Traffic Calming Programs & Emergency Response:

A Competition of Two Public Goods

by

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Professional Report

Presented to the Faculty of the Graduate School

of the University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Master of Public Affairs

The University of Texas at Austin

May 2000

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APPROVED BY

SUPERVISING COMMITTEE:

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DEDICATION

Every minute of every day, a group of dedicated people constantly remains vigilant throughout the communities of the United States to respond and provide emergency services to the victims of those who encounter the perils of fires and medical emergencies. The Fire Chief and other subordinate Chief Officers, whether professional or volunteer, provide the leadership to direct these local emergency service responses.

The Fire Chief, who is considered the “community expert” on fire protection and emergency medical service matters, is often confronted with tough policy development choices and emergency scene decisions to ensure the protection of both his/her staff and the public they serve. I wish to dedicate this professional report to the men and women of America’s fire service, particularly those Chiefs who wear the white helmets, in hopes that this research can assist them in making sound, quality decisions for their respective communities.

ACKNOWLEDGEMENTS

True professional reports, regardless of the discipline, require both the internal and external contributions of many people and organizations. This report is not different. Without their willingness to share their resources, be it time, information, or experiences, this report would have been impossible to author.

Before a report such as this can be submitted, one must have the desire to enter graduate school. My desire for such an achievement would not have been possible without the inspiration and encouragement of a former graduate of the LBJ School. My sincerest thanks goes to Elizabeth Gray (Class of 1990), who instilled the confidence within me to pursue this endeavor. At a time when I thought my formal education had ended, she saw otherwise.

I would like to thank my supervising committee, Bill Spelman and Bill Black, for their guidance and review of this report. Also, I want to thank the entire faculty at the LBJ School of Public Affairs, who has provided me, and other students, with the knowledge and ability to perform analytical public policy reviews.

Sharing professional information is not possible without networking. I wish to respectfully thank all of my colleagues throughout the U.S. fire service who were so willing to share their perspectives and experiences during the development of this paper. Particular thanks goes to the Chief Officers and officials of the Austin, Berkeley, Boulder, Fresno, Montgomery County (MD), Portland, and Sacramento Fire Departments.

A great appreciation is also extended to Joan Hudson and the staff of the City of Austin Neighborhood Traffic Calming Program. Their generosity of information and professional interactions created a positive environment, from a proponent's perspective, to explore and expound upon the subject of this paper.

Without a doubt, the greatest contributor to my research goes to Kathleen Calongne. Her collection of documents, information and sources, from an opponent's point of view, were invaluable to this report. For all of her previous work, perseverance, and accumulation of information from networking with others, I truly consider her one of the "pioneers" of the traffic calming debate. Her cohorts, such as Amy Muhs, Emily Wilcox and Ray Bowman, are three of the many others who assisted in providing research materials or methods.

Finally, my greatest appreciation goes to my wife Linda, and my two daughters, Brande and Brittani, who have graciously endured the family pressures generated during the development of this report. However, their compassion and understanding goes far beyond that. Over the last twenty years, they have given me the utmost support and encouragement to pursue

my professional development dreams at the expense of many family sacrifices. To them, I will forever be indebted.

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The University of Texas at Austin, 2000

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A natural dilemma for public policy makers occurred when two public policies conflicted with each other causing immense political and emotional stress upon both the policy maker and the public. This research paper examined the disagreement that had occurred in communities throughout the United States where traffic-calming programs were found to be in direct conflict with providing prompt emergency services. Thus, a conflict of two public goods was created.

This professional report examined the history and the positive and negative aspects of traffic calming programs. Negative impacts upon emergency services were substantiated by various emergency response time tests conducted by leading U.S. Fire Departments. Information was also

obtained on injuries that have occurred to firefighters from traffic calming devices as well as documented mechanical damages to emergency vehicles.

Traffic calming programs were found to contribute to air pollution as verified by several previous environmental studies conducted specifically for traffic calming devices. This report also revealed the enormous potential for civil liabilities for local governments, particularly with the violation of the American with Disabilities Act. In general, most U.S. local governments placed their traffic calming programs in moratorium due to all of the conflicts that were generated.

A policy analysis was conducted specifically for the conflict that had arisen in Austin, Texas. Based on quantitative processes, this analysis showed that Austin would lose an additional 37 lives per year with patients of sudden cardiac arrest if the Fire and EMS Departments experienced a 30 second delay in response times due to traffic calming. The analyses also concluded that at best, only one pedestrian life could be saved each year from traffic calming as pedestrian fatalities rarely occurred within residential neighborhoods. A *risk/benefit* analyses also demonstrated that traffic-calming devices have more of a negative impact than a positive impact to the community.

To reduce the conflict, and ensure at least a balance of these two public goods, a set of recommendations was formulated for the City of Austin policy makers and for those of other communities who had similar circumstances.

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Chapter 1. Introduction

Vibrant societies of today utilize democratic style governments to promote and maintain quality lifestyles for their people. These governments accomplish the amenable lifestyles by adhering to various core principles and values. Being responsive to the people is one of many mainstay principles. Thus, governments should be sensitive to both the general, as well as the specific needs of those expressed by the society. One value of this *responsiveness* tenet is that the government should provide services and programs that will ensure the health, safety, and welfare of the people. Such provisions do indeed provide for a quality lifestyle enjoyed by the citizens and enhances the overall well being of the society.

At all levels of government, many questions arise on how to provide the means to accomplish or uphold these desired principles and values. Determining the policies and methods to execute public policies is not always an easy task for the decision-makers of the government. As illustrated later, this process is extremely compounded when two separate public policies or programs, each of which has positive benefits to specific portions of the society, conflict with each other.

Anyone who has ever witnessed a federal public hearing regarding where to place a nuclear power plant, or who has attended a state agency public forum on the selection of public school textbooks, can certainly attest that such gatherings contain a large amount of debate and highly accentuated emotions from the citizenry. For the policy maker, particularly the elected official, this can be a difficult arena whereby they are faced with the dilemma of choosing between the specific interest groups of the society.

For example, those who want cheaper electricity production, that is less dependent upon fossil fuels, are often pitted against those who want policies of strict regulation that will protect the environment and mankind from technological disaster. Similar conflict occurs when determining if public school textbooks should contain explicit sex education, or strong emphasis on the Darwinism theory, versus those who desire for these subjects to be relegated to within the family unit of the home. In many instances such as these, government officials prefer to find some middle ground for compromise that is acquiescent to all parties.

Local governments too, are not immune from such volatile policy conflicts. These conflicts often have a very wide spectrum. Their intensities will vary from locale to locale, again depending upon the general and specific values of the community. The policy of prohibiting the smoking of tobacco products in most public places in Austin, Texas is quite different from those cities in the tobacco producing states such as the Carolinas. This decision for Austin may have been very easy, in contrast to the Carolina cities, where such a policy would strongly conflict with their economic retention policies. Although this is a specific policy concern that may not apply to other cities, there are many other government policies and programs that are applicable to all local governments. Public transportation is one such example.

The central transportation concern presented to local governments by angry neighborhood residents, is that there are too many cars going too fast within the neighborhood. As a result, they fear for their safety. These governments are faced with finding solutions to this problem, whether they be building more roadway infrastructures to handle the increased volumes, or using alternative approaches to slowing the speeds of traffic.

Often, constructing larger transportation systems requires assistance from the state and federal governments. Unfortunately, this can take an immense amount of time before a remedy is implemented. Because of these difficulties, many local governments have resorted to locally funded *traffic calming* programs to "calm" the local streets. These programs can have positive and negative results, and like nuclear power plants or textbook selections, they will also generate a lot of public debate and expression of emotion.

The term *traffic calming* is complex, meaning different things to different people and locales. "Traffic calming is a process whereby people are encouraged to find alternative means of transportation, to drive more slowly, to drive alternate routes, to drive with respect for the neighborhood through which one is traveling."[1]

Another view is that "[t]raffic calming is an attempt to strike a balance between vehicular traffic and everyone else who uses the street: pedestrians, bikers, business people and residents. That balance tilts away from cars. Some see traffic calming as a way of 'reclaiming' local streets from a traditional domination by automobiles. Others see it more modestly as a way of trying to restore the safety and peace in neighborhoods that are becoming overwhelmed with speeding traffic."[2]

Although the definitions may fluctuate, even within transportation professional circles, the best definition for the purpose of this paper is one rendered by the Institute of Transportation Engineers (ITE). "Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users".[3] This definition incorporates the use of physical street devices such speed humps, traffic circles, and street closures.

Traffic calming programs have purportedly, by some accounts, reduced traffic speed, volume, and accidents within neighborhoods, thus improving the safety and livability of the residents. Although the accuracy of results is often debated, these outcomes when they do occur can certainly be expressed as a public "good."

Another public "good" generally provided by the local government is that of efficient and prompt emergency services. Most local governments spend very large segments of their monetary resources for ensuring quality police, fire and emergency medical services (EMS). Unfortunately, providing this public good conflicts with the very core objectives of traffic calming programs.

The chief complaint is that traffic-calming devices delay the response times of emergency services to the community. Quick response times are directly correlated to the effectiveness of these emergency services. Virtually every service delivery performance measurement for fire and EMS departments is directly related to their response times. Some, but not all police services are directly impacted by quicker response times. Increasing the number of fire and EMS stations and the number of police units are actions that local governments frequently take to ensure that response times are not depredated.

Often, the response delays due to traffic calming devices are viewed as satisfying a few residents at the expense and increased risk of lesser effective emergency services, resultantly provided to the remainder of the entire community. Herein lies the debate, *Traffic calming and emergency response: A competition of two public goods.*

Like the conflicting public policy examples already presented, traffic-calming policies are full of public debate and emotion from all factions of the communities. Generally, this includes a specific group of neighborhood residents who desire traffic calming devices vying against those who routinely pass through the neighborhood, including representatives from the emergency services departments, who oppose their use.

One can easily envision the spectacle at such a public hearing debate. With fake blood cosmetology and trauma depicted bandages, young four to six year old children are marched before a city council dais, while pleading protective mothers are theatrically urging the council members to prevent child pedestrian tragedies by installing traffic calming devices within their neighborhood. Their claim is that few seconds, or even a minute, of delay encountered by emergency responders is insignificant to a child being killed by a speeding car.

On the other hand, the mayor and council is often faced with the Fire Chief, emblazoned in a full dress service uniform, advising the council members that such action will be detrimental to the emergency service delivery provided to victims and patients. Supplemented with position reinforcing remarks such as those of Fire Chief Larry Donner of the Boulder (CO) Fire Department, makes the final decision a truly high stake issue. "One minute is a long time to wait when you are the one not breathing!"[4] As he further points out, this is even more critical when you have already waited more than three or four minutes for the emergency responders to arrive.

Now, after such “battle lines have been drawn”, does the elected official go to one side or the other, or does he/she look for alternatives? What kind of analysis needs to be done for such a decision by the policy maker, or by those who assist with the policy formulation and implementation? This paper attempts to address this particular issue for the policy makers within the City of Austin, Texas. Further, this document can also serve as a model analysis for others who are responsible for policy development within their own communities.

With today’s sophisticated news media access and vast explosion of electronic information dissemination within our society, public policy is being reviewed and scrutinized more than ever before. With more and more of these public accountability tools, the public is demanding that policies be well thought out, analyzed, evaluated, sensitive to all interests, and adequately planned for, rather than decisions being made on the pure intuition of the policy makers. Good sound analytical processes are needed for superior public policy formulation. This paper has been developed with that approach in mind.

In this chapter, the reader has been given an overview of the policy conflict that can erupt from traffic calming programs and response times.

There are many other conflicts with this issue that are explored in the remaining chapters. From this, a comprehensive policy analysis may be performed.

In order to fully understand the potential impacts to traffic calming, the reader should have a thorough knowledge of traffic calming devices. Chapter Two does this by providing a brief history of traffic calming in Europe and in the United States. The objectives and benefits from traffic calming programs, as well as device descriptions, are also reviewed.

Chapter Three provides an in-depth examination that traffic calming has upon the emergency service departments. This includes an understanding of the emergency response time concept and how the physical features of emergency vehicles are not compatible for traffic calming devices. A history of firefighter and paramedic injuries along with fleet damage is also presented. The most important aspect of this chapter is a summary of the field test studies performed by five different fire department agencies. The results of these studies quantify the response time delays for various traffic calming devices.

A negative impact to traffic calming that is often overlooked is that of increased vehicle emissions. Chapter Four is a literature review of how automobile exhaust emissions are another policy conflict for traffic calming. Summarized vehicle case studies are presented which quantify the impact of automobile emissions pertaining to specific traffic calming devices.

Every public policy has civil liability implications. The issue of traffic calming is no different. Chapter Five addresses the potential legal ramifications that traffic-calming devices pose to the Americans with Disabilities Act. Several other general liabilities to the local government are also covered.

As traffic calming has gained popularity in the last five to seven years, many local governments have instituted such programs or policies. The current postures of several of the U.S. cities are examined in Chapter Six. For parallel comparison, the Austin, Texas posture for traffic calming is explained. The overview of the Austin Neighborhood Traffic Calming Program serves as background information for the next chapter.

Chapter Seven is the heart of this professional report. This chapter encompasses analyses which measure the impacts of the traffic calming initiatives for Austin. Using local data and various analytical methods, a policy analysis is conducted that studies the impacts to traffic speed and volume, pedestrian accidents, sudden cardiac arrest, Austin Fire Department response times, and the projected impact of lives saved and lost due to traffic calming devices.

Although many arguments can be made for and against traffic calming, Chapter Eight serves somewhat as a forum for that debate. In this chapter, the implications of the findings contained in Chapter Seven are discussed in detail.

And finally, Chapter Nine provides the real fruits of this policy review. A formal set of recommendations has been developed from this analysis. These recommendations are directed to the various policy makers within the City of Austin as they are based upon the Austin analysis. However, many of these recommendations would apply to most other local governments who have very similar circumstances.

Notes

[1] Build America, *Traffic Calming and Walkable Communities*, April 4, 1997. Online. Available: http://www.buildamerica.com/old97/4-7-97/wkshow.htm. Accessed: March 21, 2000.

[2] Public Technology, Inc., *Traffic Calming at a Glance*, n.d. Online. Available: http://pti.nw.dc.us/task_forces/transportation/docs/trafcalm/TRAFCAGL.HTM. Accessed: November 23, 1999.

[3] Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), p. 2.

[4] Telephone interview by Les Bunte with Larry Donner, Fire Chief, City of Boulder, Colorado, February 3, 2000.

Chapter 2. Traffic Calming Programs and Devices

History of Traffic Calming

Some 30 to 40 years ago the beginnings of traffic calming programs came into popularity in Europe. The earliest roots of traffic calming have been traced backed to the Netherlands, where in the late 1960's, the desires were "to turn the street into an obstacle course for motor vehicles, and an extension of home for residents."[1]

The Dutch utilized diversion schemes, such as street closings, one-way streets, and other traffic calming devices using physical measures such as speed humps. These concepts quickly spread to other countries such as Germany, Sweden, Denmark, England France, Japan, Israel, Austria, and Switzerland. With success on neighborhood streets, "[t]he Germans quickly learned that calming individual streets resulted in traffic diversion".[2] They then embarked upon a plan to extend the devices to the main roads.

Although traffic calming has been around for a number of years, Great Britain has elected, within the last decade, to aggressively implement traffic calming programs. This was developed in the shadow of a 1963 government document, *Traffic In Towns*, which is credited with initiating the shift towards traffic calming as a viable transportation program. Colin Buchanan, the author of the document, is considered to be the father of traffic calming.[3]

Although Omaha, Nebraska experienced with the use of speed humps in the 1960's on some selected streets, their approach was not fully considered as a traffic-calming program. Two cities in America are recognized as being the pioneers for full-scale traffic calming programs. Seattle, Washington passed a $12 million dollar bond issue in 1968 for improving neighborhood streets, and thus had both the resources and public support to forge ahead with traffic calming initiatives. Following in 1975, Berkeley, California adopted a citywide traffic management plan, which specifically included traffic calming.[4]

Although residential streets have been addressed, the outlook for traffic calming devices upon larger volume streets is of question. To begin with, traffic-calming programs in the U.S. are continuing without any official sanctioning, which is extremely vulnerable to legal review. On a lesser scale than the Europeans, "U.S. programs have generated before-and-after speed, volume, and collision data, but nothing equivalent in scope or rigor to the European studies. Some European communities have long since concluded that traffic calming must encompass higher order roads if traffic safety, livability, and walkability are to be achieved outside isolated pockets."[5]

Given the unpopularity and rising opposition to traffic calming, the move to higher-class roadways in the United States may never be reached. This may be evidenced by the growing sentiment that "[e]veryone seems to want traffic calming in their neighborhood, but not on their route into the city which might be someone else's neighborhood."[6]

Traffic Calming Objectives & Strategies

Traffic calming programs, as the name implies, are an attempt to slow down automobile speeds and reduce the volume of traffic. Thus, there are several objectives that are usually established for the programs. They are: slow traffic speeds; reduce cut-through traffic; increase the safety of pedestrians, bicyclists, and vehicles; reduce traffic noise; and improve the aesthetics of the neighborhoods.

The approaches chosen by local governments to meet these objectives are centered on two distinct strategies that may be used separately or together. "These initiatives involve passive or 'soft' strategies and active or 'hard' strategies. Passive strategies are less restrictive in nature and use subtle or psychological means to influence drivers to behave in a desired fashion."[7] Examples of this strategy include traffic signals, signs, markings at pedestrian crossings, educational programs and traditional policing, through citations and fines, for enforcement.

“Active strategies are more restrictive in that they prevent or reduce movement of traffic by changing the street configuration or by the use of physical barriers or devices.”[8] These type of devices are the one’s that generally create the most controversy in communities. Some examples of the street re-configurations or physical barriers are street closures, partial closures, diverters, roadway gates, cul-de-sacs, chokers and curb extensions to create narrower streets. Without a doubt, the most used example of this strategy is the speed hump. “These ‘hard’ control devices are largely self-enforcing and create a visual impression, real or imagined, that a street isn’t intended for through traffic.”[9]

Unfortunately, many cities have reacted too quickly to citizen complaints about traffic, without fully identifying if a problem truly exists. This generally results in traffic calming devices being installed without being fully warranted. When this occurs, one can be sure that opposition will rapidly arise and conflict ensues. In many instances, neighborhood residents perceive there is a problem, when in fact there may not be one.

Analysis & Results

The first step for any traffic-calming program then is to identify and verify the problem. To accomplish this, local governments must utilize an array of analysis methods to help clarify the nature and extent of the problems.

This analysis should include studies and data collection of daily traffic volumes, accident rates, speed levels, cut-through traffic, and post results. Once the problem is correctly identified, then the proper traffic calming devices designed for the problem can be selected and implemented.

Traffic volume studies should always be used to determine the amount of traffic that is passing through a neighborhood. These should be conducted over a 24 hour period during the middle portion of the week or for the specific times and days of the week of concern. The best conclusive data is achieved by conducting a seven-day period survey. If possible, the analysis should include the actual empirical change in daily traffic, along with the percentage change, after devices are installed.

In general, most studies indicate that traffic calming is effective in reducing traffic volume in neighborhoods. However, the accuracy of the reductions reported may not be statistically sound. This is evidenced by the perspectives of Reid Ewing, of the Institute of Transportation Engineers (ITE), who is one of the leading experts on traffic calming issues. Regarding traffic volume surveys in his writings, Ewing is quick to "[n]ote that while sample sizes for several measures are large enough to provide meaningful results, the small sample sizes for others [cities] provide only general indicators of effectiveness. Care should be taken when considering their effectiveness."[10]

Of greater debate to the accuracy of the volume reduction reports are the inconsistencies of how and where the data is collected. As asserted further by Ewing, “results depend on where measurements are taken, with volume impacts being attenuated by intervening intersections. Data from studies …indicate that volumes in the same block as diagonal diverters decline by an average of 45 percent after installation. A block away, but with an intervening intersection, volumes decline by less than half that percentage.”[11]

Accident studies should be used to identify the nature and frequency of accidents within a neighborhood. By classifying traffic incidents, the parties and factors involved, locations can be identified where traffic calming devices can be placed to reduce the hazards. Who is involved, such as pedestrians or bicyclists, rights of way, time of day, weather and speed relationships can be of great value.

Ewing also cautions the accuracy of accident studies.

> It is often difficult to draw conclusive results from traffic calming accident analysis. Most safety studies of traffic calming compare "before and after" accident experience. Few studies take into account the influence of potential changes in accident reporting, weather conditions, and traffic diversion. Most traffic calming measures result in some reduction in traffic. Thus collisions may migrate to other streets as motorists divert to avoid traffic-calmed streets. For a comprehensive review of the safety impact, it is important to examine a wide-area, including streets with and without traffic calming.[12]

A recent Canadian report, summarizing 43 international studies, indicated that collision frequency declined anywhere from 8 to 100 percent after some sort of traffic calming was implemented.[13] This illustrates a severe variability, which suggests that all parameter measurements were not the same. An example, as noted earlier, is that many foreign countries use traffic calming devices on major arterial and collector streets, whereas that is not the case in the U.S. One could easily use these statistics to argue, either for or against, the effectiveness of traffic calming.

According to Ewing's research, the reductions of collisions in the U.S. are not as favorable as in other countries. "In most cases the number of collisions went down or stayed the same, but exceptions appear frequently. One reason for these mixed results may be due to statistics. Traffic calming in the United States is largely restricted to low-volume residential streets. Collisions occur infrequently on such streets to begin with, and systematic changes in collision rates may get lost in the random variation from year to year. This limits the confidence in drawing inferences about safety impacts of traffic calming."[14]

Most traffic calming programs include some type of speed analysis. These generally measure the frequency and range of speeds incurred upon a residential street. The nationally accepted method used by traffic engineers to determine safe speeds is the *85^{th} percentile speed* methodology. This percentile represents the speed below, which 85 percent of the drivers travel upon any surveyed roadway. This standard is used to establish speed limits by government officials and is used by the court systems in determining if speed limits are reasonable and thus enforceable. Due to this standard being used in the court systems, extreme care must be taken for determining speed levels within a neighborhood. For example, if current speed data reveals that the 85^{th} percentile speed is significantly above the current posted speed limit, then this may give evidence and credence to the need for raising the posted speed limit within the neighborhood rather than slowing the speed.

The Ewing research documents the results of speed studies conducted by various cities on hundreds of streets in the U.S. Most of these studies reveal that traffic calming does indeed reduce the speed of drivers. However, Ewing notes the effectiveness of the commonly used speed humps and the suspicious statistical confidence levels associated with their dubious success.

> Speed humps have the greatest impact on 85th percentile speeds, reducing them by an average of more than 7 mph, or 20 percent. Raised intersections, long speed tables, and circles have the least impact. One critical caveat: Rarely in the researched before-and-after studies is it made clear where speed measurements were taken in relation to the traffic calming measures. Occasionally a study will report 'midpoint' or 'midblock' speeds, but because the spacing of traffic calming measures or the length of blocks is unknown, the exact location of speed measurements is also unknown. The after speeds may be 100 feet from slow points, 200 feet, or some other distance. Obviously, where the measurement is taken has a profound effect on the result, because motorists decelerate as they approach slow points

> and accelerate as they leave them. Summary statistics of this sort provide, at best, ballpark estimates of impacts.[15]

Because of the different parameters measured by each locale, Ewing points to further concern for inaccuracy in establishing a national speed reduction average:

> [t]he exact date of measurement is seldom known. The "before" measurement may be 1 month or 3 years before installation; the "after" measurement, 1 week or 2 years afterward. The exact time of measurement may affect results because of the natural growth of traffic and the tendency of travelers to adjust to the new measures…A final caveat: While sample sizes for some measures are large, and sample averages are thus likely to be close to true average by virtue of the law of large numbers, sample sizes for other measures are miniscule. The sample includes 179 studies of standard 12-foot humps, but only 3 studies of raised intersections. The potential sampling error is accordingly many times greater for raised intersections than for 12-foot humps.[16]

Cut through traffic studies should also be conducted prior to installation of traffic calming devices. Knowing when, where, and the time of day cut-through traffic is occurring is important to device selection. Another factor that has to be determined is if cut-through traffic is actually legitimate or is of those driving specifically to and from some destination within the neighborhood.

Finally, as alluded to already, post-result studies need to be performed to document the impact of the action taken. Obviously, this data is critical to the effectiveness of a specific project, but collectively the data can be helpful in evaluating the entire program within that jurisdiction.

