in the after period and that the removal of the left-hand turn restriction may have caused some traffic to be redistributed along another perpendicular arterial roadway. The study also demonstrates that once the reverse lanes were removed, the total number of car accidents decreased by 14%, especially rear-end and side-swipe crashes. With the reverse lane, 35% of all crashes, including the only 2 head-on collisions, occurred as a result of illegal left hand turns while the reverse lane was in effect. Crashes in the reverse lane did not increase during winter, when it was expected that more accidents would occur with the increased number of Tucson visitors who are less familiar with the

reverse lanes. The number of pedestrian accidents remained the same both before and after the reverse lane functions were removed. Finally, and as expected, there was an increase in left-hand turns after the lanes were removed.

Relative to the removal of the Broadway Boulevard reverse lanes, this document builds on a previous study (2004), and summarizes the crash results from 3 years before the reverse lanes were removed, and 4 years afterward. Although the Broadway Boulevard lanes are approximately  $\frac{1}{2}$  as long as those of Grant Road, some of the findings are similar. For instance, automobile crashes decreased by 6.7% per year following the termination of the reverse lanes, and the number of left-hand turn crashes increased in the after period. The most common accidents in both the before and after periods were rear end crashes, and this type increased by 14% after the reverse lanes were removed. On the other hand, sideswipe crashes decreased by 14% in the after period. After the lanes were removed, one-half of the intersections experienced a decrease in crashes, and the other half experienced increases, some of which were likely due to increased congestion.

The monograph addressed public opinions of the reverse lanes, albeit very briefly, but it noted a general disfavor for the reverse lanes by the public and the media. When an earlier reverse lane in Tucson was discontinued at 6<sup>th</sup> Street, the public expressed its approval, regardless of the increased degree of traffic delays and accidents.

### ***Featured Literature #2***

#### **Transcore. Before and After Study of Traffic Conditions for the Trial Removal of Reversible Lanes on Broadway Boulevard. Prepared for City of Tucson, Arizona (2001).**

In 2001, the City of Tucson decided to discontinue reverse lanes along Broadway Boulevard for a period of six months to identify before and after affects of the lanes. This document reports on the research findings relative to this approach, and addresses the subtopics of traffic volumes, traffic splits, left-turn delays, car and pedestrian accidents, u-turn counts, intersection studies, commercial driveway counts, and quantity of left-turns at the intersection located at the end of the reverse lane. Public opinion was also mentioned briefly.

It was found that in the after period, traffic did not divert onto alternate routes as was expected. U-turns, pedestrian volumes, and left-hand turns at the end of the reverse lane occurred less often after the reverse lanes were discontinued. The after period also found negative traffic impacts, such as increased traffic congestion and rear end crashes, and confusion with flashing red lights at newly installed pedestrian crossings. The report mentions that notwithstanding the negative impacts with traffic congestion and crashes, it was found that the public approved of the changes.

The document's final recommendations include removal of the reverse lanes, further examination of accident patterns, modification of pedestrian crossings as needed, coordination of the timing of pedestrian crossings with the traffic signals, and provision of additional signage to explain the flashing red lights at pedestrian crossings.

### ***Featured Literature #3***

#### **DMJM + Harris, Inc. Connecticut Avenue Transportation Study. Prepared for District Department of Transportation, District of Columbia (2003).**

This document discusses Connecticut Avenue in Washington, DC, analyzing current conditions including traffic volumes, speeds, safety and parking as well as analyzing future conditions. The reversible lane was found to be a safety issue and is discussed in-depth, specifically in Appendix J. Citizens comments are found and discussed in Appendix K. There is some information regarding the reversible lane safety and gathering public opinion that seems relevant to the Phoenix study.