Description of Traffic Calming Devices

Traffic calming devices can be divided into of one of two general categories which predominately addresses either traffic volume or speed. *Volume control* devices are those, which divert traffic to another route, severely limit, or eliminate through traffic within an area. Examples of these types of devices are: full street closures, half street closures, diagonal diverters and semi-diverters.

The other category is that of *speed control* devices. Within this category are three sub-categories of *vertical, horizontal* and *narrowing* type devices. Vertical devices are elevated devices upon the roadway that uses the forces of accelerated ascents and decent to discourage speed. Speed bumps are the most radical type of these devices. Horizontal devices capitalize on shifting lateral forces of the vehicle due to rapid course diversions to accomplish reduced speeds. Traffic circles and chicanes are common examples of these types of devices. Rather than using the forces of physics, narrowing devices use a "psycho-perspective sense" of enclosure to discourage speeding. Curb extensions creating "neck downs" or a diminished path of travel are the objective of these type devices.[17]

There is quite a variety of traffic calming devices. Each device has positive and negative distinctiveness. As well, some are better suited for different types of street conditions and applications. A complete listing of all types of devices and tools with their respective descriptions is contained in Appendix A. This Appendix provides in-depth information regarding the advantages, disadvantages and applications of each traffic calming measure. Brief reviews of the more common devices are examined in the remainder of this chapter. Most of the information contained in this chapter review, and in Appendix A, is adapted from the City of Boulder (CO) Neighborhood Traffic Mitigation Program Toolkit.

Volume Control Devices

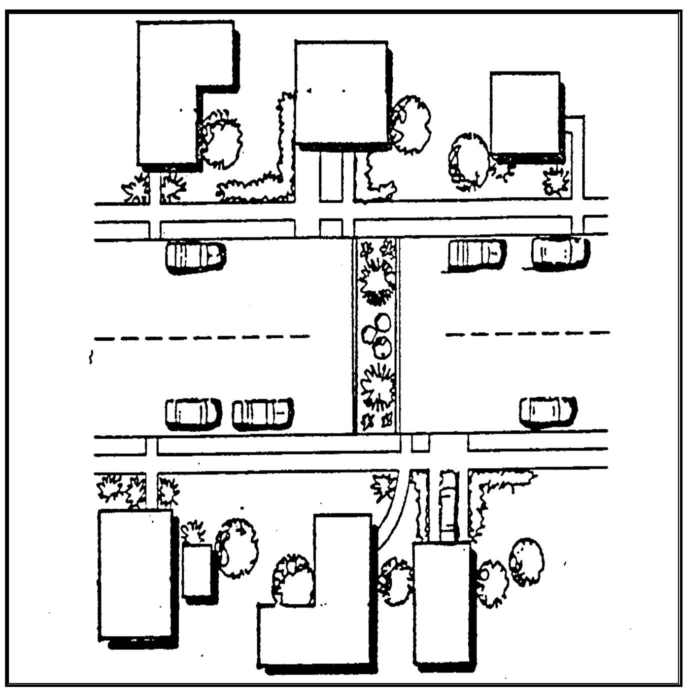
As stated earlier, the objective of volume control devices is to discourage and reduce the number of vehicles traveling through a neighborhood. Generally, this requires diverting the traffic to another route that is more suitable to handle such volume. The following are some of the more common examples of volume control devices:

Street Closure

This is probably the most drastic of all traffic calming devices as it severely limits the use of the street to the residents. Although it does eliminate cut through traffic, this device can often be perceived as an inconvenience by the residents and as an unwarranted restriction by the general public. Using planters, raised barriers, bollards or landscaping to completely block the street for traffic, accomplishes the desired effect as illustrated in Figure 2.1.

Figure 2.1

Street Closure



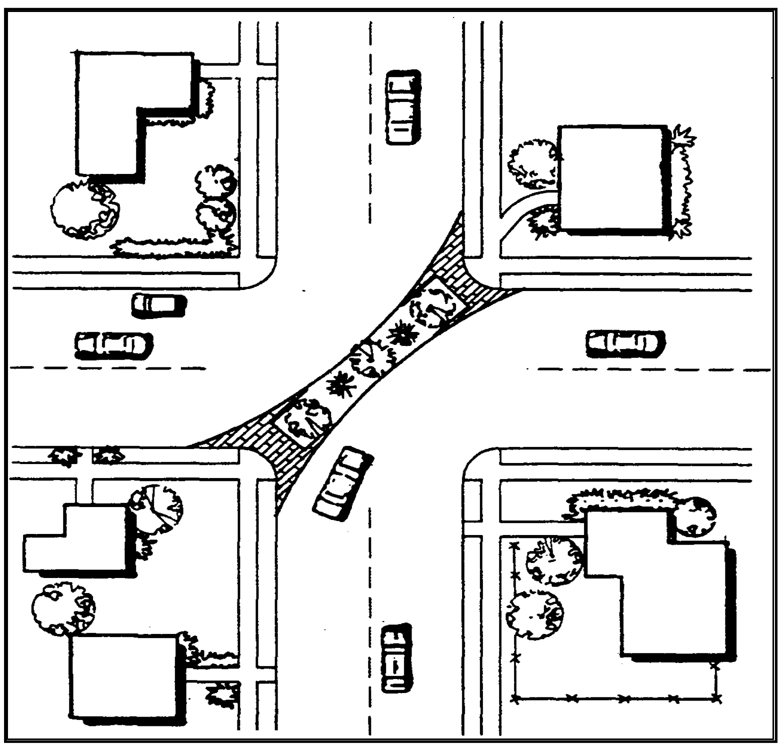
Source: City of Boulder NTMP Toolkit

Diagonal Diverter

This particular device is placed diagonally across an intersection with the design intent to interrupt traffic flow across the intersection. As a result, this installation is very effective for cut-through traffic and maintains a continuous routing of vehicles. However, because there is no opposing traffic, actual increased turning speeds by motorists can occur. As shown in Figure 2.2, this diverter could also increase trip lengths for some inconvenienced residents.

Figure 2.2

Diagonal Diverter

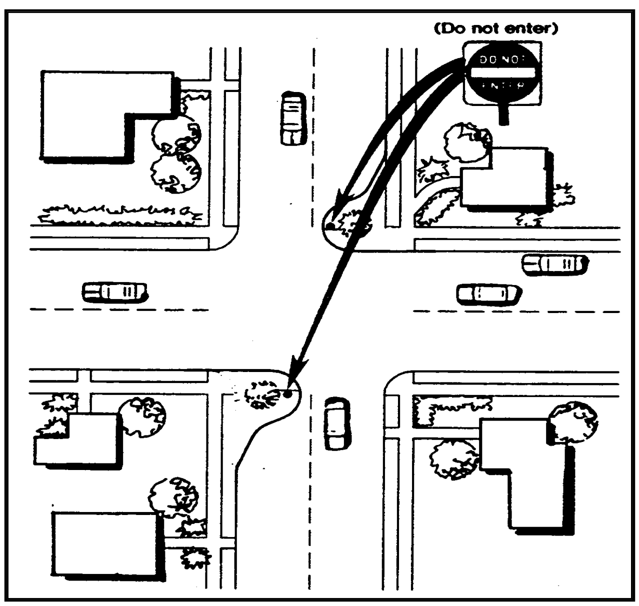


Source: City of Boulder NTMP Toolkit

Semi-Diverter

Whenever there is a desire to physically block one direction of traffic at a certain point on a two-way street, a *semi-diverter* traffic-calming device is selected similar to the one in Figure 2.3. In effect, this prevents vehicles from turning, or forcing a turn, depending upon the desire. Cut through traffic is reduced, but there is not a 100% compliance with all drivers, particularly when no on-coming traffic is encountered. Again, trip lengths could increase for some residents depending on the location of the semi-diverters.

Figure 2.3
Semi-Diverter

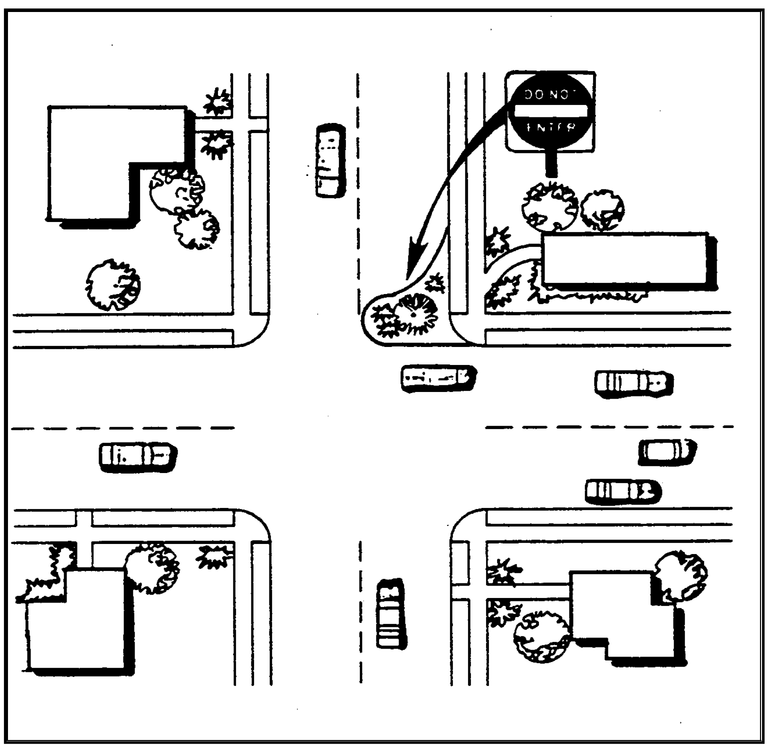


Source: City of Boulder NTMP Toolkit

Turn Prohibitions

Based on the same principle as the semi-diverter, the *turn prohibition* device is used when only a specific turning movement is desired on one particular street. This design, as shown in Figure 2.4, is very useful when only one street of the intersection experiences more traffic than the others, or when there is a need to eliminate two-way traffic conflicts. This device too, can have a detrimental effect on the access of the neighborhood to some residents.

Figure 2.4
Turn Prohibitions



Source: City of Boulder NTMP Toolkit

Speed Control Devices

Using the erratic forces of acceleration and braking to slow vehicles are the objectives of most *speed control* devices. These forces occur as a result of vertical, horizontal or narrowing deflections to the paths of travel. As with volume control devices, these installations have benefits as well as drawbacks to their intended objectives.

Horizontal Speed Controls

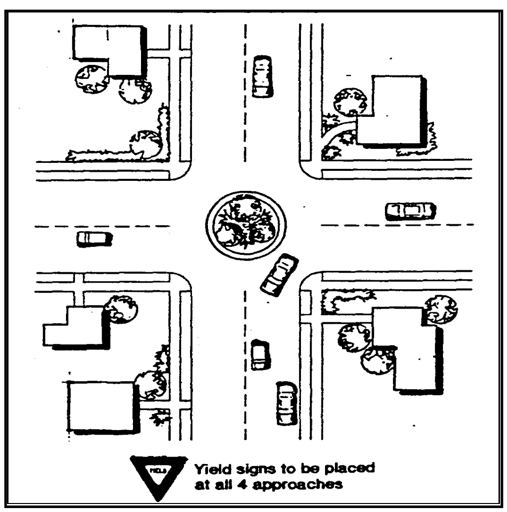
The horizontal speed controls devices have no vertical elevations within their design. They are designed to cause the driver to decelerate in order to generally maneuver from side to side, or in different directions, to successfully pass through the device. Here, the objective is to incorporate abnormal lateral forces that require the driver to reduce the speed of travel without losing control of the vehicle. Traffic circles and chicanes are the two most common types of the horizontal speed control devices.

Traffic Circles

Of all the horizontal devices, the *traffic circle* is probably the most controversial. These are raised circular medians located in the middle of a four-way intersection that requires drivers to travel in a counter-clockwise direction to reach the desired continuation street of the intersection. When properly constructed, no vehicle can travel through the intersection in a straight line as is depicted in Figure 2.5. Generally, the cars are required to "yield upon entry", thus granting the right of way to the cars already within the circle pattern. Traffic circles increase the confusion and danger for street crossing by pedestrians and bicyclists.

Figure 2.5

Traffic Circles

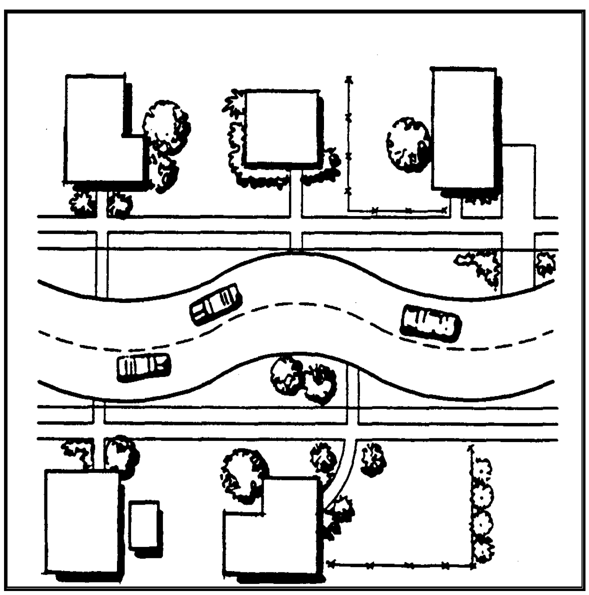


Source: City of Boulder NTMP Toolkit

Chicane Deviations

The *chicane* design redraws the path of travel so that the street is no longer straight. This is accomplished by the installation of curb extensions in between intersections. As shown in Figure 2.6, this horizontal deflection requires drivers to slow in order to maneuver to the left and right. Some residents gain additional right of way frontage to their property whereas others lose right of way frontage. Thus, this device is difficult to implement unless the street already offers a wide adequate right of way. Most residents within the entire chicane scheme lose street parking opportunities.

Figure 2.6
Chicane Deviations

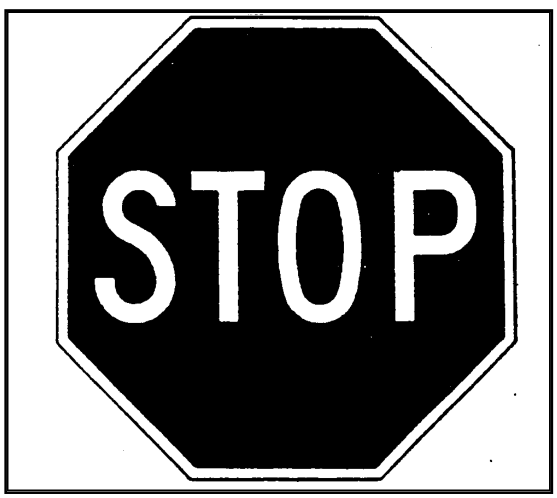


Source: City of Boulder NTMP Toolkit

Stop Signs

As most know, the red hexagonal sign containing the message to "stop", as depicted in Figure 2.7, is a traffic command established by the entity having jurisdiction. The purpose of *stop signs* is to designate the right of way of traffic at intersections. They are very useful when a low volume street intersects with a high volume street or for intersections with equal volume. If there is not enough traffic at the intersections then compliance will usually not be compelled. Many transportation officials argue that the signs do not decrease the average speed and therefore they do not support their use as a speed control tool.

Figure 2.7
Stop Signs



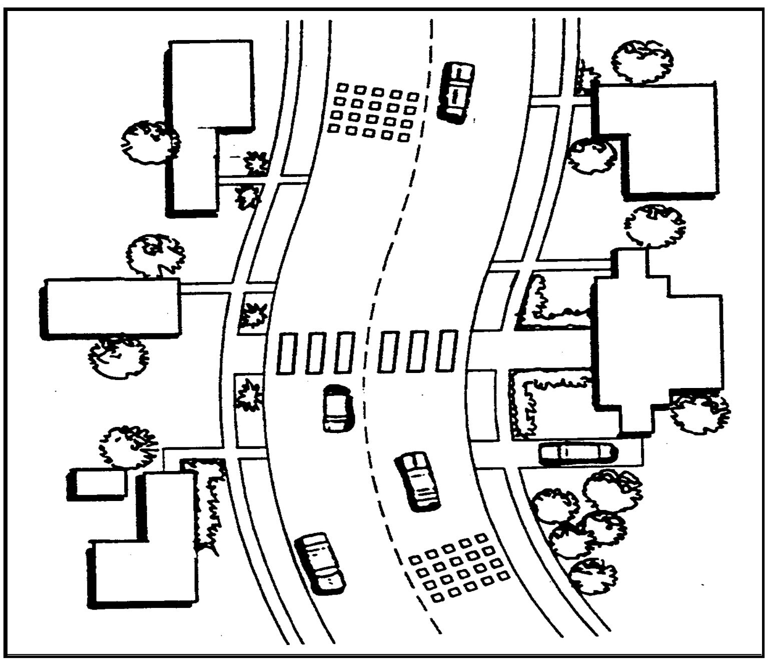
Source: City of Boulder NTMP Toolkit

Rumble Strips

These devices are patterned sections of rough pavement textures, which abruptly alert the drivers to a dangerous approaching condition. This sudden noise encountered by drivers is useful in areas of concealed stop signs or pedestrian crossings in mid-blocks. They are generally ineffective in reducing overall speeds and adversely impact bicyclists. The *rumble strips* are very noisy by design and thus are generally not recommended for neighborhood settings. Rumble strip examples are contained in Figure 2.8.

Figure 2.8

Rumble Strips



Source: City of Boulder NTMP Toolkit

Vertical Speed Controls

This device sub-category generates the most displeasure with the citizens who frequently use the roadways. The increased acceleration and braking that is necessary to traverse these vertical impediments causes speed interruptions while traveling upon the roadway. The ascent and decent of these elevated devices can cause discomfort for the passengers as well as maintaining the control of the vehicle unless they are crossed at lower speeds.

Speed humps, speed cushions, and raised intersections are the more commonly type vertical speed control devices found in communities with traffic mitigation calming plans. In general terms, the speed hump is the most economical type of vertical speed control device. As a result, this is often the most utilized device in traffic calming schemes.

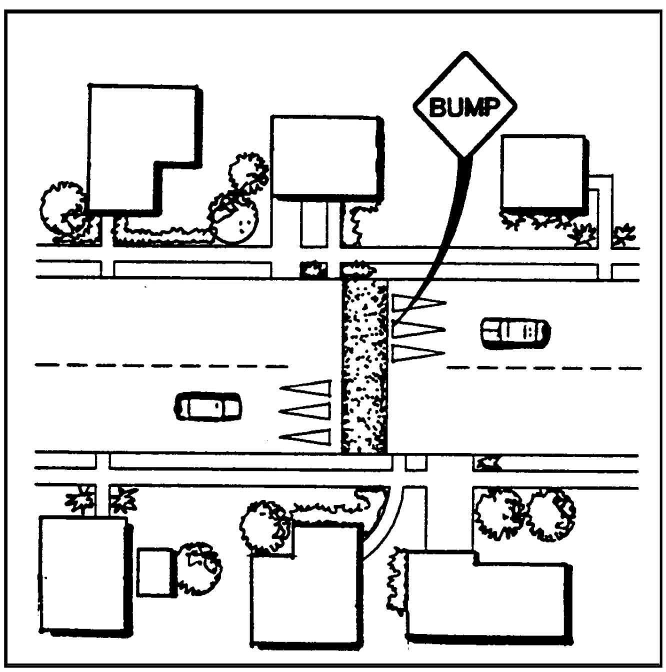
Emergency services particularly object to these devices as they contribute to delayed response times and cause repeated mechanical stresses to the suspensions of emergency vehicles. They can also increase noise and air pollution.

Speed Humps

Speed humps are wave-shaped paved humps in the street as illustrated in Figure 2.9. The height of the hump determines how fast a vehicle can traverse the device without causing discomfort to the driver or damaging the vehicle. Discomfort and the feeling of being "out of control" increases as the speed attempt increases. Without a doubt, speed humps are the most controversial traffic-calming device. Generally, the height of most humps is about four inches. They are usually 12 to 22 feet wide.

Figure 2.9

Speed Humps



Source: City of Boulder NTMP Toolkit

Speed Cushions

On a similar concept as the speed hump, *speed cushions* are designed to have a minimal impact to emergency response vehicles. Rather than extending the full width of the roadway, speed cushions partially cover the roadway. These devices, as shown in Figure 2.10, consist of either recycled rubber or asphalt, raised about 3 inches in height. The length of the cushion is about 10 feet. The spaces between the cushions allow emergency vehicles to partially straddle the device. Thus, these vehicles can traverse this device easier and faster than the speed hump.

Figure 2.10

Speed Cushion

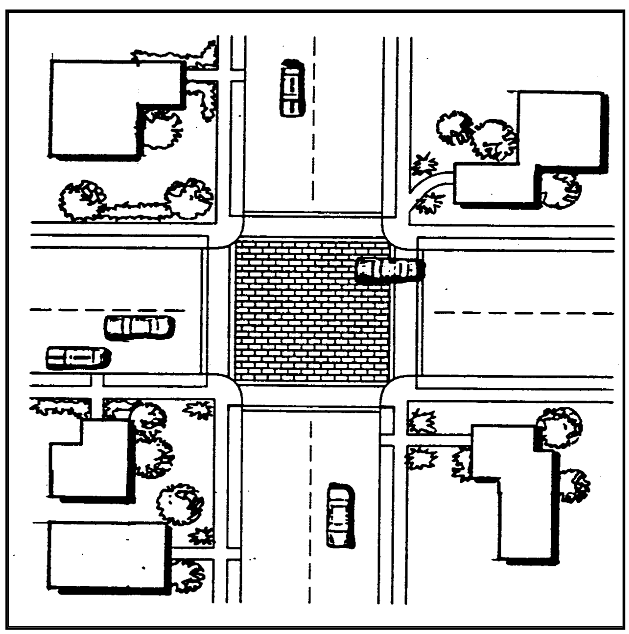
Source: City of Austin Public Works & Transportation Department

Raised Intersections

A *raised intersection* is of similar design as the speed hump except that it encompasses the entire portion of the intersection area. This raised plateau is about 4 inches higher than the surrounding streets. Thus, one must slow to enter as well as maintain a slow speed to exit the intersection. This device, like the one shown in Figure 2.11, provides excellent amenity for pedestrians and is effective for speed control at intersections. Like the speed humps, these devices have a negative impact on emergency response times.

Figure 2.11

Raised Intersections



Source: City of Boulder NTMP Toolkit

Narrowing Control Devices

In general, wider roads encourage higher motor vehicle speeds. To combat these, alterations to roadways can be made to create a "psycho-perspective sense" of enclosing or narrowing the roadway. Many of the effective traffic calming devices capitalize on this element. Decreased road widths translate to decreased traffic speeds.

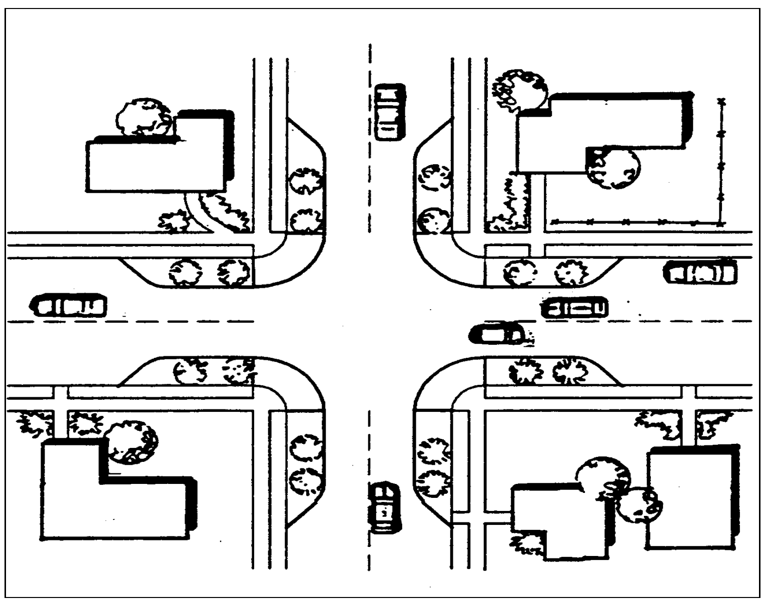
There can be many variations to the type of narrowing devices used by the communities with traffic calming programs. These types of devices are more expensive than most of the speed control devices. Due to the increased expense, narrowing devices are less likely to be utilized in traffic calming programs.

The type of devices can be used at intersections, mid-block for lane width reductions or simply to divide the center of traffic paths of a street. The following are the more commonly used narrowing control devices:

Neckdowns

The objective of these devices is to physically reduce the road width at intersections. This is accomplished by extending the curb radius of each corner point of the intersection. As the road begins to narrow, vehicles have to reduce speeds to ensure adequate fender clearances of on-coming vehicles at the entrance to an intersection. Figure 2.12 reveals how their design does not accommodate bicyclists very well.

Figure 2.12
Neckdowns



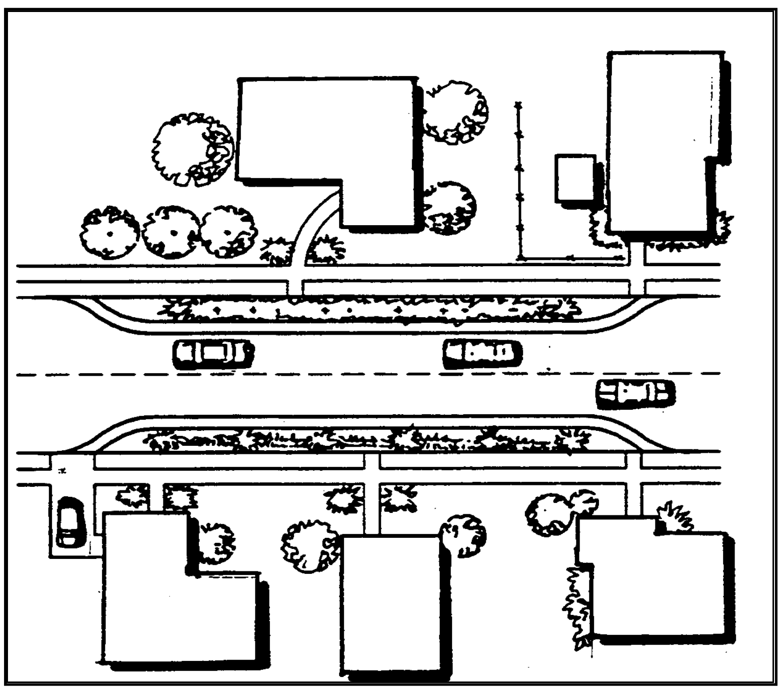
Source: City of Boulder NTMP Toolkit

Lane Narrowing

Similar to a neckdown, *lane narrowing* occurs in the mid-block portion of roadways rather than at the intersection. They are especially effective where there are long stretches of roadways between intersections. Many residents object to their placement in front of their homes as their parking is eliminated totally. These devices can also be dangerous for bike riders. Figure 2.13 illustrates a mid-block lane narrowing.

Figure 2.13

Lane Narrowing

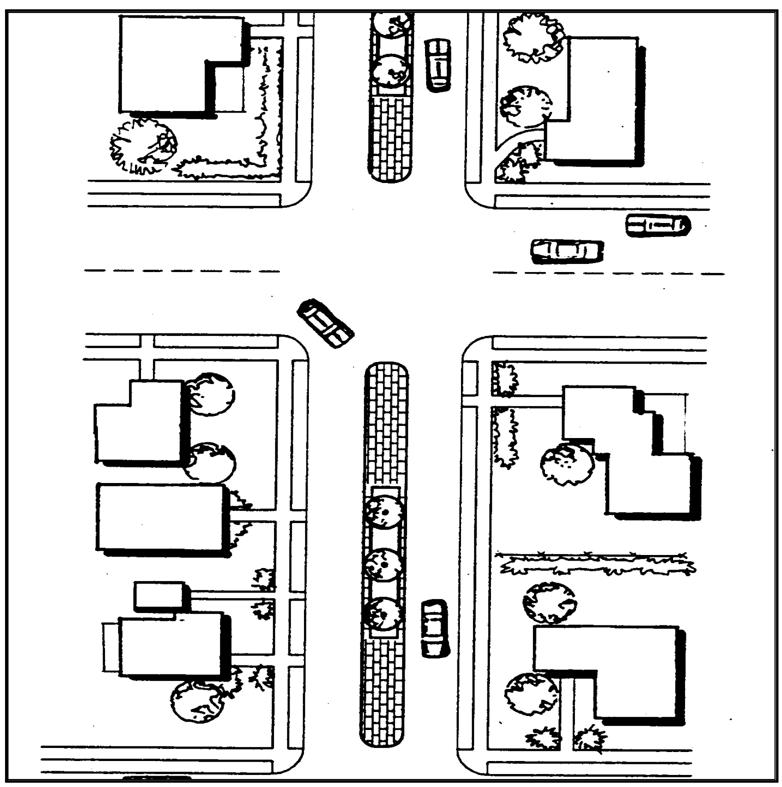


Source: City of Boulder NTMP Toolkit

Center Median

The width of the street is reduced when a median is placed longitudinally along the center of the street. This in turn narrows the path of travel for on-coming lanes as shown in Figure 2.13. The addition of landscaping can also add to the effect of a narrow passageway. This often restricts all parking where the medians may be placed.

Figure 2.14
Center Median



Source: City of Boulder NTMP Toolkit

Notes

[1] Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), p. 10.

[2] Ibid., p. 11.

[3] Ibid.

[4] Ibid., p. 14.

[5] Ibid.

[6] Kevin Edward Donahue, "Urban Access and Permeability: A Study of Traffic Calming," (Master's Thesis, The University of Texas at Austin, 1995), p. 120.

[7] Melinda Railey, "The Impact of Traffic Management Programs on the Delivery of Fire Suppression and Emergency Medical Services", (Master's Thesis, The University of Texas at Austin, 1996, p. 16).

[8] Ibid.

[9] Lindy McGinnis, "Things That Go Bump in the Night", *NFPA Journal*, (January/February 1997), p. 82.

[10]Ewing, *Traffic Calming: State of the Practice*, p. 105-106.

[11] Ibid., p. 106.

[12] Ibid., p. 109.

[13] Ibid.

[14] Ibid., p. 111.

[15] Ibid. p. 103.

[16] Ibid.

[17]Ibid., p. 19-39.

Chapter 3. Emergency Service Issues

Emergency Response Times & Routes

Operators of emergency service vehicles are charged with the responsibility of navigating their vehicles to emergency scenes by taking routes that will yield the shortest amount of travel time possible. This elapsed travel time, which begins when a unit is dispatched to an emergency, and ends when they arrive on the scene, is commonly referred to as *response time*. Undoubtedly, the most debatable issue regarding traffic calming devices rests with the negative impacts on response times for emergency service vehicles.

In conflicting roles, the neighborhood streets that are good candidates for traffic calming devices are also the very same streets that are often utilized by emergency services. Not unlike the general public, drivers of emergency service vehicles commonly select streets that provide for faster speeds, cut-through access to adjacent areas, and lesser physical impediments in order to achieve the shortest response time to their destinations. These type of preferred, frequently used streets by the emergency services are often referred to as *primary response routes*.

At least one, more often several, primary response routes are used on every emergency response to reach any location in the service area. Close proximity to emergency response routes is the very premise for optimal site selections for fire and EMS stations. In addition, most emergency service departments require their vehicle operators to devote an immense amount of time to studying and maintaining a superior knowledge of the streets within their geographical service area. This is to further ensure the emergency responders select the shortest, quickest routes that will yield minimal response times.

Recognizing the crucial importance of primary response, the Institute of Transportation Engineers (ITE) recommends that these routes should remain free of impediments. “Speed humps should not be installed on streets that are defined or used as primary or routine emergency vehicle access routes.”[1]

Fire and EMS Vehicles

As traffic-calming devices are designed to slow the vehicular traffic of the public, they also slow the speeds of emergency vehicles. Most passenger cars are lighter in weight, have a shorter wheelbase, and utilize much softer suspension systems than the other vehicles used upon roadways. In addition, they generally contain a higher horsepower to weight ratio and contain very effective, sophisticated braking systems. Although these vehicles are slowed somewhat by traffic calming devices, these features allow the passenger vehicles to traverse the devices much easier than any other type of vehicle.

As a result, the passenger type automobiles used by police departments do not generally experience significant delays in emergency responses when confronted by speed humps. Police cars have the ability to heavily accelerate between speed humps to compensate for lost time crossing over the humps.

Of the three major emergency services, fire and EMS departments experience much greater response delays due to traffic calming devices as compared to their counterparts in the police departments. The actual response delays for fire apparatus will vary due to their size and type when responding to an emergency.

One must also remember that the delay in responses for EMS units can have a double jeopardy. Unlike the police and fire departments, emergency responses for EMS units are not just a one-way trip to the emergency scene. In most instances, their services require a return trip of traversing traffic calming devices while transporting patients to the nearest hospital. So, the overall impact for EMS is significantly higher than for any of the other emergency services.

Fire departments use many different types of apparatus within their fleets to carry out their missions. Most utilize heavy truck type designs. Compared to automobiles, fire trucks have a longer wheelbase, stiffer suspensions, and heavy gross vehicle weights. Pumper and tanker type fire trucks carry various large volumes of water (between 500 to 2000 gallons), which weigh many tons. Ladder trucks, which have the largest wheelbase, carry large steel, aerial extension ladder devices (75’ to 135’ in length) which obviously are also very heavy.

With these physical features, fire apparatus operators must greatly reduce their speeds to safely traverse vertical speed humps and to negotiate very tight turning radiuses of traffic circles, chicanes, or deflector type devices. In addition, most fire apparatus are not adept for quick acceleration or de-acceleration extremes. Thus, they struggle severely to regain normal cruising speeds between devices.

EMS vehicles too are generally of a heavy truck type of design. Although they are not as heavy as fire trucks, they contain a large box type compartment for transporting patients and medical crews. This box configuration is unusually tall, quite bulky, and thus has a high center of gravity. Due to this design, when maneuvering over or through traffic calming devices, the EMS unit has a great tendency to severely shift from front to rear or side-to-side. Obviously, this type of transport condition can have very detrimental effects upon cardiac patients or severe trauma patients, i.e. bone fractures. There have also been reports that EMS personnel have been unable to successfully begin cardio-pulmonary resuscitation (CPR), intravenous medications, or intubate patients while traversing traffic calming devices.[2]

Although the delay in response time has been the focus of most opponents of traffic calming devices, there are some other severe, negative peripheral issues to fire and EMS emergency responses. Two of these issues warrant notation as they relate to both safety and additional direct costs for traffic calming programs.

Firefighter/Paramedic Injuries

There have been documented cases where firefighters have incurred injuries while traversing speed humps. A Montgomery County firefighter, responding to a 1997 fire incident, received substantial injuries to his neck and back while wearing a seat belt and full firefighter protective clothing. This employee was out of work for two months, served limited duty for another ten months before subsequently being released on full disability retirement in July of 1998.[3]

The Sacramento (CA) Fire Department has documented several firefighter injuries due to speed humps. One fire fighter was granted an early retirement after she struck her head on the roof of an apparatus while traversing a speed hump enroute to an incident. She suffered a cervical spine compression injury. Another firefighter experienced vertebrae compression injuries in another separate incident. That firefighter was awarded permanent disability status and could no longer work as a firefighter. In both of these cases, each firefighter was wearing a seat belt and yet the force of the jolt caused them to strike their heads on the cab roofs. The third known injury was believed to be an aggravation/recurrence injury. It is believed that this firefighter had a previous neck injury and that the speed humps aggravated or caused further injury. A fourth injury resulted during the performance of actual speed hump testing. This too was a spinal injury to the back.[4]

The Fresno (CA) Fire Department too has had at least four documented cases of "injury on the job" incidents during emergency responses from crossing speed humps in fire apparatus. The injuries have been incurred from firefighters striking their heads on the roofs of fire trucks. These injuries have mainly occurred to the Officers of the units who ride in the forward passenger side of the fire apparatus. Preliminary departmental investigations reveal that the drivers are not as severely impacted as they have "air-ride" seats whereas the Officers seating position generally have fixed "bench type" seating. In addition, the rear facing firefighter riding positions appear to be less vulnerable to this injury particularly for the fire unit models that contain a raised roof area.[5]

Fleet Damage

There is a growing concern that traffic calming devices cause increased maintenance to fire vehicles. The erratic weight shifts to the fire apparatus creates increased flexing and stress to suspension components such as steering devices, axles and frames. The Fresno (CA) Fire Department has experienced increased incidence of apparatus frame cracks. They attribute this to additional frame stressing and twisting from speed humps.[6]

A similar situation is documented in Berkeley, California. "Driving over speed humps cause[s] the frame to flex at awkward angles and serve to stress the apparatus needlessly. Because of this, the average life span of emergency vehicles would be shortened. One of our aerial ladder trucks had to have gussets welded to the frame to strengthen the frame member in order to stop a stress fracture. This was a direct result from the speed humps on Derby Street between Shattuck and Telegraph".[7]

Probably the department that has endured the most damage is the Sacramento (CA) Fire Department. They have documented several engines as having flattened springs, and/or body welds breaking loose from the vehicles' frame. Each apparatus experiencing these problems was assigned to response districts containing a higher number of speed humps than other areas of the city.[8] Due to this higher saturation of humps, fewer alternative routes were available to these units. Thus, these units experienced more repeated trips of passing over these devices.

One very dramatic Sacramento incident involved a 1975 Calavar Firebird apparatus, which is a 150' articulating ladder platform, weighing approximately 72,000 pounds. While responding to an incident, the apparatus had a front axle assembly shear off after crossing a speed hump. Fortunately, no one was hurt, but there obviously was significant damage to the apparatus.[9]

Although not as severe, another fleet damaging incident also occurred in Sacramento. As the ladder/tiller unit crossed over speed humps at a speed of 20 mph, tremendous flexes and twists were placed upon the unit to the extent that all of the compartment doors, on both sides, abruptly came open. This resulted in most of the loose equipment stored inside being dumped onto the street.[10] This is finding is consistent with an Austin, TX speed hump test where a “power steering dipstick was dislodged from [the] motor over hump #5; equipment bouncing noise could be easily heard within compartments at all humps; radar noted speeds at all humps was at least 20 mph.”[11]

Water tanks carried on the apparatus have also been subjected to damage. “One [San Diego] Fire Department truck tank was broken as the vehicle rolled over a hump.”[12] In another report, “This city’s first speed hump…has cost the Louisville Fire District more than $1,000 in damage to a truck.”[13]

Vehicle damage from speed humps have also been reported in other public service fleet operations. Primarily bus routes and public transportation systems seem to be the most impacted. In England, “Midland Fox has estimated that damage resulting from traffic calming costs an estimated

£40,000 a year, with double-decker buses being the worst affected. Minor incidents have occurred…resulting in broken springs, skirting and exhausts, and…collapsed suspension."[14] The Sacramento (CA) Regional Transit System experienced major bus damages also. As a result, the transit system will no longer provide bus routes on streets that contain speed humps. Whenever new humps are placed down, the transit system simply moves to another route where humps are not located.[15] This may also be true for school buses. With speed hump problems on Twain Avenue in San Diego, "[s]chool buses are opting for Estrella [Avenue] to avoid Twain's undulations."[16]

Some special transit vehicles for the disabled have also documented increased maintenance from constantly going over or around traffic calming devices. These include increase in front-end alignments, brake pads wearing more quickly, shocks and springs need more frequent replacement, and damage to water valves, fuel tanks and mufflers that are located underneath the vehicle.[17]

Response Time Tests & Studies

Although most opponents and proponents agree that traffic-calming devices cause delays to emergency services, the real heart of the issue is how much of a delay occurs and does this have a significant impact on the outcome of the emergency event? Pressed to provide quantitative and qualitative data, several fire departments and local governments have conducted various tests and studies in an attempt to measure the effect that traffic calming devices have upon emergency vehicles. Because traffic conditions and calming devices differ from one locale to another, the results of these tests and studies can vary with each jurisdiction. Each of the known major tests or studies is reviewed here along with the summary findings of each.

Portland, OR (January 1996)

The first major metropolitan city to extensively research and measure the effects on fire vehicle travel times of traffic calming devices occurred in Portland, Oregon. Beginning in the fall of 1995, the Portland Bureaus of Fire and Traffic Management initiated quantitative testing of the relationship between traffic calming devices and emergency response times. Four variables, which were thought to influence the response time impacts, were considered. The variables identified were: the driver, the type of fire vehicle, the desired speed, and the type of traffic calming devices.

Six vehicles consisting of fire engines, rescue units, squad units, and ladder trucks were used. With four test runs per vehicle, at speeds of 25, 30, 35, and 40 mph, a total of 24 tests were administered for each street. Of the six streets tested, two had 22-feet wide speed humps, two had speed hump widths of 14-feet, and the remaining two contained one traffic circle each.

The actual elapsed time from start to finish was timed and compared to the calculated response time for the same distance without traffic devices. The time difference represented the amount of response delay.[18]

The summarized findings and conclusions of the report indicated that the performance of the individual drivers did not significantly influence the results. The delays per device were interrelated to the three remaining variables of the type of vehicle, the type of device and the desired travel speed. The range of delays for all vehicles, with the four tested speeds, and the specific device tested is as follows:

22-foot Speed Humps:	0.0 to 9.2 seconds per hump
14-foot Speed Humps:	1.0 to 9.4 seconds per hump
Traffic Circles:	1.3 to 10.7 seconds per circle[19]

A closer examination of the data results for the specific speed of 30 mph reveals that the speed hump delays experienced for a fire engine is 3.7 seconds, compared to 4.9 seconds for longer ladder trucks. The rescue unit at this speed, which is comparable to an EMS unit, encountered a 1.7 second delay per hump.[20]

Most importantly of this study, interpretations of the data for the desired speeds of 25 mph vs. 40 mph would suggest that the faster a fire or EMS unit tries to travel, the greater the impact is for the delay. Most fire and EMS operators prefer a cruising speed of 35-40 mph. In essence, the more a driver intensifies his/her efforts to transverse the humps, the greater the impact delay. For some cases, the impact per hump could be upwards of three-fold as depicted in Table 3.1.

Table 3.1

Speed Hump Response Delays for 25 MPH vs. 40 MPH

Vehicle	Response Speed	Delay Per Hump	% Delay For Faster Speed (40 mph)
EMS Unit	At 25 mph	1.3 seconds	
	At 40 mph	5.1 seconds	292%
Fire Engine	At 25 mph	2.8 seconds	
	At 40 mph	8.5 seconds	203%
Ladder Truck	At 25 mph	4.3 seconds	
	At 40 mph	10.3 seconds	139%

Source: The Influence of Traffic Calming Devices on Fire Vehicle Travel Times, Portland Bureau of Fire, Rescue and Emergency Service and Bureau of Traffic Management, January 1996.

Austin, TX (March 1996)

In response to an explosion growth of popularity and request by citizens for speed humps on over 600+ streets, the Austin Fire Department conducted an analysis outlining the impacts to fire and EMS vehicles. This particular test measured the average time delays per each speed hump, with a total of six humps (14 feet wide) being crossed. The time increases to traverse the humps were approximately 2 to 10 seconds. This variation was due primarily to the type of emergency vehicle tested. For example, EMS units responding without a patient had an increase average of 2.2 seconds per hump compared to a 9.6 second increase when transporting a critically injured patient. Fire engine pumper trucks and ladder trucks experienced an average delay variation of 2.8 to 3.6 seconds per hump. These results were from test parameters requiring the drivers to maneuver over the humps at speeds of their own discretion or at 15 mph. They were to then regain a 30 mph cruising speed between the humps.[21]

Another series of tests, requiring the drivers to maintain a 20 mph speed while crossing the humps and regaining to 30 mph in between humps, was found to be close to or beyond the reasonable limits of traversing speed humps. Specifically, all drivers in this test series expressed concern that they were out of control or that this speed was very potentially damaging to their apparatus.

In fact, some drivers refused to conduct seconds runs of this test at that speed. Thus, the data from this particular test was not used to determine the impact inferences. However, this confirms that apparatus cannot traverse speed humps safely at speeds of 20 mph or greater.[22]

Applying the data from this test, and using the 1999 Austin Fire Department average response time of 4.25 minutes, a simple extrapolation would reveal the impact of the increased response time expressed in a percentage.[23] A citizen living at the end of this particular test location, which requires emergency vehicles to cross the six speed humps, would experience the increased response times noted in Figure 3.2.

Table 3.2

Response Time Increases for Six Speed Humps

Vehicle Type	Average Response Time	Average Time Increase (for 6 Speed Humps)	Total Increased Response Time	Percent Differential Increase for Delay
Pumper Truck	4.25 min.	.28 min.	4.53 min.	7%
Ladder Truck	4.25 min.	.37 min.	4.62 min.	9%
EMS (no patient)	4.25 min.	.27 min.	4.52 min.	6%
EMS (with patient)	4.25 min.	.97 min.	5.22 min.	23%

Source: An Analysis of Speed Humps Effects on Response Times, Austin Fire Department, March 1996.

Montgomery County, MD (August 1997)

Facing increased pressures from the public and from politicians, the Montgomery County Fire Department was directed to study the issue in August 1997. The scope of this study was to measure the effects of circular type speed humps and traffic circles. Two test courses were implemented, one having three speed humps, and the second course containing one traffic circle. The evaluation team, composed of Montgomery County staff personnel from the Fire and the Public Works Departments, established test methodology employing most of the same measurement techniques used previously in both the Austin and Portland tests. Three types of fire trucks and one ambulance were used in test runs.

Similar to the Austin test, the Montgomery County Fire and Rescue units experienced an average delay of 2.8 to 7.3 seconds per hump.[24] Likewise to the Portland test, a delay range of 3.2 to 7.0 seconds was experienced for the Montgomery County units maneuvering around the traffic circle test.[25] Although these delays are similar to the other studies, the research staff discovered that the four vehicles averaged slightly less than 20 mph across the test route. This is far below the widely accepted response time study by the Rand Institute in New York City, which established that fire department apparatus travel at an average cruising speed on 39.2 mph. Thus, their findings would, in all likelihood, represent the minimum delays that one could expect from fire and EMS units.[26]

Rather than just examining response time implications, this study utilized a linear form of measurement for determining service impact. Using the data, a chart was established showing how much closer, or an equivalent distance, a unit would have to be stationed to an incident scene due to the response delays it would encounter from crossing speed humps. Assuming one wanted to maintain a 5-minute response time goal, the chart shows that every speed hump the unit has to cross, while maintaining a 25 mph cruising speed, is equivalent to being .05 (1/20) mile further from the incident scene. If the scenario contained 5 humps to cross, this would have the effect of adding approximately ¼ mile to the equivalent response distance. Thus, a station would need to be ¼ mile closer to the incident in order to maintain a 5-minute response goal.[27]

Linear measurement of course is in direct proportion to station coverage area measurements. As noted by the Montgomery County report, the areas served by fire stations could be greatly impacted:

> Should speed hump-impeded routes taken by responding units limit average speed to 20 mph, the amount of area they can serve within 5 minutes may drop to the area within 1.3 linear miles from the station versus the area within 2.0 linear miles served within 5 minutes along unimpeded routes upon which a cruising speed of 35-40 mph is attainable. Coverage of 1.3 miles in each direction from a station would be about 6.8 square miles per station for a total of 210 square miles covered by the County's 31 fire-rescue stations. In comparison, coverage of 2.0 miles in each direction would equal 16 square miles per station for a total of 496 square miles covered by the same 31 stations. Assuming the 1.3 mile scenario, station coverage would be 42% of that available from stations unimpeded by speed humps, implying that 58% of the residents/service recipients would wait more than 5 minutes for service after dialing 911.[28]

These findings could be illustrated in a different manner. If the Montgomery County residents desired to maintain the 5.0 minute response time goal and wanted traffic calming to the level indicated above, they would have to add 42 more fire stations, for a total of 73, in order to keep their current level of service. Due to the decreased speeds and increased response times, these stations would have to be placed closer to each other than where they presently are. In addition, the financial impact would be overwhelming.

Berkeley, CA (October 1997)

In July 1995, after the Berkeley Fire Department (BFD) and disabled residents expressed strong concern over the proliferation of speed humps, the City Council ordered for an evaluation to be conducted. Further, the analysis was directed to consider not only the effectiveness of speed humps but also the full impacts of the devices. This study was completed in October 1997.

Two types of traffic calming devices were evaluated by the Fire Department. One test was performed on a street with six 12-foot circular speed humps, while the other was conducted on a street with two 22-foot flat top designed humps. For each test, a fire engine and a ladder truck were driven over the street segment containing the humps and then over a very similar adjacent street of the same distance but containing no humps. All test runs were timed and the response delay was identified by the time differences.[29]

Test results for the 12-foot humps suggested an increase of 10 seconds per hump. This time delay was similar for both the engine and ladder units. Based on this street, which is approximately 3 blocks or 1/3 mile long, the

Fire Department would experience an increase response delay of an additional one-minute.[30]

The results for the 22-foot humps revealed a significantly less delay particularly for the engine apparatus. The delay experienced by the engine was approximately 3 seconds per hump. However, the ladder truck had a much longer delay of approximately 13 seconds for this type of hump. This report does clarify that the delays measured by the BFD was greater than the four to six second delay per hump that other cities had identified. The BFD staff attributed these variances to driver behavior and limited physical testing.[31]

Boulder, CO (April 1998)

With growing concern and heated public debate over recent traffic calming installations, the Boulder Fire Department conducted tests to determine the response delays associated with traffic circles. Two tests, approximately one year apart, were performed.