### ***Featured Literature #4***

#### **DMJM + Harris, Inc. Connecticut Avenue Transportation Study. Appendices J and K Prepared for District Department of Transportation, District of Columbia (2003).**

These two appendices discuss a reverse lane study (Appendix J) and citizen comments (Appendix K). Appendix J provides an overview of current safety and efficiency issues regarding the reverse lanes on Connecticut Avenue. It should be noted that Connecticut Avenue is very much like 7<sup>th</sup> Avenue and 7<sup>th</sup> Streets in Phoenix – in dense urban environments with demand for left turns and other local trips. The Connecticut Avenue study was not considering removal of the lanes, and public comments found in Appendix K focused on the need for electronic signage. The study focused on observing and counting vehicles which were in the lanes incorrectly, either against traffic or making lefts from the wrong lanes. It was concluded that the present situation was “unsafe and inefficient” according to the Manual on Uniform Traffic Control Devices (MUTCD). It did not explain in detail why they came to this conclusion. They did report violation rates observed, accident rates, but did not explain what the standards are which reveal these observations to be unsafe or inefficient. Here were the conclusions (p.7):

At some locations there are constant violations, with drivers using the reversible lanes at times when they are not supposed to be using them.

The reversible lanes violations result in major safety problems.

The potential for collisions is increased significantly by the reversible lanes violations.

Because drivers traveling in the peak direction are aware of the frequency of violations, the use of the reverse lane in the peak direction is significantly less than the use of regular lanes during the peak periods.

Violators often block traffic traveling in the peak direction, reducing capacity of the reversible lane.

**The study concluded the following (p. 8):**

Reversible lane control signs [i.e. signs, not electronic signals] are permitted when an engineering study indicates that sign operation along would result in a level of safety and efficiency that is acceptable. The data collected on encroachments and the videotape recordings performed for this study indicate that there is not an acceptable level of efficiency and safety without overhead signals.

The MUTCD requires that the reversible lane control signs be mounted over the center of the lane being reversed. The existing system does not include a lane control sign mounted over the center of the lane is being reversed.

**The study recommended (p.11):**

TSA recommends the implementation of a system of overhead signals and signs in the reversible lane section of Connecticut Avenue. As documented in this report and in the accompanying videotape, the current system has high levels of violations. These violations result in the deterioration of safety in the corridor and reduce the overall capacity of the roadway.

The citizens' comments from 2 public meetings are provided in Appendix K. There is some relative information regarding the reversible lane safety and gathering public opinion that seems relevant to the Phoenix study. There were comments requesting to widen the street to add left turn lanes and to add overhead signals for the reverse lanes.

***Featured Literature #5***

**Iowa Department of Transportation (2001). Guidelines for the Conversion of Urban Four-lane Undivided Roadways to Three-lane Two-Way Left Turn Lane Facilities. Iowa State University, Sponsored by the Office of Traffic and Safety of the Iowa Department of Transportation, 2001.**

This document discusses the conversion of four-lane undivided roads to three-lane roads with a center two way left turn lane (TWLTs). There is no mention of reverse lanes and the only public participation was a survey regarding TWLTs conversions. It seems relevant, however, because it illustrates how public opinion improved after a reduction in capacity because of calmer traffic conditions. The removal of a reverse lane on 7th Avenue and 7th Street is akin to conversion of the four lanes (two lanes in each

direction with no center median) to a three lane roadway (one lane in each direction, with a two-way-left-turn lane in the center). Here, there were worries about a reduction in speed and capacity, which did materialize. But, opinion improved when the improvements in left turns, pedestrian crossings and reduction in speeding were seen. Relevant excerpts are included in the following pages (pp.20 to 25).r

### *Opinion Survey Results*

An opinion survey about the U.S. 75 conversion was also distributed to the citizens of Sioux Center. Respondents were asked their opinion about several subjects, whether they supported the conversion before and after it occurred, and whether they believed that the conversion was in the best interest of the majority of Sioux Center residents.

Nearly 2,000 surveys were distributed, and over 930 responses were received. This is about a 47 percent response rate. Included with these responses were over 500 written comments, and some of these are included in the next section of this report. The responses to the subjects or questions listed above are discussed and summarized in the following paragraphs.

In general, the survey results indicate that most respondents believed that the conversion had achieved its intended goal of reducing speeds and increasing pedestrian safety. About 60 percent of the respondents agreed or strongly agreed that traffic safety has improved along U.S. 75, and about 66 percent had a similar feeling that the conversion resulted in fewer speeding vehicles and less aggressive driving. The before-and-after speed and crash data quantitatively support these conclusions (see the previous sections of this discussion). Fifty percent of the respondents believed that the pedestrian crossings of U.S. 75 were safer after the conversion, but about 32 percent did not agree with this conclusion. These responses are summarized in the figures presented in Appendix A.

The survey results also showed that many respondents believed they were experiencing more delay. Unfortunately, but not unexpectedly, about 86 percent of the respondents reported that they sometimes to always experience more delay entering/exiting the side streets than they did before the conversion. These results represent the tradeoff that is often, but not always, required 22 after the conversion of a four-lane undivided roadway to a three-lane cross section. The decision to convert a four-lane undivided roadway to a three-lane cross section is expected to decrease crashes, but often requires the acceptance of a decrease (sometimes insignificant) in LOS during peak hours along the roadway. The Iowa DOT and the City of Sioux Center will implement several minor signalization and geometric improvements that are expected to decrease the delays currently being experienced.

In general, the survey results also showed a change in public opinion once the conversion was implemented. Some of the survey respondents reported they were either neutral or in opposition to the decision to implement the conversion but are now supporters. The survey results indicated that about 18 percent supported the conversion when it was proposed, 37 percent were neutral, and 45 percent did not support the conversion. These percentages changed to 45, 15, and 40 percent after the conversion was complete (see Appendix A). A number of people that were neutral about the conversion now appear to support it. About five percent of the respondents shifted from complete disagreement to support of the conversion. Overall, about 44 percent of the respondents believed that the conversion was in the best interest of the majority of Sioux Center residents, about 21 percent were neutral, and about 35 percent did not believe it was in the best interest of the majority of Sioux Center residents. The results appear to indicate that some respondents still did not support the conversion, but they are neutral with respect to whether it was in the best interest of the majority of the Sioux Center residents. In April 2000 the Sioux Center City Council reviewed the results of this survey and the operational impact data discussed, and decided to retain and extend the three-lane cross section along U.S. 75.

#### *General Comments*

There have been many comments, both positive and negative, from the survey respondents and Sioux Center City officials about the four-lane to three-lane conversion of U.S. 75. Both types of comments are included in the following list:

Paul Adkins (Sioux Center Police Chief): Chief Adkins was quoted by the Sioux Center News in an article entitled "Police Pleased with Three-Lane Traffic" (September 15, 1999). Chief Adkins indicated that the conversion ". . . had a calming effect on the traffic and that was the goal when the city council agreed to make the change." He believed that people were

". . . driving slower and that reduces crashes."

In the same September 15, 1999 Sioux Center News article (see previous comment), Chief Adkins did acknowledge that vehicle queues on the roadway had been a concern, "[e]specially when there are a number of trucks that need to get going after coming to a complete stop." In addition, turning left at the signalized intersections has been an issue because there are no left-turn arrow phases. Chief Adkins also indicated that there may be more local drivers using the parallel streets in the downtown area to bypass some of the delays experienced on U.S. 75. Fortunately, with respect to emergency vehicles, Chief Adkins said that on the three-lane U.S. 75 "[t]here seems to be enough room for drivers to pull off to the side and still allow the emergency vehicles through."

Overall, Chief Adkins is “. . . convinced that for pedestrians, Highway 75 is safer than it was . . .”, and that pedestrians “. . . see traffic better on the three-lane plan and drivers see pedestrians better.” He believes that it has “. . . been a positive experience. It’s not perfect, but we are happy with the initial results.” Chief Adkins admits to initially being opposed to the conversion, but now he calls himself one of its biggest advocates. He has volunteered to talk to any city that might be considering a conversion of this type.