In June of 1995, after affixing temporary orange traffic cones to depict the outline of a future traffic circles, a consulting engineer firm and the Boulder Fire Department conducted tests with fire apparatus. This test required the drivers of the units to maneuver around a traffic circle within a three-block roadway. The findings revealed that the delay was 7.5 seconds. The average speed of the units was 23 mph. [32]

One year later, the same test was performed. However, the traffic circle had the same dimensions but was constructed of temporary concrete blocks rather than the orange cones of the previous year. Under this condition, the fire units experienced an increase in the delay going from 7.5 to 10.0 seconds. Relative to the increased delay, the average speed also dropped from 23 mph to 20 mph. These increases are believed to be attributed to the more intimidating concrete barriers rather than the less harmful orange cones.[33]

Combined findings of the Portland, Austin, Montgomery County, and Berkeley tests confirm that speed humps cause considerable delays for emergency response vehicles. The Portland, Montgomery County, and Boulder tests verify that significant delays occur also from traffic circles. Thus, all of these tests substantiate that traffic-calming devices pose a negative impact to the outcome of life threatening incidents and other emergency service level deliveries. The level of this impact will be explored in Chapter Seven.

Notes

[1] Douglas W. Wiersig, *Guidelines for the Design and Application of Speed Humps,* ITE Traffic Engineering Council Speed Humps Task Force TENC-5TF-01 (Washington, D.C.: Institute of Transportation Engineers, June 1997), p. 10.

[2] Dashka Slater, "Berkeley Avoids New Speed Humps", *Berkeley Voice* (August 25, 1995), p. 2.

[3] *Mitchell v. Save Our Streets*, Civil No. 191477 (Md. Cir. Ct., September 19, 1998), Affidavit of George Gosbee.

[4] Telephone interview by Les Bunte with Gordon Duncan, Battalion Chief, Sacramento (CA) Fire Department, February 8, 2000.

[5] Telephone interview by Les Bunte with James Christiansen, Bureau Chief of Operations, Fresno (CA) Fire Department, February 10, 2000.

[6] Letter from Operations Chief James L. Christiansen, Fresno (CA) Fire Department, to District Chief Matthew Shuler, Eugene (OR) Fire Department, April 10, 1996.

[7] Letter from Assistant Fire Chief Michael J. Migliore, Berkeley (CA) Fire Department, to Susan Sanderson, Transportation Planner, City of Berkeley, May 8, 1995.

[8] Telephone interview by Les Bunte with Gordon Duncan, Battalion Chief, Sacramento (CA) Fire Department, February 8, 2000.

[9] Ibid.

[10] Ibid.

[11] City of Austin Fire Department, "An Analysis of Speed Hump Effects on Response Times", Austin, TX, March 1996, (Annex A) p. 16.

[12] Ronald W. Powell, "The speed humps make bumpy issue on Twain Street", *San Diego Union-Tribune*, (May 31, 1996), p. B-1.

[13] Sally McGrath, "Louisville may dump speed bump", *Daily Camera*, (May 14, 1997), p. B-1.

[14] P.G. Boulter and D.C. Webster, *Traffic calming and vehicle emissions: A literature review,* TRL Report 307, (Crowthorne, UK: Transport Research Laboratory, 1997), p. 26.

[15]Telephone interview by Les Bunte with Gordon Duncan, Battalion Chief, Sacramento (CA) Fire Department, February 8, 2000.

[16] Powell, "The speed humps make bumpy issue on Twain Street", p. B-1.

[17] Letter from Linda Diebert & Lenna Kottke, Executive Co-Directors, Boulder Special Transit, to Boulder City Council, April 3, 1997.

[18] City of Portland, Bureau of Fire, Rescue & Emergency Services and Bureau of Traffic Management, "The Influence of Traffic Calming Devices on Fire Vehicle Travel Times," Portland, OR, January 1996, pp. 1-4.

[19] Ibid.

[20] Ibid.

[21] City of Austin Fire Department, "An Analysis of Speed Hump Effects on Response Times", Austin, TX, March 1996, p. 3.

[22] Ibid.

[23] Piet Sybesma, "Dispatch TQM Project," personal email to Les Bunte, March 22, 2000.

[24] Montgomery County Fire and Rescue Commission, *The Effects of Speed Humps and Traffic Circles on Responding Fire-Rescue Apparatus in Montgomery County, Maryland*, Montgomery County, Maryland, August 1997, p. iv.

[25] Ibid., p. v.

[26] Ibid., p. 8-9.

[27] Ibid., p. 9.

[28] Ibid.

[29] City of Berkeley, Advance Planning Division, "An Evaluation of the Speed Hump Program in the City of Berkeley," Berkeley, CA, October 1997, p. 21.

[30] Ibid., p. 22.

[31] Ibid., p. 22-23.

[32] Memorandum from Kevin L. Jones, Transplan Associates, Inc., to David Mentor, City of Boulder, Colorado, June 3, 1996.

[33]Ibid.

Chapter 4. Environmental/Air Quality Emission Issues

Vehicle Emissions

The very core principle of local government is to adopt and enforce policies and standards that will ensure a high quality of life for the local citizens. Obviously, policies and programs that provide for safe, sustainable neighborhoods along with efficient emergency services are one of many pieces to achieve that end. Equally important to those services and programs, local government officials are mandated to protect the environment and natural resources of their region.

The relationship between traffic management calming devices and the subsequent environmental impacts is a relatively new issue that will demand further exploration and analysis.[1] Resultantly, the extent to which traffic management schemes bring about environmental improvements or degradations is difficult to quantify at present. However, like the negative impacts for emergency response times, there is some preliminary evidence that would strongly suggest that traffic calming contributes to increased air pollution.

We do know that the emissions from an individual car are generally low, in relation to the smokestack images of factories and refineries that many people associate with air pollution. But in numerous major metropolitan areas across the U.S., the personal automobile is the single greatest polluter, as emissions from millions of vehicles add to a growing problem. Driving a car is probably the most *polluting* daily activity of a typical citizen.[2]

According to the U.S. Environmental Protection Agency (EPA), motor vehicles in this country are presently responsible for up to half of the smog-forming volatile organic compounds (VOC's). They release more that 50 percent of the hazardous air pollutants and up to 90 percent of the carbon monoxide (CO) found in urban air.[3] The EPA has identified and established acceptable concentration levels for six specific pollutants in outdoor air. They are: ground level ozone (O_3) commonly referred to as smog; nitrogen oxides (NO_x) of which nitrogen dioxide (NO_2) is the most abundant; sulfur dioxide (SO_2); carbon monoxide (CO), lead (Pb); and particulate matter (PM).[4] These serve as the target gases for measuring automobile emissions. Obviously, local governments must maintain a constant vigilance to these pollutants that contribute to air pollution.

Factors contributing to automobile emissions can be classified into two broad categories, one being *technical*, and the other *operational*. Vehicle weight, engine size and design, fuel type, exhaust configuration, and aerodynamic features are all technical factors effecting emission qualities and quantities. Operational factors relate to how the driver uses the vehicle, such as speed, acceleration and deceleration techniques, and idling.[5] The operational factors are likely to be the most influenced by traffic calming devices since their primary objective is to change the driving patterns of vehicle operators.

Vehicle Emission Case Studies

Within the last several years, various studies have been conducted in Australia, Austria, Denmark, Germany, Holland, Sweden and the United Kingdom (UK), which show that vehicle emission pollutants, along with fuel consumption, are increased with traffic calming devices, particularly speed humps. Two of these studies related to area-wide traffic calming features, whereas the remaining six measured the emissions on single sections of roadways containing the devices. To date, only one U.S. study was identified that measured vehicle emissions resulting from traffic calming devices. All of these case studies, with the exception of the German study, revealed increases in air pollution emissions primarily due to acceleration and deceleration while traversing speed humps. Summaries of these studies can be found in Appendix B that convincingly demonstrates that traffic-calming devices contribute considerably to air pollution and fuel consumption.

Buxtehude, Germany

The lone positive test from Germany, which appears to be one of the first studies for this issue, studied the impacts of traffic calming for five major to medium size cities in Germany from 1983 to 1986. This report concludes that traffic-calming devices reduce air pollutants. Strangely, only the positive results of one of these cities (Buxtehude) were reported extensively in the report. Therefore, the Buxtehude study is regularly referenced as an example in which traffic calming has been shown to reduce vehicle emissions[6]. There is concern to the overall validity of this report since the details of the other German cities were not amply pronounced or revealed.

United Kingdom

In 1993, the Transport Research Laboratory in Crowthorne, England studied the effects of vehicle emissions in regards to acceleration and deceleration while traversing speed humps. This research group constructed hypothetical speed hump profiles at different intervals (50, 75, and 100 meters) over a 300-meter length of roadway. Both flat top and circular design humps were incorporated into the scheme. Established test assumptions were that vehicles accelerated 67 percent, and decelerated 33 percent of the time respectively, for the distances between the humps. The emission outputs of the different hump schemes were compared to the same linear configuration without any devices, i.e. traveling unobstructed and at the same speed.

For the 75 meter scheme, with average speeds of 15-17 mph due to hump traversing, "cars showed increases in CO and HC [hydrocarbons] of around 70-80% and 70-100% respectively, and an increase in CO_2 [carbon dioxide] of around 50-60%. NO_x emissions were predicted to be around 0-20% lower after calming."[7] With emissions showing a large increase while accelerating and decelerating, the scientists also analyzed the emissions generated by cars traveling at constant speeds of 20 and 30 mph without going over speed humps. The lower speed of 20 MPH was shown to generate more harmful emissions than a vehicle traveling at 30 mph. This was evidenced by increases of both CO and HC to approximately 40-80 percent, and an increase of CO_2 by 30-40 percent. Emissions of NO_x were also seen to increase by around 20-30 percent.[8]

This study clearly demonstrates that automobile emissions increase with accelerating and decelerating. In addition, the results reveal that more emissions are emitted at slower travel speeds than higher speeds normally encountered on residential neighborhood type streets.

Sweden

A Swedish study in 1995 examined the impacts of automobile emissions in relation to the number of humps crossed and the regaining of desired vehicle speeds in between humps. The parameters of this test included the emissions for a constant speed with no humps, compared to emissions for traversing one hump, and then another test for ten humps. On tests with humps, all vehicles were to reduce their speed from 50 to 30 km/h [32 to 19 mph] before the hump, and then reestablish a speed of 50 km/h after the hump.

The analysis showed emissions increase of 20 percent and a fuel consumption increase of 5 percent while crossing over one hump. As anticipated, each of these test measurements was significantly increased when traveling over 10 humps. Rather than being solely proportional to the number of humps crossed, increases in emissions were found to be between 200-300 percent, while fuel consumption saw an increase of 40-50 percent.[9]

Austria (AIT/FIA)

One of the most disturbing findings involves a case study performed in Austria by the Alliance Internationale de Tourisme/Federation Internationale de I'Automobile (AIT/FIA) Traffic Commission. This study analyzed the emissions of vehicles limited to a travel speed of 30 km/h [19 mph] upon a test site composed of a 1.5 km [.93 mile] containing six speed humps. The test results and findings were as follows:

> A vehicle, which slows down to 15 km/h [9 mph] before the bump and accelerates to 30 km/h immediately after the bump emits 10 times as much nitrogen oxide (NO_X) as a vehicle which maintains a constant speed of 30 km/h. NO_X emission per kilometer thus increases from 0.03 to 0.3 gm. The vehicle which drew to a halt at each bump showed a NO_X emission of 0.24 gm/km, i.e. 8 times more than that of a vehicle maintaining a constant speed of 30 km/h. On the stretch of road containing speed bumps carbon monoxide (CO) emissions were three times a great as those of a vehicle maintaining a constant speed. Fuel consumption increased from 7.9 litres to an additional two litres per 100 km on the stretch of road where the vehicle braked six times. Carbon dioxide emission (CO_2) increased in the same way. Hydrocarbon (HC) emissions were so low in all cases that they were below the probative level.[10]

Table 4.1 contains the measurements and percentage impacts of this study.

Table 4.1

Environmental Impacts of AIT/FIA Case Study

Environmental Impact	**Test 1: Without speed bumps**	**Test 2: With 6 speed bumps**	**Test 3: With 6 speed bumps**
Driver Behavior	Constant speed of 30 km/h (19 mph)	Slowing down from 30 to 15 km/h (9 mph)	Slowing down from 30 to 0 km/h (19-0 mph)
Fuel Consumption (litres/100 km)	7.9	9.9 (+24%)	10.8 (+36%)
Nitrogen Oxide (No_x) (gm/km)	0.03	0.3 (+900%)	0.24 (+700%)
Carbon Monoxide (CO) (gm/km)	0.23	0.6 (+160%)	0.62 (+170%)
Carbon Dioxide (CO_2)	199.9	247.3 (+24%)	271.4 (+36 %)

Notes:
Length of Test Route: 1.5 km (.93 mile) with 6 speed bumps (Tests 2 and 3)
Comparative Test: 1.5 km without speed bumps (Test 1)
Vehicle used or the test: medium-range car with tuned catalytic converter

Source: Jean-Martin Kuntschen (TCS), AIT/FIA Traffic Commission

Although the AIT/FIA report focuses on measuring vehicle emissions, the physical methodology and course layout is very similar to the previously reviewed Austin, Texas test. That analysis was conducted only to measure the time delays associated with speed humps. Due to the similarities, these two tests serve to complement each other in their findings regarding the two different elements of the research issues.

Portland, ME (Stevens Avenue)

The referencing of the Buxtehude, Germany study actually caused some extreme embarrassment and severance of federal funding for a traffic-calming project awarded to the City of Portland, Maine. The City of Portland applied for a grant under the Congestion Mitigation/Air Quality (CMAQ) program of the Federal Highway Administration (FHWA) within the U.S. Department of Transportation (DOT). This federal funding mandated that approved projects must reduce air pollution and improve air quality. In particular, the City of Portland sought the funding to install traffic calming devices on Stevens Avenue within their city.

In their justification documents for the federal funding, the City of Portland noted “There is no experience in Maine and little in the United States that documents the effect of traffic calming on air quality. Based on published data, the City of Portland believes the proposed traffic calming measures will improve the air quality.”[11] The document then refers to the how the lone study of Buxtehude, Germany (population 33,000) demonstrated a decrease in emissions contrary to other studies.

The project was approved for federal funding and began in 1997. The devices were installed and DeLuca-Hoffman Associates, Inc. served as the contractor for the City to collect and analyze the results of this entire initiative. In May 1998, De-Luca-Hoffman Associates, Inc. submitted the findings to the City of Portland, which showed increases, rather than decreases, in air pollution for the project.[12]

Based on these findings, the FHWA/DOT had no choice but to suspend the funding for the project.

> The study evaluated the impacts of the traffic-calming project, including air quality impacts. The report documents a 46% increase in VOC [volatile organic compounds] emissions and a 17% decrease in NO_X [nitrous oxide] emissions. In sum, the study indicates that the Stevens Avenue Traffic Calming project has resulted in an increase in pollutants. Indeed, the actual pollution impacts could be worse than what was presented in the report, as the report did not take into account the emission impacts of increased braking and acceleration associated with the raised crosswalks…As a result of the study, we are not willing to approve any further expenditure of CMAQ funds on this project.[13]

A total of $233,600 was originally approved for the project. However, with the increased emissions verified, and to the embarrassment of City officials, $140,000 was withheld by the FHWA/DOT from the City of Portland to complete the project.[14]

Cold Start Emissions

A new area of concern is that of vehicle *cold start* emissions.   The greatest amount of tailpipe pollutants is emitted during a vehicle’s cold start phase. A cold start phase is the first few minutes, or miles traveled, of an engine’s operation before the catalytic converter becomes effective.[15] A 1994

Swedish Environmental Protection Agency report verifies there is “a substantial increase of CO and HC emissions during the cold start sequence.”[16] In another similar study conducted in the U.S., the Society of Automotive Engineers (SAE) found that “cold engines use more fuel and generate more pollution than engines that are fully warmed up. The effect on catalyst equipped cars is marked because catalysts do no work until their temperature reaches a suitable level.”[17]

In relation to traffic calming, the concern is that a large percentage of the vehicles traversing over a neighborhood’s calming devices are vehicle trip departures that originate from within the neighborhood. As a result, these vehicles generate higher cold start emissions due to early acceleration and deceleration, and thus add further to the increased air emissions than those produced by the non-resident general traffic. However, the exact impact of this condition is not known.

Air Quality Impact to Austin, Texas

The significance of increased air pollution from excessive automobile emissions is currently of paramount importance to the City of Austin, Texas. Under the Federal Clean Air Act of 1970, Congress authorized the U.S. Environmental Protection Agency (EPA) to set thresholds on the quantities of which certain types of pollutants can be in the ambient air at any time. States are required to carry out most of the enforcement responsibilities for these federal standards. The Texas Natural Resource Conservation Commission (TNRCC) is the designated state agency to fulfill this responsibility.[18]

Metropolitan areas that are considered to have air quality as good as, or better than, the National Ambient Air Quality Standards (NAAQS) as established by the EPA are classified as "attainment areas". Those areas that are close to violating the standard are "maintenance" areas. These areas are encouraged to enact voluntary policies and programs aimed at reducing pollution. Any metropolitan area that is in violation of any one of the six identified pollutant standards is classified as a "non-attainment" area. An area may be an attainment area for one pollutant and a "non-attainment" area for another pollutant.[19] These "non-attainment" areas are mandated to implement actions and programs that will reduce the pollution levels back to acceptable standards. The NAAQS establishes the limits for the six specific pollutants that were identified at the beginning of this chapter.

In 1997, the EPA implemented a tougher measurement standard for determining "attainment." Austin was on pace to fail that standard for ozone until a federal court ruled, in an unrelated case, that the new EPA methodology was unconstitutional. Although this gave Austin a reprieve for a while, the EPA is expected to be authorized to soon reestablish the new measurement methodology. Austin will again be expected to not meet the new ozone requirements.[20]

The ramifications to the citizens of Austin for being in a "non-attainment" area can be severe and costly. For certain, the metropolitan area would be mandated to implement a basic vehicle inspection and maintenance program for vehicles. This would require all vehicle owners to have their vehicles regularly inspected for excessive emissions. A fee accompanies the inspection. Owners would also be required to repair any deficient vehicles.[21]

The other main concern deals with federal highway funding for major transportation projects. The city's failure to take mandatory and proactive actions to reduce the pollution levels could result in federal funding being withheld for the major projects within the Austin area.[22] Failure to receive such funding would place a greater burden on the citizens.

Thus, the City of Austin needs to evaluate the negative impact that increased vehicle emissions from traffic calming measures can have upon other programs and initiatives to prevent air pollution. Again, traffic calming is in competition with another public good.

Notes

[1] P.G. Boulter and D.C. Webster, *Traffic calming and vehicle emissions: A literature review,* TRL Report 307, (Crowthorne, UK: Transport Research Laboratory, 1997), p. 4.

[2] U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Automobile Emissions: An Overview*, EPA 400-F-92-007, Fact Sheet OMS-5, (August 1994). Online. Available: http://www.epa.gov/oms/05-autos.htm. Accessed: February 4, 2000.

[3] U.S. Environmental Protection Agency, Office of Air and Radiation, *The Plain English Guide to the Clean Air Act*, EPA-400-K-93-001, (April, 1993). Online. Available: http://www.epa.gov/oar/oaqps/peg_caa/pegcaa04.html#topic4f. Accessed: February 4, 2000.

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[5] P.G. Boulter and D.C. Webster, *Traffic calming and vehicle emissions: A literature review,* p. 18.

[6] P.G. Boulter and D.C. Webster, *Traffic calming and vehicle emissions: A literature review,* p. 21-25.

[7] Ibid., p. 23.

[8] Ibid.

[9] Ibid., p. 24.

[10] Jean-Martin Kuntschen (TCS), "Power and Speed of Vehicles: Speed Bumps Cause Ten Times More Air Pollution" (paper presented to the Alliance Internationale de Tourisme/Federation Internationale de I' Automobile [AIT/FIA] Traffic Commission, Munich, Germany, September 6, 1994), p. 1-2.

[11] City of Portland, Public Works Department, "Congestion Mitigation /Air Quality Program Application, Portland, ME, July 1994, p. 8.

[12] DeLuca-Hoffman Associates, Inc., *City of Portland Stevens Avenue Traffic Calming Report, Final Monitoring Report,* (South Portland, ME, May 1998).

[13] Memorandum from Steven Beningo, Division Transportation Planner, Maine Division, Federal Highway Administration, U.S. Department of Transportation, to John G. Melrose, Commissioner, Maine Department of Transportation, August 13, 1998.

[14] Mark Shanahan, "Federal government pulls funds from traffic-slowing experiment," *Portland Press Herald* (August 18, 1998), p. 1A.

[15] Texas Natural Resource Conservation Commission, Office of Pollution Prevention and Recycling, "Ground-level Ozone: Cars & Trucks Pollute", (July 14, 1997). Online. Available: http://www.tnrcc.tx.us/publications/gi/210.html. Accessed: March 21, 2000.

[16] Swedish Environmental Protection Agency, Transport Section, *Cold Temperature/Cold Start Tailpipe Emissions for Light Duty Vehicles; Requirements and Standards*, (Stockholm, Sweden, June 1994), p. 3-4.

[17] Society of Automotive Engineers, *Influence of Instantaneous Speed and Acceleration on Hot Passenger Car Emissions and Fuel Consumption*, report no. 950928, (Warrendale, PA, 1995), p. 214.

[18] Texas Natural Resource Conservation Commission, Natural Outlook, "Clean Air Standards in Limbo", (November 28, 1999). Online. Available: http://www.tnrcc.texas.gov/admin/topdoc/pd/020/99-04/limbo.html. Accessed: December 15, 1999.

[19] Texas Natural Resource Conservation Commission, Office of Environmental Policy, Analysis, and Assessment, "Air Quality Issues in Texas, Background Material", (Austin, Texas, December, 1999), p. 33.

[20] Ibid., p. 2-3.

[21] Ibid., p. 9.

[22] Ibid., p. 11.

Chapter 5. Civil Liability Issues

In any high profile, controversial issue that occurs within local government, one usually can be assured that legal implications will be introduced into the debate. The issue of traffic calming is certainly not immune from the realms of civil jurisprudence. In most instances, the legal aspects are usually centered on three elements of law. The first one generally questions the statutory authority of local governments to provide for traffic calming devices. Second, for local actions and decisions, it is reasonable to expect legal challenges to the constitutionality of infringing upon the rights of residents. And the third area for review will usually involve the level of exposure the local government might incur from those seeking personal and/or property damage relief as a result of the public policy. Obviously, for these reasons, legal review is recommended for good public policy formation.

The formally adopted decisions and actions of all elected officials of government are always subject to legal scrutiny and risk. That level of risk is usually based on established precedents of case law coupled with sound practices that are reinforced with established national standards. Traffic calming actions and programs are vulnerable to suit.

Although there are national and professional standards for components of public transportation roadway systems, there are none from an adoptive government body or agency for traffic calming devices. Two nationally accepted transportation standards, the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) established by the U.S. Federal Highway Administration, and *A Policy of Geometric Design of Highways and Streets*, produced by the American Association of State Highway and Transportation Officials, are silent as to required design features or placement of traffic calming devices. Again, with no authorizing laws, standards or accepted professional practices, a local government has potential exposure to unwanted legal challenges and claims.[1]

ADA Implications

Recently, more and more concern and debate is emerging regarding the impacts that traffic-calming devices have upon persons with disabilities. Disabled citizens charge that these devices cause undue pain, suffering, and injury whenever they routinely encounter these roadway modifications. Generally, these citizens are opposed to the vertical devices such as speed humps, raised crossings and traffic circles on public right of ways.

One legal exposure to local governments is related to the federally mandated American with Disabilities Act (ADA) of 1990 and the law's application to public roadways. A review of some of the provisions of this law reveals the potential legal exposures:

ADA, Title II, State and Local Government, Department of Justice Regulations, 28 CFR Part 35.

§35.104 Definitions.

Facility means all or any portion of buildings, structures, sites, complexes, equipment, rolling stock, or other conveyances, roads, walks, passageways, parking lots, or other real or personal property, including the site where building, property, structure, or equipment is located.[2]

The ADA law also addresses the new construction and alterations of roadways.