Murray Hulstein (Assistant City/Utilities Manager): Mr. Hulstein believes that the public reaction was initially very negative, but that since the conversion was implemented the feedback has been mostly positive, rather than negative. The Mayor of Sioux Center agreed with this assessment. The increase in vehicle delay during peak travel periods at the signals on U.S. 75 during peak hours appears to be the most significant concern, but the most significant benefit has been the reduction in speed.

#### *Representative Negative Survey Responses*

- The change has not improved anything! If anything, it has made people be more aggressive.
- Traffic backs up pretty bad at all stoplights, can be several blocks backed up!
- During certain times of the day you have to wait for two green lights to get through the downtown stoplight.
- It is the semi-truck trailers that cause congestion at the traffic lights during the busiest times.
- Highway 75 is so busy that no matter when I try to get off the side streets I always have to wait.
- I often take 4th Avenue (a parallel local street) across town during busy times. I see others doing so also, so you might just be moving the problem to a new area.
- I have witnessed dangerous, almost wild-eyed urgency to gain first position in the areas leading into the three-lane portions.
- I feel with the town growing that you have not found a good solution by going four lanes to three.

#### *Representative Positive Survey Responses*

- I can now stop for a pedestrian without putting them in danger of getting hit by a vehicle in another lane.

- Even though I don't like the change it was the best alternative and I'm willing to live with it.
- I am pleased with the results of the three-lane conversion project. I definitely feel the three-lane option was a much better option than the five-lane option.
- Very comfortable and pleased with the three lanes. Safer, too, for elderly drivers like me.
- So what if it does take us a bit longer to enter and exit, it definitely is safer. That's what counts.
- We feel safer now on the main street. Thanks.
- I was definitely against it when first proposed, but I am 100 percent for it now.
- Safety—Yes. Convenience—No.

The preceding paragraphs represent a summary of the comments from the opinion survey, numerous public meeting discussions, and the local newspaper. A four-lane to three-lane conversion is a new idea and can only be successful or feasible if there is support in the community to experiment with it. In addition, the expected safety and traffic flow characteristics of the converted roadway must be compatible with the goals of the community. The roadway characteristics that need to be considered and evaluated to determine the feasibility of a four-lane to three-lane conversion are discussed later in these guidelines.

Some highlights of the survey responses are shown below.

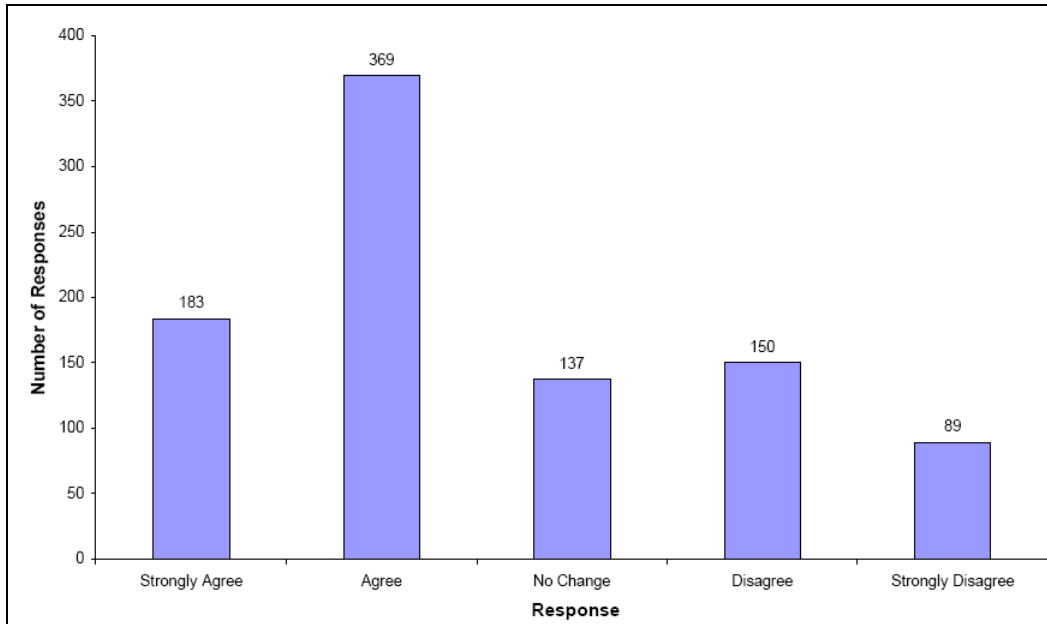


Figure 12 - 1 Question 1 (Source: Iowa Department of Transportation (2001), p. 75)

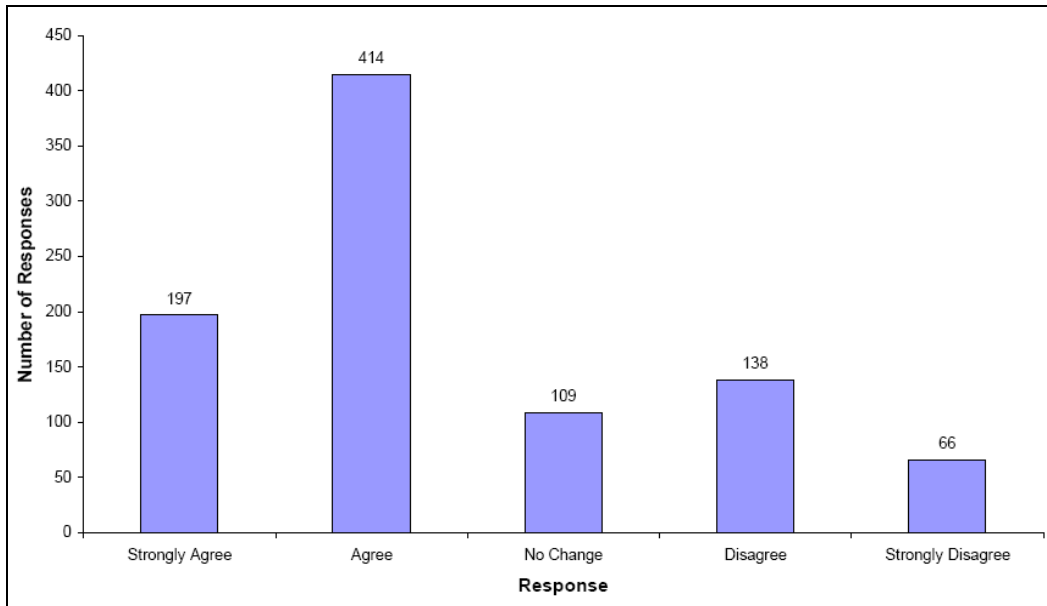


Figure 12 - 2 Question 2 (Source: Iowa Department of Transportation (2001), p. 75)