§35.151 New Construction and Alterations.

(a) Design and construction. Each facility or part of a facility constructed by, on behalf of, or for the use of a public entity shall be designed and constructed in such manner that the facility or part of the facility is readily accessible to and usable by individuals with disabilities, if the construction was commenced after January 26, 1992.

(b) Alteration. Each facility or part of a facility altered by, on behalf of, or for the use of a public entity in a manner that affects or could affect the usability of the facility or part of the facility shall, to the maximum extent feasible, be altered in such manner that the altered portion of the facility is readily accessible to and usable by individuals with disabilities, if the alteration was commenced after January 26, 1992.[3]

Some ADA compliance problems, and even court issues, have arisen from differing interpretations of the term “alteration”. In most instances, the removal of a roadway surface and replacement with a new layer of paving is not considered by most highway agencies as an “alteration”. However, the above ADA definition of an “alteration” appears to be much broader with the language of "affects or could affect the usability of a facility or part of a facility". This was reflected in a recent court case interpreting the definition. "In *Kinney v. Yerusalim* (812 F. Supp. 547[F.D. PA, 1993]), a Federal district appeals court decision held, 'if a street is to be altered to make it more usable by the general public, it must also be made more usable for those with ambulatory disabilities.'"[4] This ruling makes traffic calming, particularly vertical devices, more vulnerable to potential litigation.

Disabled citizens certainly view that placing speed humps upon roads is an "altered portion of the facility" that becomes less accessible and usable, and thus is in direct violation of Title II of the ADA. This is supported by the concern expressed in a City of Berkeley (CA) internal memorandum. "The Commission [on Disability] is concerned that installation of speed humps appears to be contrary to the intent of the Americans with Disabilities Act (ADA), which stipulates that new facilities must be 'readily accessible to and usable by individuals with disabilities.' The ADA Title II regulations define 'facility' to include 'roads'. The regulations go on to say that alterations to facilities must be accessible and usable 'to the maximum extent feasible.'"[5]

Most recently, the Berkeley Commission on Disability further asserted their concerns prior to City Council action slated for November 23, 1999:

> The Commission opposes installation of any traffic management tool preventing equal access. If vertical deflection devices were scientifically evaluated and show to be safe for

> vulnerable populations, there would be no such opposition; but it is not acceptable to install any vertical deflection devices for traffic management if they are designed to cause discomfort by generating up-and-down motion. Devices differing from current designs, but causing similar discomfort, also would restrict access for persons with disabilities. Examples of such variations included speed tables or raised pedestrian crosswalks, raised sections of roadway designed for vertical deflection of vehicles…Until adequate biomedical and engineering research is conducted, the moratorium should be retained on vertical deflection devices.[6]

Obviously, concerned about the legal implications regarding the ADA statute, the Berkeley City Council voted to indefinitely extend the moratorium on speed humps that had been in effect since July 1995.

Like other issues with traffic calming, the impacts upon disabled residents are difficult to quantify or qualify. There is little doubt that traveling over speed humps can be painful for those with orthopedic medical conditions and disabilities. "Contacts with disabled residents in Berkeley indicate that a number have problems with speed humps…they feel pain riding over humps in a vehicle, and they know of others who also do…Some slow down to nearly a full stop before crossing the humps, or cross them at an angle to lessen the impact."[7] The Berkeley report also revealed that crossing humps in para-transit vehicles was frequently cited as a problem. Like EMS units, these para-transit vehicles have a high center of gravity and heavy suspension systems.

Similar concerns have been expressed from other special transit providers. “Many of our passengers have called us to complain about the rough ride they experience with speed humps and traffic circles.”[8] This local transit provider urged the Boulder City Council members to consider traffic device alternatives that do not use physical barriers such as humps and traffic circles.

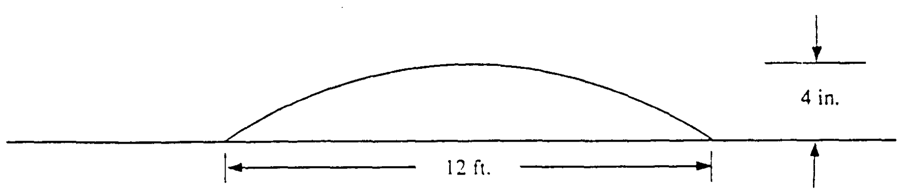
General Local Government Liability

With exception of federal law, the general liabilities to local governments fall under the auspices of state law. As state laws vary within states, so do the decisions and verdicts of the state courts. This generally depends upon how much authority has been extended to local governments by the states to regulate and implement traffic control measures. Some states have retained full control of all public roadways and streets, whereas others have granted limited authorities to the local government for local control. Civil action resulting in imposed personal or property damage could be expected in a number of areas.

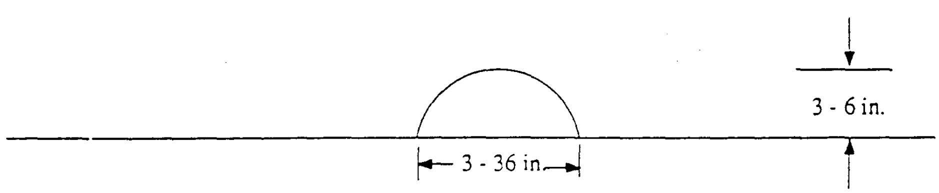
Speed Bumps Banned

After automobiles were invented at the turn of the century, and their use became abundant and common, local governments were immediately confronted with how to control their speeds. As such, the traffic calming issue of today is by far nothing new for policy makers. The actual idea of using physical barriers began early on with the installation of *speed bumps* on public streets. Speed bumps differ greatly than speed humps as they are much narrower and have a greater degree of rise, as do the more modern speed humps of today. Speed humps generally are 12 feet to 22 feet wide, and are generally 3 or 4 inches in height. Whereas, the older speed bump were only 3 to 36 inches wide and 3 to 6 inches high.[9] However, their public use was short lived. Figure 5.1 displays the differences of the two:

Figure 5.1
Speed Hump vs. Speed Bump Design



Typical Speed Hump



Typical Speed Bump

Source: *Transportation Quarterly*, Vol. 47, No.3, July 1993, p.459.

Clear, case law has been established which bans the use of speed bumps on public streets. One such case was *Vicksburg v. Harralson*, 101 So. 713 (Miss.1924); whereby the court issued a directed verdict against the City of Vicksburg. In upholding this verdict, the Mississippi Supreme Court asserted:

> We do not think the city had the right to place a dangerous device or obstruction in its street, making it unsafe, and which would likely injure persons traveling in automobiles over it.
>
> This scheme or method of warning drivers appears to us to be unreasonable, too drastic, and perilous for the purpose intended. The method of injuring one person in order to prevent danger to another is wrong in principle, as we see it, and is not such a reasonable regulation for the public safety as is warranted under the law, but is negligence. Creating one danger to prevent another is not in accord with the public safety – the very thing involved and desired.[10]

Traffic Control Device Legalities

One case in California had established that some devices used in traffic calming programs were illegal. "A locality has no right to interfere with the free flow of traffic unless expressly authorized by State statue. This fact led to the best-known legal challenge to traffic calming. *Rumford v. City of Berkeley*, 31 Cal.3d 545, 645 P.2d 124 [1982]…The California Supreme Court ruled that the diverters and half closures were traffic control devices not authorized by State law…Hence, the diverters and half closures were declared illegal."[11] However, after this case law was established, the California

Legislature responded by revising the statute to allow the local governments to use certain traffic calming devices not previously defined under the old law.

A 1998 Florida case brought the speed hump program in Sarasota to a complete halt. Challenging the City of Sarasota's authority to install speed humps, two citizens filed suit in state court. In a June 29, 1998 ruling from the Twelfth Judicial Circuit Court of Florida, Judge Robert B. Bennett ruled in favor of the plaintiffs. "In his order, the judge explained that Sarasota can put up only the traffic-control devices that are noted in the Federal Highway Administration's Manual on Uniform Traffic Control Devices (1988 Edition). Speed humps and speed tables are not included."[12]

This Court also adjudged: "Defendant [City of Sarasota] is permanently enjoined from erecting speed humps or speed tables on the streets or highways of the City of Sarasota. [Further, the] Defendant is permanently and mandatorily enjoined to forthwith remove from the streets and highways of the City of Sarasota all speed humps and speed tables previously erected and to restore the effected streets and highways to the condition they were in prior to the construction of the speed humps and speed tables."[13]

However, on appeal by the City of Sarasota, the Florida Second District Court of Appeal overturned the ruling from the lower court. "In overruling Bennett, the appellate court did not address the key question of whether speed humps are legal, however. Instead, the three-judge panel ruled that the plaintiffs, Robert Windom and John Hartenstine, did not have legal standing to file the suit. The court's failure to address the legality of the humps themselves leaves open the possibility of another successful action against them...the appellate court stopped well short of declaring humps legal. The narrow scope of the court's ruling means that adding more humps could still pose some risk."[14]

Another case, *Marlboro Township v. Freehold Regional High School District*, involves speed bumps and the local fire code. The Freehold High School installed speed bumps at the entrance of the school and at a side entrance in an effort to keep students from speeding through the parking lot. The local fire department of Marlboro Township, New Jersey considered the speed humps a clear violation of the fire code. Adopted by ordinance, the BOCA (Building Officials and Code Administrators, Inc.) Fire Prevention Code/1978, prohibits the erection and maintenance of speed humps. Formal requests to remove the humps were denied by the school district.

After failing to obtain voluntary compliance, the fire inspector swore out a summons charging the school administrator with violation of the ordinance. The municipal court judge found the school district in violation, ordered the humps removed, and fined the school administrator $250. On appeal, the Superior Court of New Jersey reversed the decision, citing the school district was not bound by the code.

However, the State Appeals Court reversed and upheld the municipal court decision stating that the school building was exempt from the fire code, but that the surrounding parking lot was not. The court in upholding the conviction, enjoined the hump removals, and suspended the imposed fine for the administrator.

Recognizing conflicting policy and intentions the Appeals Court had this to say: “This appeal demonstrates graphically that which occurs when genuinely caring persons face each other armed with substantial and genuine conflicting policy concerns”.[15]

Currently, Texas law is silent regarding the authorization or use of traffic control devices. In addition, no Texas legal cases were identified pertaining to the usage of such devices upon public streets.

Personal Injury

There is great potential for vehicle occupants to be injured from traffic calming devices. Severe injuries can occur to the head, neck and spinal vertebrae, along with various strains and/or bruising whenever a vehicle becomes out of control after crossing a device and striking another vehicle, fixed object and/or pedestrian.

Local governments lie dangerously close to the liability for such injuries. A state court appeals case from Ohio, *Sanchez v. Austintown Township*

Trustees, 1986 Ohio App., LEXIS 5410 (Ohio App. 1986) serves as notice to local governments for personal liability claims. After a passenger was unexpectedly thrown to the floor of a motor home when it crossed over a speed bump in a public park, the court ruled that a municipality could be liable for the personal injury and damage resulting from such a device.[16]

Such a liability was also found in the private sector in *Harrington v. LaBelle's of Colorado, Inc.*, 765 P.2d 732 (Mont. 1988). In this case, a bicyclist was awarded a $125,000 settlement against the parking lot owner when he was injured after striking a speed bump.[17]

Noise Nuisance

The creation of additional noise as a nuisance is potential for another legal liability. Residents often complain of increased noise from vehicles downshifting, decelerating, accelerating, or actually making physical vehicular/street contact while navigating calming devices. This is noted in the case of *Friends of H Street v. City of Sacramento*, 24 Cal.2d 607, (Cal. Ct. App. Oct. 21, 1993). This case also makes reference to "cut-through traffic", which is a common occurrence in neighborhoods with traffic calming devices, as the traffic tends to move to a parallel street. Residents were trying to get the City to take some action regarding heavy traffic volumes, speed, and noise on their neighborhood street. Their preference was to place restrictions on the street so that these nuisances would be removed. "The court ruled against the residents, holding that the routing of traffic is at the discretion of the city council, that the rerouting of traffic in this case would hurt other streets, and that the city council could not please everyone. As the court saw it: '[l]oss of peace and quiet is a fact of life which must be endured by all who live in the vicinity of freeways, highways, and city streets."[18]

Vibration/Structure Damage

In the United Kingdom, there is growing concern that increased vibrations from vehicle weight shifting while traversing over speed humps has caused cracks in the foundations of nearby homes. Recent studies by the Transport Research Laboratory (TRL), England's leading authority on transportation issues, have shown that certain soils can transmit harmful tremors straight into the foundations of buildings. As a result of these findings, the TRL will recommend local governments to test soil stability before installing any speed humps.

"Amanda Dickson is one of many homeowners whose worst fears have been confirmed by the latest studies. Large cracks appeared in the basement of her north London house soon after humps were laid outside."[19] She went on to report that trucks and vans caused the worst vibrations. Further, a chartered building surveyor of the area noted that vibrations from speed humps can be a serious contributing factor to damage of older buildings. "The new findings will worry local authorities, many of which first installed humps on the TRL's advice and now face lawsuits from disgruntled householders which could run into millions of pounds".[20]

Accidental Air Bag Deployment

With more and more U.S. vehicles being required to install airbags, there is a growing concern that accidental deployments of these safety devices will increase. This has been evidenced by Nissan's four confirmed incidents of air bag deployments involving Maxima sedans after striking speed bumps.[21] "The vertical jolt of going over a speed bump can trigger some crash sensors to go off and inflate the airbag…Air bags have been triggered when going over speed bumps and potholes on the road, hitting curbs at low speeds, and by other minor disturbances…Air bag-caused injuries to the face, chest, hands, and arms could occur to the driver and passenger, as have occurred in crashes as low as 8 to 15 miles per hour. Of the approximately 42 children who have been tragically killed by airbags, the vast majority has been in low-speed accidents below 15 miles per hour."[22]

Failure to Warn Drivers

Associated with unexpected impacts, significant liability could be imposed particularly when the local government fails to properly sign and adequately warn the motorist of traffic calming devices. This duty to warn was established in *Polk County v. Donna M. Sofka.*

"If, however, the governmental entity knows when it creates a curve that a vehicle cannot safely negotiate the curve at speeds of more than twenty-five miles per hour, such entity must take steps to warn the public of the danger."[23]

Street Damage

There is debate, within transportation professionals, over whether or not speed humps cause damage to the actual streets they are placed upon. The City of Griffin, Georgia failed to meet the legalities of a policy interpretation by the State Department of Transportation (DOT). In Georgia, the State DOT provides financial assistance for street paving within cities. In order to receive state funding of $285,000 to repave 18 streets, this City had to meet all of the terms of the DOT. One of those terms was DOT's refusal to repave any street that contained speed humps. The City agreed to remove speed humps so as to receive the funding.[24]

"DOT Commissioner Wayne Shackelford confirmed in an interview that speed humps are against department policy and have been for years. 'We don’t fund resurfacing on any street that has speed humps,’ he said. Shackelford believes speed humps cause pavement to wear out quicker.”[25] Additionally, severe gouging and abrasion can occur to the pavement from the undercarriages of vehicles when crossing speed humps too fast.

Vehicle Damage Claims

In some cases, one could certainly argue that calming devices cause damages likewise to the undercarriages of vehicles while traversing over humps at posted speed limits. In turn, one could expect a higher frequency of damage claims rather than actual law suits. “Montgomery County has paid two claims involving speed humps. In one case, the driver of a community college van went over a hump at a speed alleged to be too high, and a student was injured. The county agreed to pay $2,500 in medical expenses to avoid the expense of litigation. In the other case, hump markings came off on the undercarriage of a car that had bottomed out traveling too fast. Because the hump markings had been improperly applied, the county assumed liability…”[26]

Summary

On the surface, one would not expect significant liability potential with the use of traffic calming devices. However, there are numerous legal vulnerabilities that exist for local governments with traffic calming programs. The largest exposure appears to rest with the modifications to roadways while complying with the Americans with Disabilities Act. Another area that is not very clear is the authority of the local government to use traffic calming devices since they are not recognized within national transportation standards.

As has been reviewed, there are also numerous potential liabilities relating to personal liability and property damage from traffic calming devices. In short, there are no precedent setting cases that have outright declared speed humps illegal. However, there is strong evidence that some citizens are turning more towards the court systems in an attempt to suspend traffic calming programs. As such, local governments must fully examine their legal liability potential prior to adopting traffic calming initiatives.

Notes

[1] Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), p. 130.

[2] 28 CFR 35.104: Nondiscrimination on the Basis of disability in State and Local Government Services. (Current through March 8, 2000). Text from Code of Federal Regulations. Available from: Congressional Universe (Online Service). Bethesda, MD: Congressional Information Service.

[3] 28 CFR 35.151: Nondiscrimination on the Basis of disability in State and Local Government Services. (Current through March 8, 2000). Text from Code of Federal Regulations. Available from: Congressional Universe (Online Service). Bethesda, MD: Congressional Information Service.

[4] U.S. Architectural and Transportation Barriers Compliance Board, "Accessible Rights-of-Way: A Design Guide", (Washington, D.C., November 1999), p. 20.

[5] Memorandum from Karen Craig, Chair, Commission on Disability, City of Berkeley (CA), to Mayor and Members of the City Council of Berkeley (CA), November 10, 1998.

[6] Memorandum from Karen Craig, Chair, Commission on Disability, City of Berkeley (CA), to Mayor and Members of the City Council of Berkeley (CA), November 23, 1999.

[7] City of Berkeley, Advance Planning Division, "An Evaluation of the Speed Hump Program in the City of Berkeley," Berkeley, CA, October 1997, p. 29.

[8] Letter from Linda Diebert & Lenna Kottke, Executive Co-Directors, Boulder Special Transit, to Boulder City Council, April 3, 1997.

[9] Marcel Klik and Ardeshir Faghri, "A Comparative Evaluation of Speed Humps and Deviations", *Transportation Quarterly*, vol. 47, no. 3 (July, 1993), p. 459.

[10] *Vicksburg v. Harralson*, 136 Miss. 872, 101 So. 713 (Miss. November 17, 1924)

[11] Ewing, *Traffic Calming: State of the Practice*, p. 131.

[12] Joanne B. Walker, "Speed bumps, tables meet legal obstacle", *St. Petersburg Times*, Neighborhood Times, Neighbor to Neighbor Section, (July 5, 1998), p. 6.

[13] *Windom v. City of Sarasota*, Case No. 96-4501-CA-01 (Fla. 12th Cir. Ct., June 29, 1998).

[14] Gordon Russell, "Speed control devices allowed; the appellate court ruling skirted the issue, however, so it may not be over", *Sarasota Herald-Tribune*, June 24, 1999, p. 1-A.

[15] *Marlboro Township v. Freehold Regional High School District*, 195 N.J. Super. 245; 478 A.2d 1228; 1984 N.J. Super. (N.J. Super. Ct. App. Div. August 7, 1984).

[16] *Sanchez v. Austintown Township Trustees*, No. 85 C.A.1, LEXIS 5410, at *1 (Ohio Ct. App., January 28, 1986).

[17] *Harrington v. LaBelle's of Colorado*, Inc., 235 Mont. 80, 765 P.2d 732 (Mont. December 6, 1988)

[18] Ewing, *Traffic Calming: State of the Practice,* p. 134.

[19] Jonathan Leake, "Road humps can damage houses", *Sunday Times*, Home news (December 28, 1997).

[20] Ibid.

[21] [21] Bryon Bloch, "Speed Bumps Can Cause Vehicle Airbag Activation", (paper presented to the "Save Our Streets" citizen organization of Rockville, MD, August 4, 1997), p. 1-2.

[22] Ibid.

[23] *Polk County v. Donna M. Sofka*, 95-01886, 675 So. 2d 615 (Fla. Dist. Ct. App., April 19, 1996).

[24] Joey Ledford, "DOT thinks humps are for camels", Atlanta Journal-Constitution, (July 31, 1988), p. 1C.

[25] Ibid.

[26] Ewing, *Traffic Calming: State of the Practice,* p. 135-136.

Chapter 6. Traffic Calming Postures of Local Governments

With limited planning and awareness in the early beginning, many major, “progressive oriented” cities within the U.S. entered the uncharted waters of traffic calming devices and programs. Their use was viewed as a fresh new approach for managing transportation problems within these cities. The concept for this strategy emphasizes the intellectual placement and force of physics rather than the traditional oppressive force of policing. As this approach came into vogue by the mid-1990’s, there was an immense proliferation of placing these devices in the communities without ensuring that all stakeholders had ample input for widely accepted support. As a result, objections, complaints, and concerns began to engulf politicians who soon began looking for neutral ground.

Realizing the difficulty in reaching neutral ground, actions were taken by many local governments to slow down the issue. These de-escalations took on many forms such as moratoriums, reduced funding, or pending legal litigation. A summary review of several U.S. cities is provided to illustrate the status of many traffic-calming programs across this country. A more in-depth policy review is given for the City of Austin, Texas, as this information will provide a good background for the analysis contained in upcoming Chapter Seven.

Postures of Various U.S. Cities

In the publication *Traffic Calming: State of the Practice*, author Reid Ewing examined the top 20 most innovative cities with traffic calming programs. From this literature, it is evident that many traffic-calming programs have been "calmed" in and of themselves. The following reports from this source reveal the postures or current states of practice by ten of those cities:[1]

Montgomery County, Maryland

Citizens challenging the legality of its speed hump program filed a lawsuit against the county. This was then followed by an anti-hump petition drive calling for a vote to prohibit speed humps. Both the lawsuit and the petition were dismissed, thus there was no legal or voter decision. In response to the controversy, the county council imposed a moratorium on new speed hump applications, which was later lifted after eligibility requirements were established. However, due to the stringent approval guidelines, a virtual moratorium still exists.

Portland, Oregon

Similar to Montgomery County, Portland has been sued and had a moratorium on the continuance of traffic calming devices. The City won the lawsuit, however it is under appeal, so the legality is yet to be determined. Because of emergency services concerns, a moratorium was put into effect restricting speed humps and circles on the primary response routes. Once the moratorium was lifted, city leaders discontinued the funding for the program.

San Diego, California

A moratorium was imposed in this city over the dispute of warrants for the placement of traffic calming devices. Under pressure from citizens, city council members violated previously established warrants and had speed humps installed on some collector roads. As a result, some citizens and fire officials were outraged by the action. To immediately alleviate the situation, a moratorium has been put into effect for all new speed humps until new warrants can be established.

Boulder, Colorado

The issue of traffic calming in the City of Boulder was attacked from two sides. Many first questioned the $900,000 annual budget for this "general reentrenchment of traffic calming" program. Again, with growing public opposition, along with the never-ending debate of emergency response times, the City Council eventually reduced the budget to $250,000 each year. Since then, it has been cut again to $100,000 annually. In addition, the funding can only be used for demonstration, education and enforcement projects until the response time issue can be satisfactorily addressed.

Gwinnett County, Georgia

In an attempt to ensure that all stake holders were considered, this County expanded the notification area of the neighborhoods so that all of those involved would be informed. This resulted in opposition groups being formed from the adjacent streets that became active in opposing new applications for neighborhoods wanting traffic calming. Reacting to the revolts of the program, the Commissioners placed all applications on hold until it could be determined what level of public support there is for the program.

Five Other Local Governments

"Sarasota, FL, has been sued, and lost; the decision is being [was] appealed. Berkeley, CA, has a total moratorium in effect. Eugene, OR, has a moratorium on speed humps, while Howard County, MD, has a moratorium on speed humps and most other vertical measures. San Jose, CA, has stopped funding comprehensive neighborhood traffic calming plans."[2] Director

Wayne Tanda, Department of Streets and Traffic with the City of San Jose was quite blunt with their posture. According to Tanda, "San Jose decided to stop penalizing 95 percent of the its drivers for problems caused by the other five percent."[3]

Posture of Austin, Texas

"Traffic management programs often focus entirely on the installation of one or two types of traffic control devices with little or no area-wide planning…A neighborhood group complains and a speed hump, stop sign or other device is installed where requested and that is the end of the process. This strategy has occasionally been successful."[4] Austin's initial traffic calming strategy in 1994 certainly would have fit that description during its early era.

Actually, Austin's experience and current posture toward traffic calming is very similar to those cities already noted. What began as a full-blown proliferation of speed hump installations, has now been reduced to a very limited use of speed humps, while other devices are being tested in pilot neighborhoods.

In response to citizens expressing concerns to intensified traffic volumes, speed and safety for pedestrians, the City of Austin Transportation staff developed the Neighborhood Traffic Management Program during the mid-

1980’s. This program was designed to conduct neighborhood surveys to analyze the growing traffic problems. However, this concept was short-lived, as the program was not funded due to budget constraints from a souring economy.