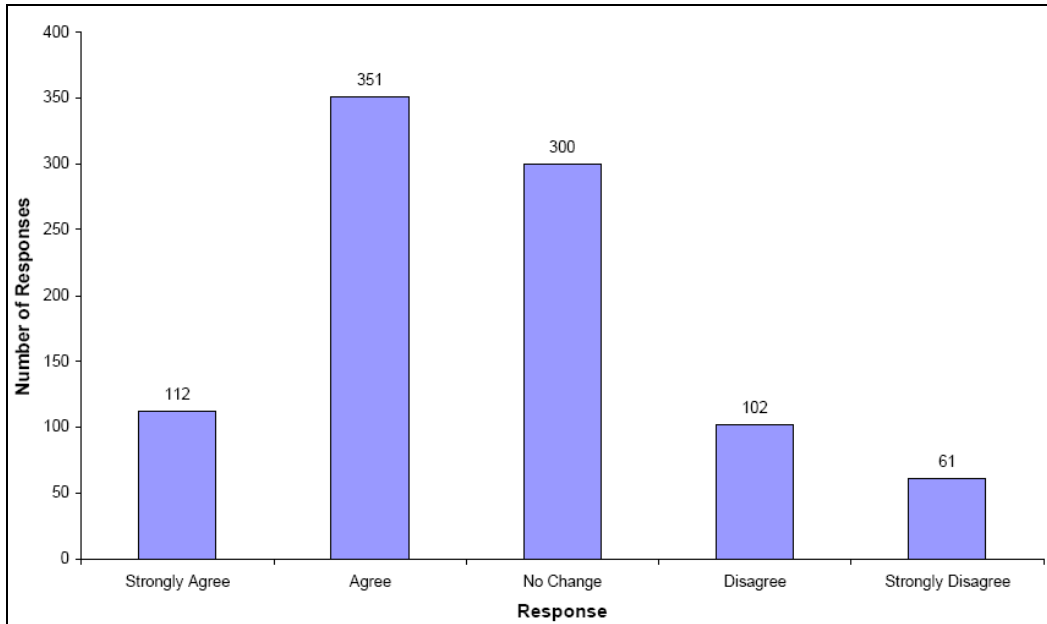


Figure 12 - 3 Question 3 (Source: Iowa Department of Transportation (2001), p. 76)

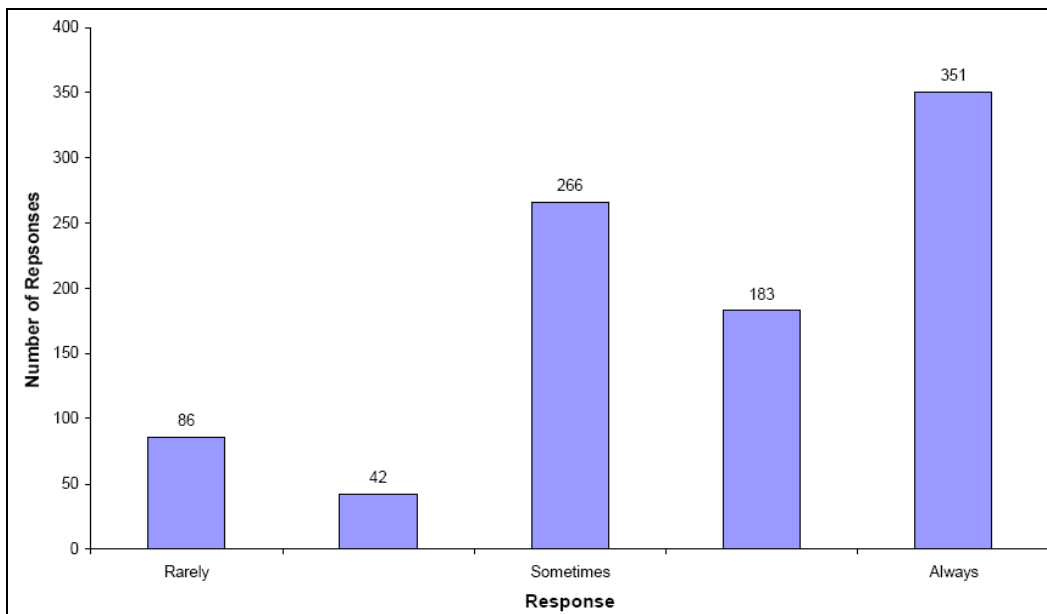


Figure 12 - 4 Question 4 (Source: Iowa Department of Transportation (2001), p. 76)

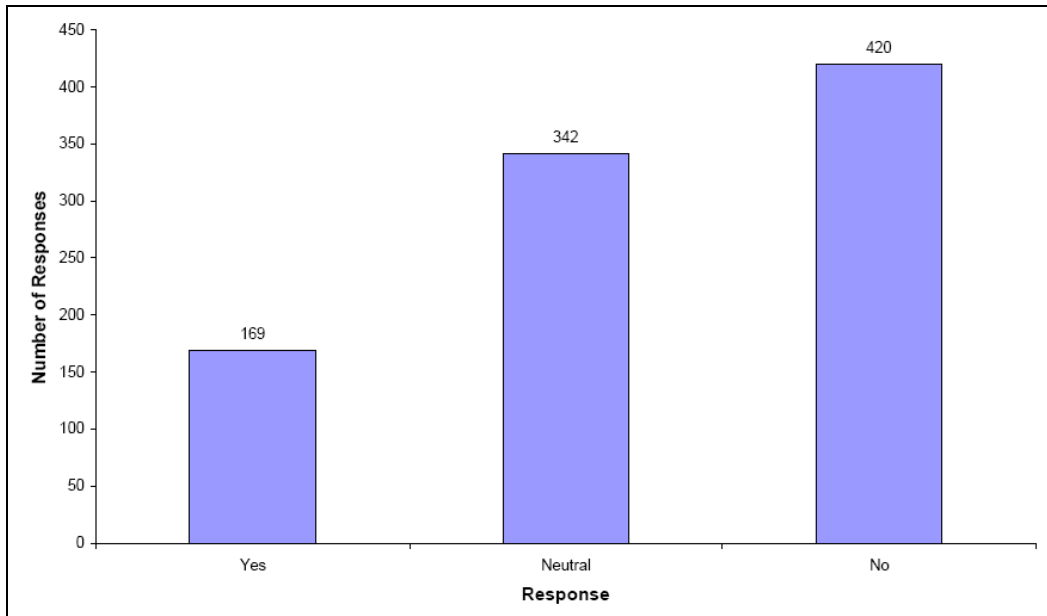


Figure 12 - 5 Question 5 (Source: Iowa Department of Transportation (2001), p. 77)

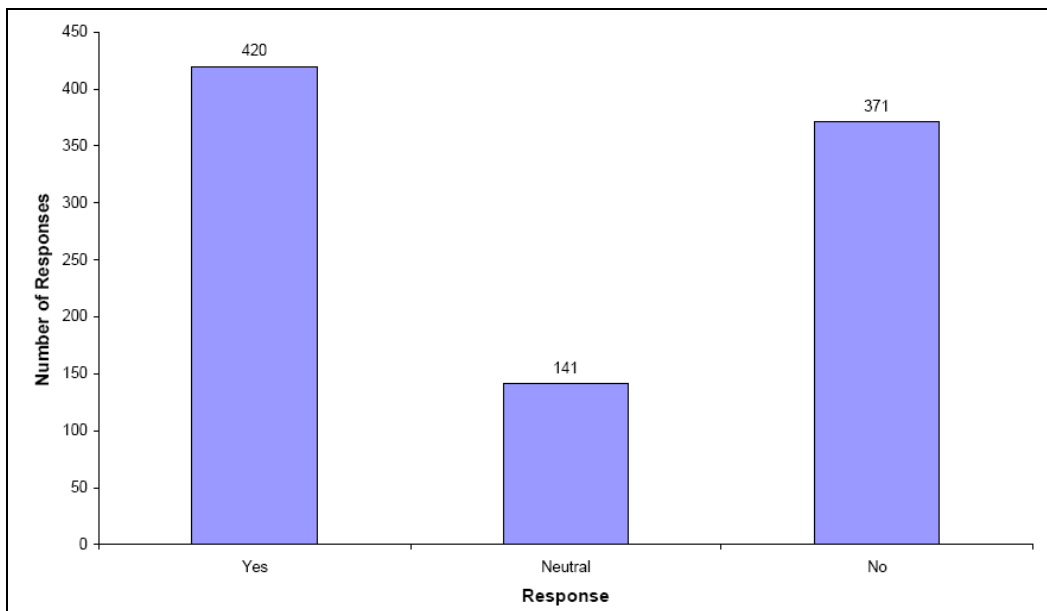


Figure 12 - 6 Question 6 (Source: Iowa Department of Transportation (2001), p. 77)