The requests for action by citizens kept coming in at City Hall. During 1994, the Department of Public Works and Transportation (PW&T), along with several neighborhood associations, was successful in getting the City Council to include funding in the Fiscal Year 1994-95 budget for a Speed Hump Program.[5] After the initiation of the program, the PW&T Department received requests for speed humps on over 600 streets. Currently, that list has grown to 1400 streets.[6] Many of the streets requested multiple humps. For this type of demand, the level of funding was not adequate for all requests, much less conducting comprehensive traffic studies to determine their need.

Realizing that the funding would not meet the demand, the Department of PW&T began allowing the installation of humps that were privately paid for by the neighborhoods. Resultantly, a flooding of speed hump installations began to proliferate the city, particularly in the wealthier northwest quadrants.

In 1995, as the Austin Fire Department was denying many installation requests, the Department quickly found itself on the opposing side of many neighborhood associations. The separate Austin Emergency Medical Services Department joined the Fire Department in expressing reservations about speed hump installations. Both of the departments' concerns focused upon the increased response times for fires and medical emergencies, damage to apparatus, along with the safety and effectiveness of medical care during patient transport.[7] Compounding the issue, the PW&T Department quickly pointed blame to the Fire Department, whenever irate citizens called in reaction to their speed hump applications being rejected.

In March 1996, the Austin City Manager requested that the Fire and EMS Departments conduct tests to measure the delays in response times due to the humps. As previously discussed in Chapter Three, the average delay for emergency response vehicles was found to be between 2 and 10 seconds per hump. This test helped substantiate the similar findings of the Portland test conducted earlier that year.

Neighborhood Traffic Calming Program

Due to the concerns expressed by the emergency service departments, and the potential for shifting traffic from one neighborhood street to another neighborhood street, the Speed Hump Program was temporarily suspended in the spring of 1997. Later that year as directed by the City Council, a focus group of stakeholders from the neighborhood associations, city council appointees, transportation officials, and other city staff, addressed the issues and made recommendations. These recommendations were incorporated into the Neighborhood Traffic Calming Program (NTCP).[8]

"The purpose of the Neighborhood Traffic Calming activity is to provide transportation improvements for neighborhood residents in order to enhance the safety and quality of neighborhoods in Austin."[9] This program allows for neighborhoods to submit an application for program consideration. Annually, five project areas are chosen in different geographical sections of the city. These selections are based on a needs assessment.

The heart of the program requires that city staff and the selected neighborhoods work together in developing a traffic-calming plan for the awarded area. An equal amount of funding is designated for the devices in each neighborhood. Once selected, a neighborhood group is formed to create the neighborhood traffic plan. After the plan is finalized, the plan is submitted to the residents of the neighborhood for voter approval. If more than 60 percent of the returned ballots approve the plan, then the plan is implemented.

Initially, the NTCP requires city staff to conduct a comprehensive traffic study to identify and prioritize the traffic problems of the selected neighborhood. Measurements and levels of traffic volume, vehicular speed, pedestrian activity, and other observations are recorded. This data is later used in developing the neighborhood plan.

Representatives from the neighborhood, working as committee, meet with the city staff to develop effective area-wide solutions to the problem. This working group, no larger than 15 people, is comprised of residents living within the area and at least one board member from the neighborhood association. No more than two members can reside on the same street. In addition, representatives of local businesses within the project area may participate. This generally includes the actual selection and placement of the devices to match the traffic study findings.

There are many traffic calming devices that a neighborhood may select. The devices selected will depend upon the traffic problem, i.e. vehicular speeding or cut-through traffic. Also, the device cost is a factor, as each plan must stay within a prescribed budget. The devices may include traffic circles, speed humps/cushions, diverters, curb extensions, textured crosswalks, chicanes, slow points, and/or others.

Once some consensus is achieved for the types and locations of devices, the PW & T Department staff then analyzes the proposal. "The evaluation may result in changing the proposed device. The technical expertise of the Transportation Division staff governs the selection and location of the proposed devices. For example, steep grades may preclude the installation of a device. Staff identifies these barriers and informs the working group."[10] Interestingly, the Austin guidelines allow for the Transportation

Division to prohibit devices but the same authority is not given to public safety departments. Further, public safety departments are not given the opportunity for staff comment prior to the plan being revealed to the working group.

Once the plan is developed it is presented for review to the other neighborhood residents. The plan is mailed to each resident within the project area along with a ballot. Prior to the vote submission, an “open house” is conducted within the neighborhood where residents may “come and go” at their pleasure to ask questions about the plan. Members of the neighborhood working group and city officials, including emergency services representatives, are on hand to answer any questions.

Originally, the plan review required a public meeting within the neighborhood that was conducted by the residents’ working group and city staff members. This was a more formalized meeting where the staff and working group would present the plan and answer questions from the audience. This forum generated much debate, however the residents in attendance were able to hear and witness collectively the pros and cons of the plan and the respective views of their neighbors.

In 1998, after a very heated public meeting, the residents of a northwest Austin neighborhood voted down the proposed plan. This was the first neighborhood to reject a traffic-calming plan. Shortly thereafter, the PW&T

Department staff revised the requirement for a formal public meeting and substituted the "open house" forum which has generated a lot less public discussion, participation, and input.

Residents may mail in their vote or turn in their ballot at the "open house" meeting. Each household, and property owner (if different) along with each business is allowed to vote. If 60 percent of those voting are in favor of the plan, then the project is approved for construction and implementation.

Currently, the Traffic Calming Section administers the program with 7 FTE's (full-time equivalent) employees. For the 1999-2000 fiscal year, the operating budget for this section is $413,371.[11] However, "[f]unding for the construction of traffic calming devices in 1999-2000 is anticipated from a $1,053,000 transfer from the General Fund to the traffic calming Capital Improvement Fund (CIP)."[12] With this expenditure for 1999-2000, the Department projects the program will reduce the current neighborhood speeds by 20 percent, in the project areas only.[13] In summary, the City of Austin expends approximately $1.5 million each year in an attempt to lower current speeds by approximately five to seven mph or less only within five distinct neighborhoods.

Traffic Calming Viewpoints of PW&T Staff

The City of Austin Public Works and Transportation Department (PW&T) has been actively involved in traffic calming for over the last six years. Currently, Ms. Joan Hudson administers the Neighborhood Traffic Calming Program for the PW&T. A personal interview was conducted with Ms. Hudson to obtain the positive and negative aspects of traffic calming from a local proponent point of view.

Ms. Hudson was asked to outline the general benefits of traffic calming initiatives. She stated, "at the forefront, there should be three major objectives. Reduction of speed, and cut-through traffic, should be accomplished along with meeting other desires of the neighborhood to increase the quality of life for the residents."[14] As examples of the "other desires", she pointed to residents being able to walk their streets or ride bicycles without being in fear of their safety. Quality of life is an important aspect of neighborhood livability. However, Ms. Hudson did point out that the City of Austin has yet to conduct any follow-up surveys to determine if citizens have indeed felt that their quality of life has improved from the traffic calming initiatives.

When asked to expound upon any negatives to traffic calming, Ms. Hudson gave the following response. "As a whole, to the neighborhood and city, no significant negative aspects have been identified. Now, for the individual, there are some negatives that develop, such as how to go around traffic circles, parking in front of their house is disturbed, or the impacts of increased response times".[15] In general she felt that the negatives presented to her thus far were more so from individual concerns rather than resident groups or clusters.

When specifically asked about the impact to emergency response times, Ms. Hudson confirmed that traffic calming would have some delay. According to Ms. Hudson, "with traffic calming, if you delay anybody, then your delaying everybody, as there will be some impact. The level of that impact is the main question that needs to be considered."[16]

Ms. Hudson revealed that there have definitely been improvements and benefits to the City of Austin with the newer Neighborhood Traffic Calming Program compared to the older Speed Hump Program. "We are now looking at the whole neighborhood and allowing everyone to be involved and vote on a plan. Whereas before, the Speed Hump Program was too isolated. Neighborhood association members who were pushing for speed humps did not necessarily seek or gain the approval of the majority of residents."[17]

The current program is more responsive to the neighborhood. In general, there is greater neighborhood acceptance as the process now allows for the residents to be better informed and to be involved. The group is now offered a greater array of traffic calming devices to choose from rather than just speed humps. Landscaping options allow for the neighborhood to be beautified or aesthetically pleasing. Also, the program is receiving more financial support allowing for more resources to be applied to the projects. Equally important, representatives from the emergency services are directly involved with the neighborhood working groups in developing traffic calming plans.

When asked how the program has directly benefited the City of Austin, Ms. Hudson was quick to point out that Austin's approach has employed several features and alternatives that other cities have not. As an example, Austin conducts a comprehensive study of the applicant neighborhood to determine if it qualifies for traffic calming and to identify what devices would be most effective. When concerns by the emergency services departments arose, the PW&T explored and implemented the speed cushion. This modified vertical device, was designed to be less detrimental to emergency vehicles yet maintain similar effects for ordinary traffic vehicles.

Ms. Hudson was asked to identify the greatest successful traffic calming projects undertaken in Austin. She felt that the Rainey Street project was a success as that neighborhood experienced a one-third traffic volume reduction. She also pointed to the accomplishments of the Bouldin Creek neighborhood as speed reductions reached 17 percent. In addition, the devices selected blended in well with the neighborhood creating more acceptance.

As she noted Rainey Street as a success story, a follow-up question was asked if that neighborhood would have been better served with a street closure rather than all of the calming devices used. She expressed that such an action certainly would have yielded better results but we “should respect the desire of the neighborhood and that it is up to the neighborhood residents to decide what to accept.”[18]

In regards to measuring the effectiveness of the program, Ms. Hudson indicated that performance measurements relating to speed and volume reductions within project neighborhoods are reported to the City Council. She was not aware of any other alternative performance methodology that was being used by other entities.

When asked to project the future of traffic calming programs, Ms. Hudson felt that there would be a continuance as the demand for the devices continues to increase as more and more citizens hear about and witness the programs in other areas of the city. She readily admits that the program will continue to be very controversial. With a follow-up question to that response, she was asked to identify, in her opinion, the biggest threat to traffic calming issues. Without any hesitancy she cited the “conflict of emergency response impacts upon the community” as the greatest obstacle for the program. She also identified the difficult balancing of “resident inconvenience” as a horizon issue for neighborhood acceptance. Further, Ms. Hudson was not aware of any threats to the program from discrimination or violation claims of the ADA.

In closing, Ms. Hudson revealed the value of this program to the citizens of Austin. “Building community teams to bring forth their ideas in improving their neighborhoods, in their minds—and fulfilling the goal of improving the quality of life in their neighborhood has been a very rewarding thing.”[19]

Program Results

The first year, 1998-99, included funding projects in the neighborhoods of Rainey Street, Bouldin Creek, Windsor Hills, Hyde Park/Hancock, and Northwest. Four of these approved traffic calming plans, while the Northwest neighborhood rejected their plan. For 1999-2000, the included neighborhoods are Highland, Wooten, Zilker, Old West Austin, and East Town Lake. Currently, one plan has passed, one has failed, and the other three are still being developed with resident approval/rejection to be determined later this year.

Notes

[1] Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), p. 7-8.

[2] Ibid., p. 8.

[3] Public Technology, Inc., *San Jose, CA, Taking the Highway*, http://pti.nw.dc.us/task_forces/transportation/docs/trafcalm/CASE18.htm. Accessed November 23, 1999

[4] Melinda Railey, "The Impact of Traffic Management Programs on the Delivery of Fire Suppression and Emergency Medical Services", (Master's Thesis, The University of Texas at Austin, 1996, p. 15).

[5] City of Austin, Transportation Division, Department of Public Works and Transportation, "Neighborhood Traffic Calming Program Guidelines", Austin, April 1999 (draft), p. 2-3.

[6] Joan Hudson, "City of Austin", Personal email to Les Bunte, March 1, 2000.

[7]Railey, "The Impact of Traffic Management Programs on the Delivery of Fire Suppression and Emergency Medical Services", p. 6.

[8] City of Austin, Transportation Division, Department of Public Works and Transportation, "Neighborhood Traffic Calming Program Guidelines", p. 3

[9] City of Austin, Finance and Administrative Services Department, "1999-2000 Proposed Budget Volume I", Austin, Texas, n.d., p. 518.

[10] City of Austin, "Neighborhood Traffic Calming Program Guidelines", p. 8

[11] City of Austin, "1999-2000 Proposed Budget Volume I", p. 517.

[12] Ibid., p. 414

[13] Ibid., p. 413.

[14] Interview with Joan Hudson, Supervisor, Neighborhood Traffic Calming Program, Public Works & Transportation Department, City of Austin, Texas, April 25, 2000.

[15] Ibid.

[16] Ibid.

[17] Ibid.

[18] Ibid.

[19] Ibid.

Chapter 7. Impact Analysis for Traffic Calming Devices

Overview of Analysis Methodology

Although there have been several studies conducted by various fire departments for determining the response delays of specific traffic calming devices, little has been done to evaluate the effect of these delays. This section will be devoted to analyzing and quantifying the impacts to the public safety responders and to the citizens whom they serve. Specifically, this analysis will be conducted utilizing the data trends and inputs from the City of Austin, Texas.

Conducting a valid analysis of reduced speeds and cut-through traffic is difficult to accomplish due to many variable factors. Good “before and after” data, that is collected at the same time periods, days, seasons, etc., is often very hard to procure consistently. Also, the timing of how soon or how long after the device installation the study is conducted is a major factor regarding data validity. More importantly, with cut-through traffic, area wide surveys need to be conducted as the traffic generally moves somewhere else. These area wide surveys are obviously very labor and cost intensive. However, with these known variables, an attempt will be made to evaluate the effectiveness of the traffic devices for reducing speed and traffic volume within one Austin neighborhood.

Accident reduction rates require an intense study of historical data to determine any effectiveness. To fully study the aspects of accident reduction goes far beyond the resources and capability of this research paper. Also, due to the many contributing external factors of accidents, interpretation of accident rates in relation to traffic calming should be viewed with extreme caution. Therefore, no attempt will be made to analyze the actual impact of the use of traffic calming devices to reduce the number of accidents occurring in Austin. This approach is consistent with a recent publication from the Institute of Traffic Engineers (ITE), who certainly has the resources to conduct such studies:

> It is often difficult to draw conclusive results from traffic calming accident analyses. Most safety studies of traffic calming compare "before and after" accident experiences. Few studies take into account the influence of potential changes in accident reporting, weather, conditions, and traffic diversion…In addition, the before-and-after studies presented here do not control for time trends or regression to the mean or other factors that could possibly affect the validity and reliability of the results. These limitations should be kept in mind when interpreting the results…[1]

In addition to speeding and traffic volume, residents of neighborhoods always voice their concerns for pedestrian safety. An examination of the pedestrian fatality rate in Austin over the last few years will be conducted. Although there is significant numbers of pedestrian accidents each year, this analysis will focus upon those occurring only upon neighborhood streets excluding major thoroughfares.

As the population increases, so does the demand for public safety services. With the Austin Fire Department being an integral component of the emergency medical system, a review of their response time data in conjunction with Austin's growth patterns will be reviewed. Since they respond to both fire and medical emergencies, their response data would appear to reflect a more inclusive impact to public safety services.

Incidents in which someone's life is in immediate jeopardy are the highest priority of all emergency calls. These most frequently are the incidents involving sudden cardiac arrest (SCA) victims. The sooner, or conversely later, that a victim of SCA receives field medical intervention will have a direct impact on the survivability rate of that patient.

With the response time history established, and identifying the frequency and survival of SCA, one can then examine the impact that traffic calming devices has on providing emergency services. A statistical analysis will be conducted utilizing this data to predict the number of lives of SCA victims that can be saved or lost due to changes in response times within Austin.

Finally, from the data perils of pedestrian accidents and sudden cardiac arrest victims, a parallel can be drawn discerning their comparative impacts. Utilizing a risk/benefit ratio, one could determine the value, in terms of lives saved or lost, for measuring the effectiveness of traffic calming programs. By determining the greater value or "good", official decision-makers would then be formulating policy more so on fact rather than perception or mere intuition.

Reduced Speeds & Volume/Cut-Through Traffic

Caution must always be used in interpreting the effectiveness of traffic calming with speed and volume reduction statistics. What may appear as positives on the surface, can translate into a negative situation when comparing the whole. Because of the low established speed of 30 mph for most neighborhood streets, speed reductions reported in percentages may sound appealing, but are they really significant reductions to make a neighborhood calmer? As depicted in Table 7.1, the Davis Street observations of the Rainey Street Neighborhood Traffic Calming Project serve as a good example. The accompanying map of the Rainey Street Neighborhood is contained in Figure 7.1.

Table 7.1

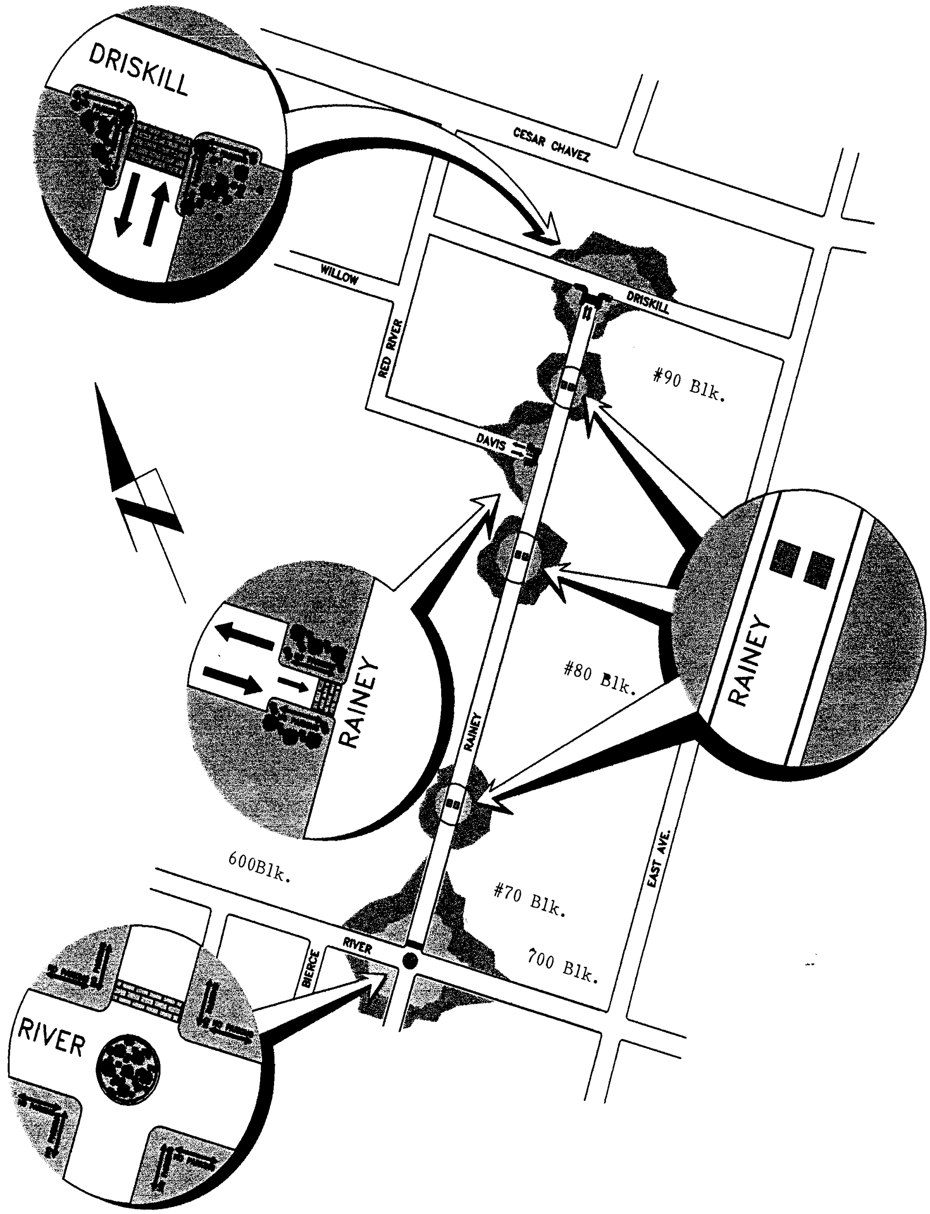
Rainey Street Neighborhood Traffic Calming Project

Location	TC Device	85th Percentile Speed (mph) Before	After	% Change	Volumes (vehicles/day) Before	After	% Change
Davis St.	Half Closure	25	23	-8	2233	568	-75
Rainey St. (60 Blk.)	Circle	33	35	6	389	269	-31
Rainey St. (70 & 80 Blk.)	Speed Cushions	35	28	-20	3323	2321	-30
Rainey St. (90 Blk.)	Speed Cushions & Neckdown	28	22	-21	835	1869	124
River St. (600 Blk.)	Circle	N/A	N/A	N/A	610	590	-3
River St. (700 Blk.)	Circle	26	27	4	3152	2033	-36

Source: Adapted from Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), Appendix A: Speed and Volume Data, p. 207.

After traffic calming, speed reduced by eight percent, a mild reduction but certainly not one with glowing results. However, in contrast to the eight percent reduction, speed was reduced by only two mph! Albeit a reduction, reducing the speed from 25 mph to 23 mph on a street with a designated speed limit of 30 mph can hardly be considered as a very productive yield in relation to the cost.

Figure 7.1
Map of the Rainey Street Calming Project



Source: City of Austin, Department of Public Works & Transportation

Did the neighborhood actually gain that much with this installation? Perhaps the greater question is did this street warrant traffic calming in the first place, since the 85^{th} percentile speed was 25 mph or below? A closer look shows this street had a volume problem rather than a speeding problem.

In fairness, however, one of the other streets showed a favorable increase. The #70 & #80 block of Rainey Street showed a 20 percent reduction in speed. This was a seven mph decrease from 35 mph down to 28 mph. Given that the existing condition prior to traffic calming was in excess of the established 30 mph norm, bringing the speed down below the posted speed should be viewed as a success. However, one must also consider the 85^{th} percentile again. This percentile standard is used universally in transportation studies to establish speed limits, as 85 percent of the drivers travel at a reasonable safe speed. In this case, one could argue that the speed limit on this section of road should be 35 mph instead of 30 mph, thus again, no need for traffic calming devices. Nonetheless, a 30 mph speed for a non-collector street would appear to be reasonable to maintain a safe neighborhood.

These two speed comparisons, both positive and negative, illustrate that the evaluation of a program needs to encompass the entire project rather than just providing a blanket success statement heard by many transportation officials that “we have accomplished speed and volume reductions”. Again, Table 7.1 reveals that only two locations of the five (with data) had speeding in excess of 30 mph. Although small, two of the locations actually saw speed increase rather than decrease after traffic calming. Three locations actually had speed decreases, including the one that was only by two mph.

Of the other two locations, the cautionary advice previously expressed by Ewing regarding the unreliability of “after” speed data may be in order here. One of these sets of data could have easily been skewed, as persons traveling on this portion of the street were accustomed to making a turn onto another street in this area.

However, with the data taken right after the implementation of the half closure, many travelers probably found themselves slowing at this intersection realizing they could not turn and would have to change their traffic patterns and proceed on through the portion of the route they were not fully acquainted with. Thus, a lower speed would immediately be expected thereafter until driver/region familiarity increases. Also, the 85^{th} percentile speed for this particular street was also below 30 mph to begin with.

The fifth street does indeed show a reasonable decrease. Thus, one could say that traffic-calming devices realistically reduced the speeds for this neighborhood on one out of five streets. Again, knowing when the “after” data collection was taken for this location, along with ensuring consistent methodology with the “before” collections, is critical in trying to make any reasonable inferences.

A similar interpretation can be made for the traffic volume impacts within this neighborhood. At first glance, an immediate impression would show a large decrease in traffic volume as five out of the six locations show volume decreases. The overall mathematical decrease for the neighborhood is approximately 27.5 percent, which is an admirable decrease. But a closer examination using the data, along with a field visit to the site, can lead to different interpretations than just what the raw data portrays.

Introspectively, a look at who has actually benefited might not be as nearly uplifting. Two of the locations, #60 Block of Rainey Street and the 600 block of River Street have only one dwelling and very minimal traffic volumes. Thus, their effect on the registered decrease has very little impact on neighborhood satisfaction. The device for the 700 block of River Street apparently had a good effect in reducing volume, with a 36 percent decrease. Unfortunately, this portion of the street has only two dwellings facing the street.