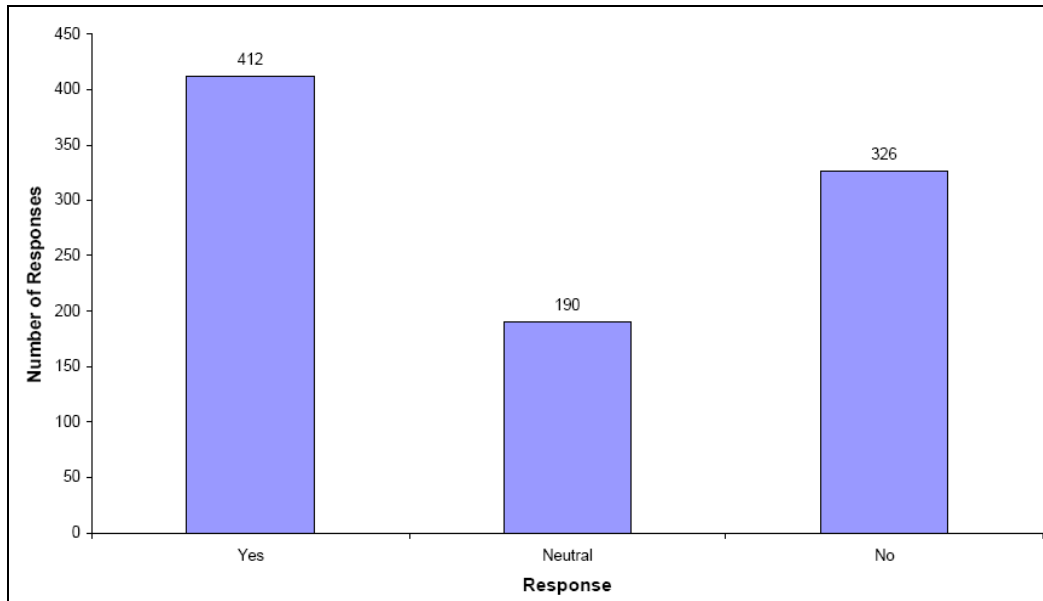


Figure 12 - 7 Question 7 (Source: Iowa Department of Transportation (2001), p. 78)

## Conclusions

Few places have sought public input into a process of determining the future of a reverse lane operation. The most relevant cases come from within Arizona: Tucson recently decided to remove two of its reverse lanes after extensive public outcry over what were seen as high and concentrated burdens from the lanes' operations. Unlike in Phoenix, no lefts at all were allowed during the reverse lane operation and this created similar barrier effects mentioned throughout the Phoenix study. In Phoenix, confusing rules and major limitations (even though no prohibition) create similar problems of local east to west accessibility – for vehicles and pedestrians. These burdens were highly localized, much like in Phoenix, affecting local businesses and neighborhoods well above the benefits these neighborhoods were receiving from the policies. Aggressive commuters and safety issues, even in light of statistics which showed that the lanes were no less safe than any others, were added to the list of cited problems. The Tucson City Council unanimously voted to return the lanes to normal left turn operations. Though studies have shown accident rates rose in one case, and fell in the other, the community is very satisfied with the outcome, and is now involved in a process to upgrade the streets.

The Washington D.C. case was not one where removal of the reverse lane was considered. Safety and operational concerns were brought forward to evaluate whether additional overhead signaling was needed. There are similar concerns in Phoenix. The approaches taken in Phoenix and in Washington D.C. are very different. In Washington, safety was not measured in terms of actual accidents, but in terms of observing potential accidents, encroachments into the lanes and near misses. They determined that these issues were significant enough (but by what measure was never explored in the report) to warrant more significant overhead signaling and that static signs were not enough. It is not known why this same evaluative approach is not used in Phoenix.

The IOWA U.S.-75 case does not concern a reverse lane but is relevant because a satisfaction survey was performed after a lane was removed from the urban roadway. The effect of a loss in capacity and an increase in congestion is probably similar to the Phoenix case if the reverse lanes are removed. Fewer than 20% supported the conversion before it was performed. The conversion did add some congestion, as noted in the report, but the calming effect, increase in pedestrian safety, and improvement in left-turning ease on the street was noted by a significant number of the public surveyed. About 40% supported the conversion after the fact.