The neighbors living at the #70 & #80 block of Rainey Street received a clear benefit from the program as they saw a 30 percent decrease in volume. This portion of the street contains 25 residential structures. The greatest benefactor was the lone resident on Davis Street where the half-closure device drastically reduced traffic by 75 percent. Of noteworthy mention, this one

Davis Street resident is a former Austin City Council Member who advocated traffic calming for the neighborhood.

The real losers of the neighborhood are the residents of the #90 block of Rainey Street. Due to the partial closure at Davis Street, these residents suffered an astounding 124 percent increase in traffic volume. As noted in an earlier chapter, traffic-calming devices have a tendency to divert traffic to other areas. In essence, the bulk of the traffic volume burden shifted from the lone Davis Street resident to all of the #90 block Rainey Street residents. With this heavy volume increase, coupled with a questionable decrease in speeding, one would have to wonder how supportive this section of the neighborhood is now towards the traffic-calming project. This particular section of Rainey Street has eight households.

From these findings, one could argue that 25 households clearly benefited whereas eight residential structures saw a major decline in the livability of their neighborhood. The net gain was that 17 households benefited from this $150,000 to $200,000 project to improve the safety and livability of the neighborhood. In other words, for every three households that improved, one household saw a deterioration of the previous livability status. There is no doubt that a majority benefited. However, this was at the expense of others within the neighborhood.

So, one must thoroughly look at the overall impact of speeding and traffic volume to evaluate the project's effectiveness. This consists of reviewing the empirical data, as in Table 7.1, along with on-site observations, so as to better interpret the data. In this case an improvement analysis chart, contained in Table 7.2, helps illustrates the effectiveness of this particular project.

Table 7.2

Improvement Analysis of the Rainey Street Neighborhood Traffic Calming Project

POSTIVE FINDINGS (Significant Improvement)	**MARGINAL FINDINGS** (Marginal Improvement)	**NEGATIVE FINDINGS** (Negative Improvement)
Speeding/#70 & 80 Rainey St.: 7 mph decrease in speed (-20%)	*Speeding/Davis St.*: 2 mph decrease (8%); already well below 30 mph	*Speeding/#60 Rainey St.*: 6% <u>increase</u> in speed
Volume/#70 & 80 Rainey St.: 30% reduced volume	*Speeding/#90 Rainey St.:* Already below 30 mph; dropped 6 mph; data skew questionable	*Speeding/River St. (600 Blk.):* 4% <u>increase</u> in speed
Net Households Benefited: 17 (25 Benefit - 8 non-benefit=17)	*Volume/Davis St:* 75% reduction (but only 1 resident improved)	*Volume:* River St. Major 124% <u>increase</u>
	Volume/#60 Rainey St: small volume count of the whole "before & after"	
	Volume/River St. (600 Blk.): decrease of 20 cars per day (-3%); insignificant volume	
	Volume/River St. (700 Blk.): 36% decrease (but only effects 2 houses)	

Note: Speeding and Volume Data obtained from Table 7.1; Households benefited from on-site visit

As the improvement chart illustrates in Table 7.2, the marginal and negative findings outweigh the positives. Specifically, for this neighborhood, the analysis suggests that the overall impact of this project was of very limited success to the entire neighborhood. Although a 30-36 percent traffic volume decrease occurred on the most used street, the fact still remains that more than 2000 vehicles per day (vpd) continued to use this thoroughfare. Although better than 3000+ vpd, 2000+ vpd would still seem excessive for a truly neighborhood street like Rainey Street.

These findings also seem to be substantiated by the recent comments of residents and landowners. With almost a full year of traffic calming devices, they say "their quiet neighborhood has become nearly uninhabitable. Cut-through traffic going to Interstate 35 races past driveways. Out-of-towners use the street and driveways as satellite parking for the Austin Convention Center."[2]

Apparently, in retrospect, a full or partial street closure device at one end of the neighborhood would have resolved the volume and subsequently the speed problem. With Rainey Street not being classified as an emergency response route strengthens this choice even more. In all likelihood, this option would have been more economical than the cost of all of the other devices combined. The downside to this option is that the residents themselves are more inconvenienced by closure devices than the cut-through drivers. By having only “one-way-in/out” routes they lose a greater freedom of movement.

For the analysis of this neighborhood, one could easily view the overall success as at best marginal, rather than optimal.

Pedestrian Fatality Data

One of the goals of traffic calming is to make the neighborhoods safer for pedestrians and bicyclists. In theory, slower speeds and less traffic volume will reduce accidents. As already indicated, accident rate studies generally are not good measurement tools due to the number of uncontrollable factors not related to traffic calming devices. However, a review of the pedestrian fatality data can at the very least establish a baseline of frequency and severity of traffic problems.

Data was obtained from the Austin Police Department for all pedestrian fatalities for the last three years. This data included deaths of both pedestrians and bicyclists. As depicted in Table 7.3 for the years of 1997 through 1999, Austin averaged 15.3 pedestrian fatalities per year. The surprising finding was that no more than one fatality occurred each year, and zero in 1999, on Austin neighborhood streets. Again, speaking in average terms, Austin experiences only .66 pedestrian deaths per year on neighborhood streets.

Table 7.3

City of Austin Pedestrian Fatality Data

Year	Pedestrian Fatalities	Pedestrian Fatalities on Neighborhood Streets	Percent of Pedestrian Fatalities on Neighborhood Streets
1997	15	1	6.6%
1998	17	1	5.8%
1999	14	0	0%
Avg. Per Year	**15.3**	**.66**	**4.3%**

Source: Austin Police Department, Planning & Research Section

Another shocking find, was that out of the 46 pedestrian fatalities for that three-year period, only five involved *failure to control speed* as a factor. None of these five speeding incidents occurred on neighborhood streets. The primary contributing factor for virtually all of the fatalities, including the two residential fatalities, involved the *pedestrian failure to yield the right of way to vehicle* or *pedestrian in roadway*.

All of the data collections revealed that both speeding and pedestrian fatalities within neighborhoods occur with low frequency. Detailed information regarding this data for each year can be found in Appendix C.

For the purpose of the impact analysis performed in this chapter, precise pedestrian fatality data was collected for the period of December 1, 1997 to November 30, 1998. During this particular analysis period, Austin recorded 17 pedestrian fatalities, of which one occurred upon residential streets. That data, also in Appendix C, will be used comparatively as a baseline to other analyses.

Sudden Cardiac Arrest Data

As previously established, traffic calming devices have a detrimental effect upon the response times of emergency service providers. The delay in response times can have a profound impact on bringing a raging fire under control as well as providing life saving medical care. The most crucial, time sensitive emergency situations are those in which a person has undergone respiratory or cardiac arrest. Without immediately restoring these vital life functions, a person can die or suffer permanent brain damage in 6 to 8 minutes.[3]

This crucial 6 to 8 minutes begins when someone goes into an arrest, not when the fire or EMS units begin their response. Elapsed time for detecting someone in arrest, calling 911, dispatchers processing the call, notifying the fire/EMS stations, and response travel time all have to be completed within that six to eight minute window. Additional time on the scene is also needed to diagnose the problem, and set up to administer the emergency medical care.

Sudden Cardiac Arrest and Defibrillation

Cardiac arrest is not the same thing as a heart attack. A heart attack occurs when the blood arteries of the heart muscle become blocked, depriving blood to a portion of that muscle, which in turn impairs or reduces the heart's ability to adequately supply blood to the remainder of the body. The severity of a heart attack is classified by how much of the heart muscle is damaged from lack of blood flow and the changed production capacity of the heart. This condition also mandates prompt medical intervention.

Sudden cardiac arrest (SCA) is different in that the electrical nerve impulses of the heart muscle, rather than the muscle blood supply, do not operate normally. SCA is a major cause of death in the United States that claims an estimated 250,000 lives each year. "Abnormal heart rhythms called arrhythmias cause most sudden cardiac arrests. Ventricular fibrillation (VF) is the most common arrhythmia that causes cardiac arrest. It is a condition in which the heart's electrical impulses suddenly become chaotic, often without warning. This causes the heart to stop abruptly. Victims collapse and quickly lose consciousness. Death usually follows unless responders restore a normal heart rhythm within 5-7 minutes."[4]

The basic cause of SCA is not well understood. Many victims have no history of heart disease, nor have their lives been affected by this underlying heart condition. So, much of the public is susceptible to SCA. However, unlike other life threatening diseases such as cancer or AIDS, there is a definitive therapy for SCA that can even be administered outside a hospital environment. This therapy is known as *defibrillation*.[5]

Defibrillation occurs when an electrical shock is delivered to the heart of an unconscious patient through a series of wires and telemetry from an electronic device called a *defibrillator*. This shock stops the abnormal rhythm and restores a coordinated rhythm that results in the normal pumping action of the heart to resume. Originally, defibrillators could only be used by emergency room physicians or field paramedics assigned to EMS units. However, with the advances in miniature solid-state circuitry and microcomputers, field devices have been developed to automatically recognize when a patient is in a ventricular fibrillation state. This particular device no longer requires an operator of extensive medical training background. Further, the devices advise the emergency responder that a shock is needed, and then deliver the shock automatically. These new devices are known as *automatic external defibrillators*, or AEDs.[6] Widespread deployment of AEDs throughout many emergency service departments has resulted from this new technology.

The Chain of Survival

There are four critical links to providing effective emergency treatment of SCA. Starting and implementing these links will very well determine whether one lives or dies from SCA. The American Heart Association describes and advocates the use of the "chain of survival" as follows:

1. *Early Access to Care* - In most communities, dialing 911 activates the emergency medical system, which dispatches the appropriate emergency personnel to the scene.

2. *Early Cardiopulmonary Resuscitation [CPR]*- If performed properly, CPR can add a few minutes to the time available for successful defibrillation. Millions of people have learned the breathing and chest compression techniques of CPR, but it does not replace defibrillation in saving lives.

3. *Early Defibrillation* - The critical link in treating victims in VF is delivery of an electrical shock. Each minute of delay in returning the heart to its normal pattern of beating decreases the chance of survival by 10 percent. After as little as 10 minutes, very few resuscitation attempts are successful.

4. *Early Advance Care* - After successful defibrillation, some patients require more advanced treatments, such as airway control or intravenous drugs, on the way to the hospital.[7]

The City of Austin has invested considerable resources over the last few years to ensure that this chain of survival is improved to provide better emergency medical care to its citizens. The 20 year-old 911 Center will have improvements made this year to the computer aided dispatch (CAD) system for quicker dispatching services. The EMS Department, along with other health agencies and colleges, has aggressive public training programs for teaching citizens CPR.

AEDs have been placed on over 55 fire department front-line response units for the city. They provide the first responder role for over 22 front-line EMS units who also carry defibrillators. These EMS units also provide advance drug intervention treatments to patients while enroute to local area trauma centers.

But as in any chain, it is only as strong as its weakest link. Traffic-calming devices severely hamper and jeopardize the delivery of two of the four links of the chain of survival. Response delays will impact the most critical link of early defibrillation, and will affect the early advanced care during transport to hospitals.

Cardiac Arrest in Austin

The Austin Emergency Medical Services (AEMS) department provides basic and advanced life support services to all of the residents of Travis County. AEMS is one of the few EMS systems in the country that maintains a very thorough database on cardiac arrest cases that they respond to. This tracking includes information about the incident, patient history, and includes tracking the surviving patient’s progress through their discharge from a hospital. Annually, AEMS produces a report on this data. Not to be confused with heart attack incidents, this data collection applies only to those victims who were in cardiac arrest at some point.

For the 1998 reporting year, which began on December 1, 1997 and extended through November 30, 1998, AEMS, AFD and other county fire departments responded to 486 confirmed sudden cardiac arrest cases in Travis County. The population for Travis County for that period was 1,205,895. A total of 251 victims (52 percent) were pronounced dead at the scene after resuscitation attempts. Conversely, 235 (48 percent) patients, with positive vital life signs, were transported to a medical facility. Of those transported, 108 (22 percent) were discharged from the emergency room to a unit or floor of the hospital. Out of this, 49 patients (10 percent) were discharged alive from the hospital.[8]

The frequencies of the SCAs are maintained for each zip code within the County. Since this analysis is limited to the effects of traffic calming within the City of Austin, only the data from the zip codes within the city limits of Austin are used. Because Austin encompasses a substantial area and comprises the bulk concentration population of Travis County, AEMS, along with the Austin Fire Department responded to 442 SCAs within the city limits of Austin. This figure will be used hereafter for other quantitative analysis documented within this report. A complete listing of the Austin included zip codes and frequency for SCAs is contained in Appendix D.

AFD Response Time Data

The best trained emergency responders and the highest quality life saving equipment is of no value to the public when those resources cannot respond in an expedited efficient manner. *Response time*, without a doubt, is the most frequently used performance measure of the fire and EMS services. Virtually every other performance measure, whether positive or negative, is directly dependent upon how fast either of the departments can put their skills and resources into action. *Response time*, for the purposes of this report and the respective data collections, is the amount of time that elapses from when a dispatch signal is given to a fire or EMS station until the unit arrives on the scene of an emergency. This includes all travel time and excludes the time for dispatchers to triage and process the call for help.

Fire Responses

Although the consequences of poor response times to medical emergencies have been documented, they are also similar for fire suppression. The speed and quickness that a fire department commences actions to combat a fire has a direct relationship to fire spread, the difficulty in controlling the fire, as well as minimizing property damage from other perils such as smoke and water.

Of course, the first priority in any fire department response is that of rescuing people who may be trapped within a fire building. A fire will increase at various exponential rates for each uncontrolled minute depending upon many condition factors. At this rate, a fire can easily intensify and achieve excessive elevated temperatures to cause other nearby combustibles to reach their ignition temperatures in less than five minutes. This condition is known as *flashover*.

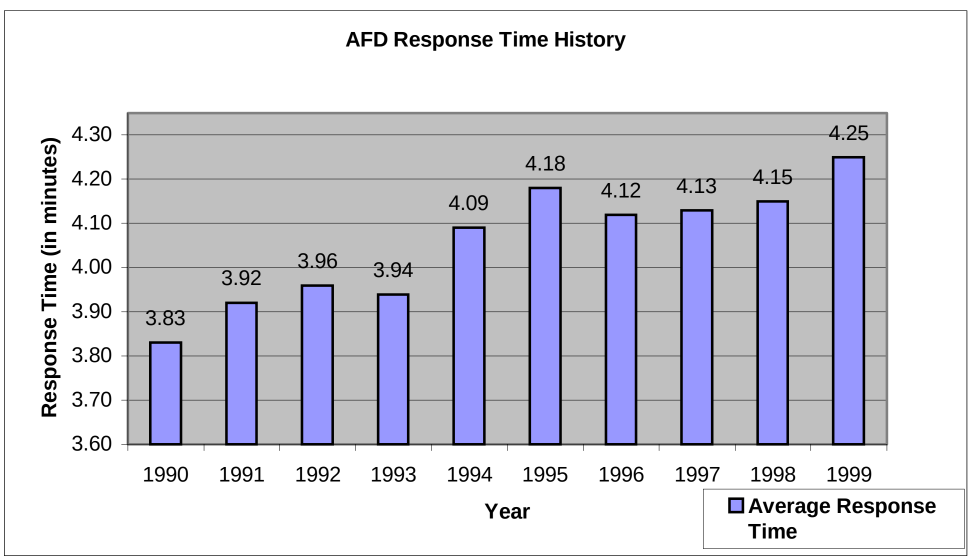
In order to prevent this stage and regain control of such an emergency, the fire department should be on the scene within five minutes. This requires the fire unit to have a travel time of not more than three minutes from the station. Like the medical emergencies, the fire must first be detected, help called for, and time to process and dispatch the fire units. So, two minutes or less generally elapses during this portion of the chain.

To compound matters, new federal standards have recently been established that require at least four firefighters to be assembled on the fireground before an interior attack can be made. Because a lot of communities cannot afford to have a minimum of four firefighters assigned to each unit, this usually requires the arrival of a second fire unit before such an attack can commence. Thus, traffic calming does not delay merely the first due unit to fire scenes. There is an old and very valid adage within the fire service. "What gets done in the first five minutes at a fire scene determines what will occur in the next five hours".

Although a three, or even 3.5, minute goal is highly desirable, the Austin Fire Department has not enjoyed such a response time for over ten years. In 1990, AFD recorded a respectable 3.83-minute response time. Unfortunately, the department has witnessed response time increases virtually every year since. Of greater concern, is that the recorded response times have been over the four-minute mark for the last six years. As depicted in Figure 7.2, these response times are for all fire and medical emergency related incidents.

Figure 7.2

AFD Response Time History

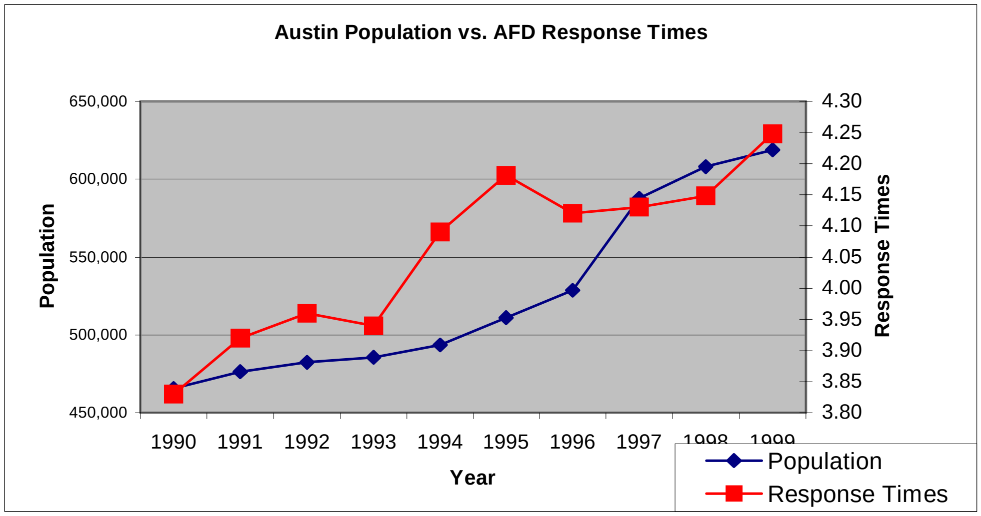


Source: Austin Fire Department, Administration Division, MIS Section

There can be numerous reasons for increased response times. Growth, both in population and landmass, is the primary contributor to the changes. More people equate to more fires, more cardiac arrests, more traumas, and other demands for increased service. Undoubtedly, more traffic and congestion accompanies this growth due to the lack of adequate arterial or collector streets. Unless the local government develops aggressive policies and capital improvement projects to stay in front of the demand, the quality of emergency services will degrade for the community.

Figure 7.3 shows that Austin has experienced a phenomenal growth rate over the last ten years. During most of that period, response times rose more than the growth rate. Only in 1997 & 1998 was the annual response time increase below the population growth rate. Regardless of the growth rate correlation, the response time is still far in excess of four minutes.

Figure 7.3
Population vs. AFD Response Times

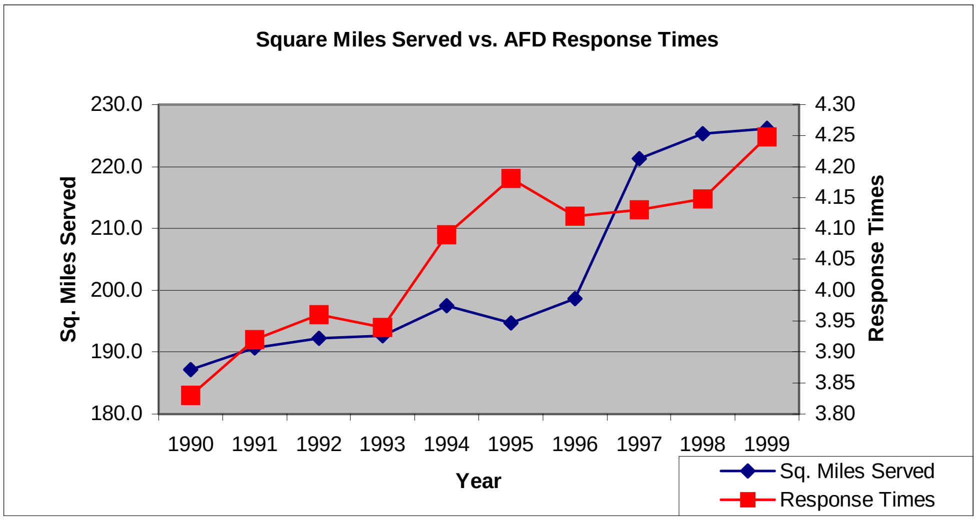


Source: Austin Fire Department, Administration Division, MIS Section

As the land mass increases, the travel distances to emergencies also increase. Unless additional fire stations or first responder contracts with existing volunteer fire department are implemented, response times will continue to escalate for newly annexed areas. The relationship of increased landmass to increased response times is contained in Figure 7.4. Again, as for population, AFD response times escalated more with land mass increases until 1997. Yet, this is still an undesirable level. Obviously, resources were increased during that period to get under the growth curve.

Figure 7.4

Square Miles Served vs. AFD Response Times



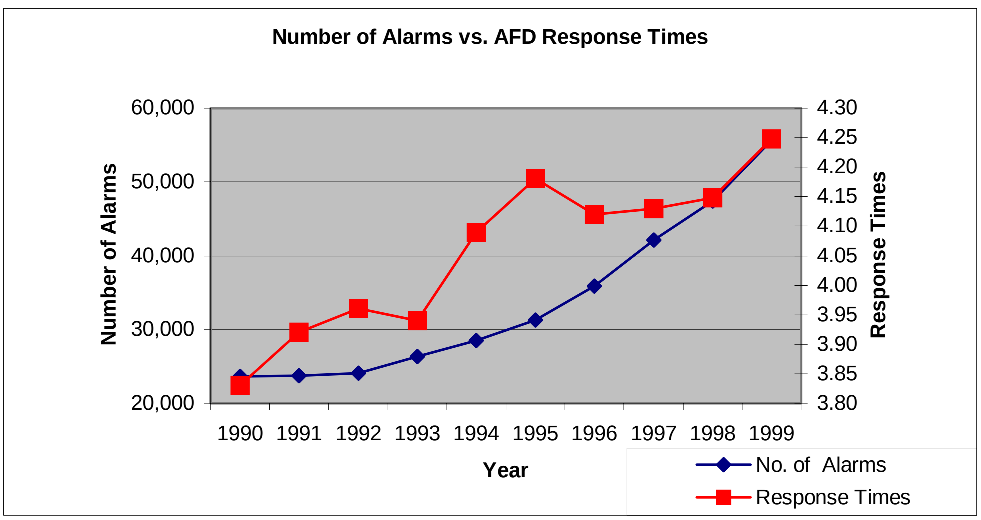
Source: Austin Fire Department, Administration Division, MIS Section

As mentioned earlier, increased populations and area will lead to more service demand. As expected, there was a sharp rise in the number of emergency incidents AFD responded to over the past ten years. Figure 7.5 reveals that response times were rising with the increased alarm volume until it dipped slightly in 1993. Then significant response time increases occurred in 1994 and 1995. A minimal decline occurred in 1996 but immediately began rising again in 1997. This data is interesting as during 1995 and 1996, the installation of speed humps in Austin was at an all-time high. Ironically, response times dropped slightly in 1996 when two fire stations were added. Responses are now at an all time high of 4.25 minutes in 1999.

Although certainly not the sole reason for these increases in response time, one could argue that traffic calming was a contributor to this escalating data finding. However, the data definitively demonstrates that response times are steadily increasing at an alarming rate. Any additional burdens or further proliferation of external increase factors such as traffic-calming devices, severely compounds the issue.

Figure 7.5

Number of Alarms vs. AFD Response Times

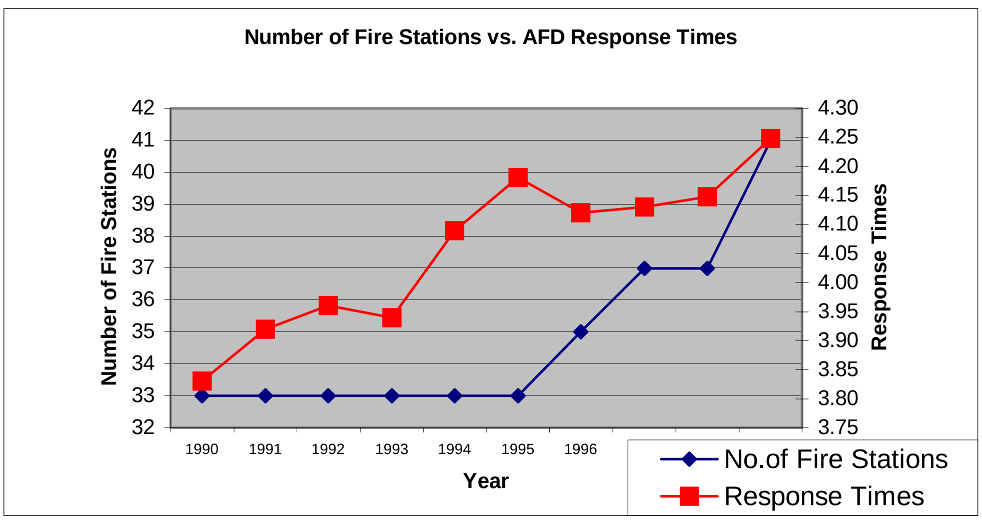


Source: Austin Fire Department, Administration Division, MIS Section

As shown in Figure 7.6, the addition of fire stations can lead to improvement to response times if done in a timely and consistent manner. However, with a "plan and build" time taking almost two years, a city can easily find itself playing "catch up". Seeing an increase to a then "all-time high" in response times in 1995, procurement plans for two more fire stations began immediately. After increasing from 33 to 35 stations in 1996, response times showed a decrease from the year before. However, even with the addition of four other stations by 1999, the average response still rose to the highest mark yet of 4.25 minutes. Thus, increased resources are still not keeping up with other factors contributing to response time increases.

Figure 7.6

Number of Fire Stations vs. AFD Response Times



Source: Austin Fire Department, Administration Division, MIS Section

As demonstrated by the growth trends in population, land mass, call volume and increased fire station locations, the annual average response time of the Austin Fire Department has seen a significant degradation over the last ten years. With an alarming increase again in 1999, the response time is still not below the four-minute mark the department recorded in 1993.

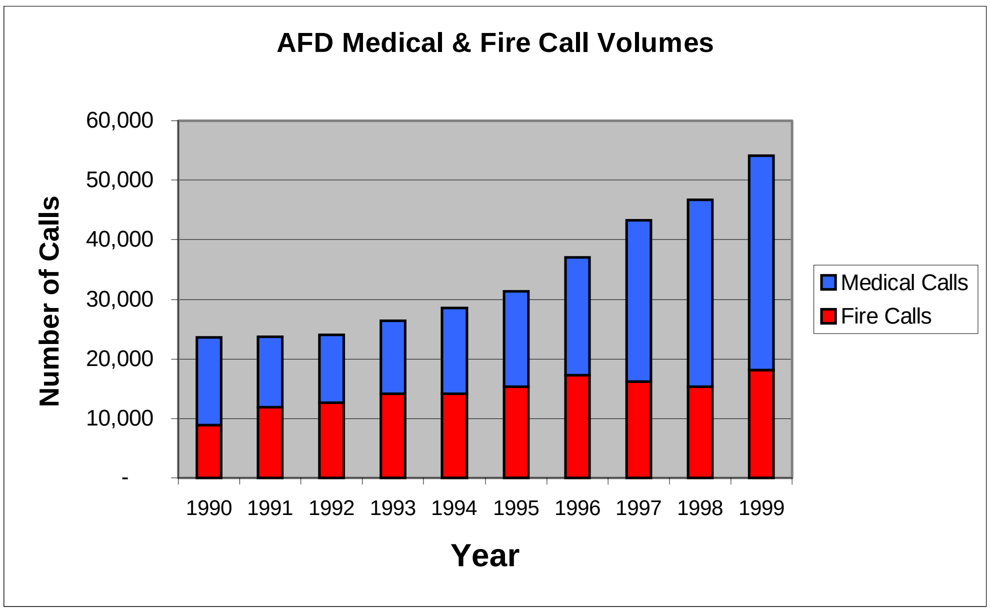
The economic vitality forecast for Austin is still very bright, meaning that notable growth levels will continue for some time. As growth is also probably responsible for neighborhood traffic calming initiatives, the emergency service data suggest that the local government is barely able to keep services at an acceptable level. This government will be hard pressed to return to the response times achieved seven years ago. All of this suggests strongly that emergency service providers and citizens cannot afford additional delays from traffic calming with continued increases of future sustained growth.

AFD Medical Responses

The Austin Fire Department, as a first responder to medical emergencies, is the first tier of a two-tier emergency medical services system within Austin. Working under the same standards and protocols with the second tier Austin Emergency Medical Services Department, AFD is an integral component of the system delivery to the citizens.

Although total call volumes have increased over the last ten years for AFD, the ratio of fire calls to medical calls has decreased significantly. This trend parallels with the rest of the U.S. With better fire detection equipment, improved hazard environments, and better safety education, the number of fires is decreasing per capita in this country. Resultantly, many fire departments now experience more than 50 percent of their call volume for medical calls than for fire calls. Austin is no exception to this trend as revealed in Figure 7.7. For the last five years medical calls have exceeded the number of fire calls. In 1999, 67 percent of the AFD call volume was for medical calls, an all-time high. .

Figure 7.7
AFD Medical and Fire Call Volumes



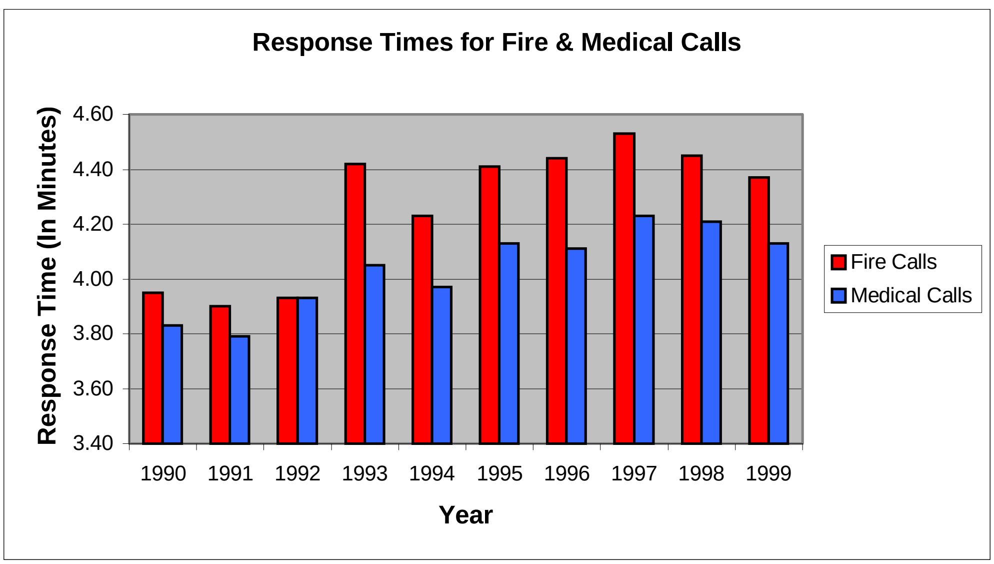
Source: Austin Fire Department, Administration Division, MIS Section

In Austin, there are 41 fire stations that house 59 fire apparatus, whereas AEMS has 22 paramedic/transport units. With this disparity and a high call volume, the AEMS units are most often likely to be migratory, rather than stationary, in moving from call to call throughout the city. Since the more abundant fire stations are strategically located throughout the city, a fire apparatus will generally arrive on the scene of a medical emergency faster than an EMS unit. Thus, the reasoning for having fire units serve as the primary first responders and carry AEDs, for emergency medical care.

Although the routes are the same, AFD response times for medical emergencies is somewhat quicker than the response times for fire calls. In most instances, fire fighters don fire protective garments and self-contained breathing apparatus prior to leaving the station for fire calls. This equipment is not required for medical calls. Although the "scramble time" can vary, medical response times are usually one-half of a minute quicker than for fire responses. Figure 7.8 illustrates the AFD response times for medical and fire incidents for the last ten-year period.

Figure 7.8

Response Times for Medical and Fire Emergencies

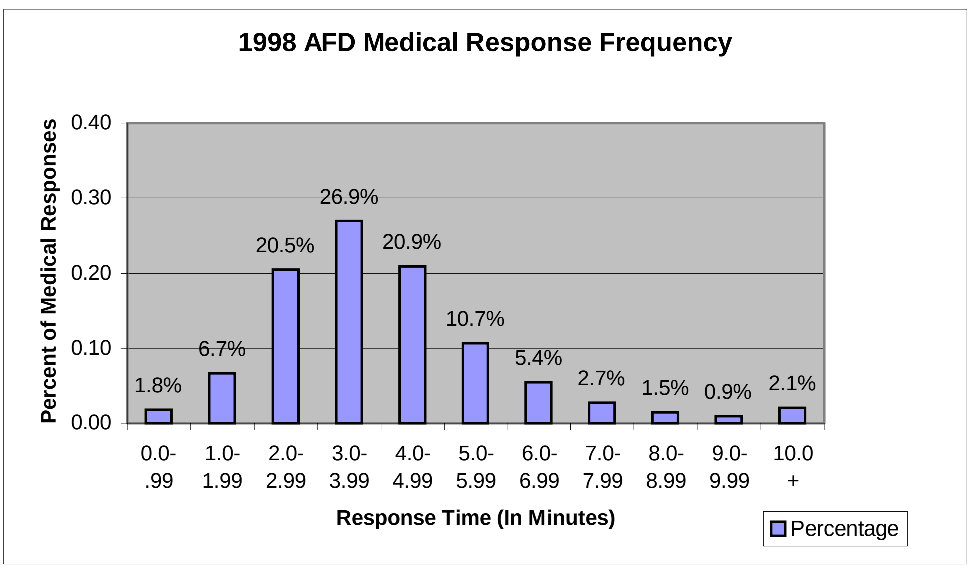


Source: Austin Fire Department, Administration Division, MIS Section

As already noted, the effectiveness of quality emergency medical care is directly dependent upon when that care can arrive at a scene. Call frequency distribution then has a profound effect upon the efficiency of the service. In preparation for an analysis later in this chapter, the percentage frequency distributions for medical calls responded to by AFD are contained in Figure 7.9. This 1998 data was purposely selected to coincide with the 1998 Austin SCA data reviewed earlier in this chapter.

Figure 7.9

1998 Medical Response Frequency



Source: Austin Fire Department, Administration Division

In summary, AFD has experienced increased response times over the last ten years. Emergency medical calls are now the bulk of the fire department's services to the city. Response delays due to traffic calming devices can severely jeopardize the delivery of emergency medical care and fire protection services. The implementation of additional resources has not adequately kept up with the growth demands for the emergency service delivery of seven to ten years ago.

Impact to SCA Victims in Austin

With the availability of good data from both the Austin Fire Department and Austin Emergency Medical Services, sound statistical analyses can be performed to quantify the impacts that traffic calming devices have upon victims of sudden cardiac arrest in Austin. Utilizing probability calculations, one can project the negative impact of lives lost due to traffic calming devices. Conversely, one could also predict the positive gains of lives saved when response times are improved. This specific analysis incorporated a risk probability model spreadsheet developed by Ray Bowman of Boulder, Colorado.[9] The visual layout of the model has been modified for this analysis, however the statistical calculations for the projections have not been altered.

The time period analyzed is from December 1, 1997 to November 30, 1998. All of the source data reviewed heretofore for that period will be used for this analysis. In general, this model contains four major elements. The first element requires the current response time frequency distribution of the local fire department for medical emergencies. The second data set involves the survival probabilities of sudden cardiac arrest as established by reputable medical authorities. The third element requires an input variable for the estimated response time delay/improvement to be tested. From this, an adjusted local survival probability can be calculated.[10] The fourth and final element requires an input variable to denote the number of sudden cardiac arrest cases experienced within the response area for the analyzed time period. From these data sets, an extrapolation can be made as to the number of SCA lives saved or lost due to the traffic calming conditions from what is currently predicted.

The versatile Bowman model can be viewed in three methods. One method makes projections based on the overall increase in response time due to any reasons, such as increased traffic volume, a fixed delay such as a blocked railroad crossing, or response delays from traffic calming. Projections can also be made for the aggregate impacts generated for each number of calming devices along a response route, i.e. three speed humps. The third option allows for one to also examine the positives from improving response times, such as the installation of electronic devices at traffic signal locations whereby the light changes in favor of the responding emergency unit. This analysis will look at all three methods. A complete listing for the response time models pertaining to the City of Austin and the statistical verification for the Bowman model can be found in Appendix D.

Analysis for a General Response Delay

For 1998, AFD maintained an average response time to medical emergencies of 3.62 minutes. For this analysis test, the current response time is increased by 14 percent (about 30 seconds). Recalling that an emergency vehicle would encounter 2 to 10 second delays per device while responding through a neighborhood containing several devices, the 14 percent (30 second) variable is not an unreasonable delay approximation. The data sources and prediction for this scenario is contained in Table 7.4.

As depicted, a 14 percent, or 30 second, increase in response time from traffic calming initiatives would now save only 177 lives compared to the predicted 215 lives saved if there were no increases in overall response times. In this case for 1998, 37 additional lives would be lost due to the delays caused by traffic calming devices. It should also be noted that this is a per year loss, that would continue year after year provided there was no decrease in the response times.

Some clarification is needed here for the “predicted lives saved” category of the model. This term relates to those victims who, in the field, maintained positive vital life signs and are transported to the hospital. The objective of the first responder is keeping the patient alive until they can be handed over to a more qualified medical authority such as an ER physician.

Table 7.4

Impact of a General Increase in Response Time

	Agency:	*Austin Fire Department*			
Date of Analysis:		*03/01/00*			
Analysis Period:		*12-1-97 to 11-30-98*			
Analysis Type:		*General Increase in Response Time*			
Response Times					
Current Response Time:		3.62	*Minutes*		
Risk % Delay:		14%	*is equal to a*	0.51	*Minute Delay*
Delayed Response Time:		4.13	*Minutes*		
Current FD Incident Information		**Cardiac Arrest Probable Survival Fraction**	*General Delay Response Fraction*	*Current Local Survival Rates*	*Traffic Calming Adjusted Survival Rates*
Midpoint of Arrival Interval	***1998* Arrival Fraction**		14%		14%
0.50	0.018	0.91	0.070	0.016	0.016
1.50	0.067	0.86	0.210	0.058	0.057
2.50	0.205	0.77	0.350	0.157	0.149
3.50	0.269	0.62	0.490	0.167	0.134
4.50	0.209	0.33	0.630	0.070	0.035
5.50	0.107	0.11	0.770	0.012	0.008
6.50	0.054	0.07	0.910	0.004	0.002
7.50	0.027	0.03	1.050	0.001	0.000
8.50	0.015	0.01	1.190	0.000	0.000
9.50	0.009	0.00	1.330	0.000	0.000
10.50	0.020	0.00	1.470	0.000	0.000
		Overall Survival Rates:		0.486	0.401
Annual SCA		**Predicted Lives Saved:**		215	177
Cases:	442	Change from Present:		0	-37
Notes:					
Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte					
AFD Response Times obtained from the AFD Adminsitration Division					
AFD Arrival Fractions obtained from the AFD Administration Division					
Cardiac Arrest Fractions from the American Heart Association					
Annual SCA Cases obtained from Austin Emergency Medical Services					

Source: Adapted from the Ray Bowman spreadsheet "Consequences of Emergency Response on Cardiac Arrest Survival"

The “predicted lives saved” of 215 by the model is a very close approximation of the 235 actual SCA patients transported to a medical facility in Austin during 1998. This gives reasonable statistical validity to the Bowman Model as the prediction closely resembles the actual history data.

Analysis of Delay Per Device

The negative impact results are further illustrated when utilizing the delay per device feature of the Bowman model. In this instance, delays are incorporated for each device encountered by the emergency medical responders. The model has been inputted with three devices for the emergency responders to travel over. Table 7.5 projects the number of lives lost from this hypothetical, but real, delay.

Table 7.5

Delay Impacts For Three Traffic Calming Devices

Agency:	*Austin Fire Department*
Date of Analysis:	*03/01/00*
Analysis Period:	*12-1-97 to 11-30-98*
Analysis Type:	*Response Delay per Number of Devices*

Response Times				
Current Response Time:	3.62	*Minutes*		
Risk % Delay:	0.083	*Minute Delay per Device X*	3	*Devices =*
Total Delay	0.25	*Minute Delay*		
Delayed Response Time:	3.87			

Current FD Incident Information		***Cardiac Arrest***	*Device Delay*	*Number of*	*Current Local*	*Traffic Calming Adjusted*
Midpoint of Arrival Interval	***1998 Arrival Fraction***	***Probable Survival Fraction***	*Response Fraction*	*Devices On Route*	*Survival Rates*	*Survival Rates*
			0.083			8.3%
0.50	0.018	0.91	0.25	3	0.016	0.016
1.50	0.067	0.86	0.25		0.058	0.056
2.50	0.205	0.77	0.25		0.157	0.151
3.50	0.269	0.62	0.25		0.167	0.152
4.50	0.209	0.33	0.25		0.070	0.054
5.50	0.107	0.11	0.25		0.012	0.010
6.50	0.054	0.07	0.25		0.004	0.003
7.50	0.027	0.03	0.25		0.001	0.001
8.50	0.015	0.01	0.25		0.000	0.000
9.50	0.009	0.00	0.25		0.000	0.000
10.50	0.020	0.00	0.25		0.000	0.000
		Overall Survival Rates:			0.486	0.444

Annual SCA		**Predicted Lives Saved:**	215	196
Cases:	442	Change from Present:	0	-18

Notes:

Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte

AFD Response Times obtained from the AFD Adminsitration Division

AFD Arrival Fractions obtained from the AFD Administration Division

Cardiac Arrest Fractions from the American Heart Association

Annual SCA Cases obtained from Austin Emergency Medical Services

Source: Adapted from the Ray Bowman spreadsheet "Consequences of Emergency Response on Cardiac Arrest Survival"

Fire and EMS units having to cross three traffic-calming devices significantly reduces someone's probability for survival. With Austin's current history of 442 sudden cardiac arrest cases, only 196 could expect to survive rather than the predicted 215 without any traffic calming device delays. This translates into a nine percent reduction of potential lives that could be saved. According to the model, there would have been 18 less Austinites surviving SCA in 1998 had emergency responders encountered three traffic calming devices along their routes.

Analysis for a General Response Improvement

Additional lives can be saved whenever response times are improved. Reduced response times can be achieved in a number of ways such as increasing the number of arterials on the transportation grid system, adding fire stations or improving traffic control signals at intersections.

Numerous cities around the country have capitalized on the technology improvements by implementing Emergency Response Management Systems (ERMS) using the Opticom™ Priority Control System developed by the 3M Company. In general, this system allows on-coming emergency vehicles to control an approaching traffic signal in their favor, thus minimizing the delay for stopping for red lights. The technology allows an emergency vehicle to activate or hold a green light at traffic signals along its route when making an emergency response. Each emergency vehicle is equipped with electronic emitters that sends a signal to the traffic light and modifies the normal operation sequence of the light. The emitters can activate a traffic signal from as much as a ¼ mile distance from the intersection. With a green signal captured for the emergency vehicle, a red is displayed with sufficient yellow to red intervals for the cross street traffic to safely clear the intersection or stop and allow the emergency vehicle to pass through with minimal delay.[11] In addition, the potential for accidents involving emergency vehicles is also reduced.

A 1978 study using the Opticom™ system with the Denver Fire Department revealed that their response times decreased proportionally with the number of Opticom™ controlled intersections. With three controlled intersections, the response time improved by 14.3 percent, whereas six intersections with Opticom™ equipped traffic lights saw a 22.5 percent improvement.[12] This report was further affirmed by a similar study conducted in Houston, in 1991. With tests performed from two different fire stations, response times were reduced with one station experiencing a 16 percent reduction while the other improved by 23 percent.[13]

Currently, the City of Austin has approximately 750 traffic controlled intersections within the city limits. Almost 50 of these are actually maintained by the Texas Department of Transportation (TxDOT) for the state highways within Austin. Approximately 125 of the 750 (16 percent) controlled intersections, are equipped with the Opticom™ devices. Ninety-five of these are concentrated in the immediate downtown area rather than residential areas. Most of these were installed with grant funding from TxDOT as no permanent funding for a sustained program has ever been authorized.[14]

Again, using the Bowman model, a projection can be made of how many sudden cardiac arrest lives can be saved from the present history if Opticom™ devices allowed for a quicker response. Table 7.6 reveals the positive impact that can be attained if response time were improved by approximately 30 seconds, or 14 percent. This seems to be a reasonable target increase based on the study results of Denver and Houston.

Table 7.6

General Response Time Improvement of 30 Seconds

Agency:	*Austin Fire Department*
Date of Analysis:	*03/01/00*
Analysis Period:	*12-1-97 to 11-30-98*
Analysis Type:	*General Response Time Improvement*

Response Times				
Current Response Time:	3.62	*Minutes*		
Risk (-%) Improvement:	-14%	*is equal to a*	-0.51	*Minute Delay*
Delayed Response Time:	3.11	*Minutes*		

Current FD Incident Information		***Cardiac Arrest Probable Survival Fraction***	*Desired Improvement To Response Time*	*Current Local Survival Rates*	*New Improved Survival Rates*
Midpoint of Arrival Interval	***1998 Arrival Fraction***		-14%		-14%
0.50	0.018	0.91	-0.070	0.016	0.016
1.50	0.067	0.86	-0.210	0.058	0.059
2.50	0.205	0.77	-0.350	0.157	0.165
3.50	0.269	0.62	-0.490	0.167	0.190
4.50	0.209	0.33	-0.630	0.070	0.111
5.50	0.107	0.11	-0.770	0.012	0.028
6.50	0.054	0.07	-0.910	0.004	0.006
7.50	0.027	0.03	-1.050	0.001	0.002
8.50	0.015	0.01	-1.190	0.000	0.001
9.50	0.009	0.00	-1.330	0.000	0.000
10.50	0.020	0.00	-1.470	0.000	0.000
		Overall Survival Rates:		0.486	0.577

Annual SCA		**Predicted Lives Saved:**	215	255
Cases:	442	Change from Present:	0	41

Notes:

Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte

AFD Response Times obtained from the AFD Adminsitration Division

AFD Arrival Fractions obtained from the AFD Administration Division

Cardiac Arrest Fractions from the American Heart Association

Annual SCA Cases obtained from Austin Emergency Medical Services

Source: Adapted from the Ray Bowman spreadsheet “Consequences of Emergency Response on Cardiac Arrest Survival”

With an improved response time of this extent, a projected 255 people would have been saved from SCA rather than the estimated 215 lives. This translates to 41 more Austin citizens would have been saved than what was currently projected for 1998.

This entire analysis signifies that there is a direct correlation of survival from sudden cardiac arrest to the response time arrival of emergency medical personnel. The Austin experience illustrates that their traffic-calming program does have a significant detrimental effect to SCA survivability and the quality of emergency services provided to the community.

Risk/Benefit Ratio

A number of analytical processes can be used to evaluate public policy. One such process is establishing a *risk benefit ratio* whereby the risk of one public service can be divided by the benefits of another service. In general, policy decisions are reached or reinforced with the policy option that has the lesser risk and greater benefit ratio. Such a comparison can be made for the Austin traffic-calming program. One ratio will be established for traffic calming device installations; the other will be conducted for traffic flow improvements utilizing the Opticom™ systems.

Table 7.7 shows the results of this analysis, again using the previously established data for Austin, Texas.

Table 7.7

Risk Benefit Ratio for Austin, TX

Policy/Program	Projected Risk	Projected Benefit	Risk/Benefit Ratio
Installation of Traffic Calming Devices	37 lives lost to SCA	1 pedestrian life saved	37 lives lost for 1 life saved
Installation of Opticoms to Reduce Response Time	1 pedestrian life lost	41 lives saved from SCA	1 life lost for 41 lives saved

Again, based on this analytical comparison, one can easily determine that there is a much greater risk for installing traffic calming devices compared to the benefit for a policy or program that provides a reduction in emergency vehicle response times. In essence, Austin has adopted a public policy program that loses 37 lives (SCA) for every one life saved (pedestrian).

Notes

[1] Reid Ewing, *Traffic Calming: State of the Practice*, (Washington, D.C.: Institute of Transportation Engineers, August 1999), p. 109.

[2] Dylan Rivera, "Austin council will debate plans for Rainey Street", *Austin American Statesman*, Metro & State Section, (April 5, 2000), p. B1.

[3] Bruce Browner, Lenworth Jacobs & Andrew Pollak, ed., Emergency Care and Transportation of the Sick and Injured, 7th ed. (Sudbury, MA: Jones and Bartlett Publishers, 1998).

[4] American Heart Association, "Cardiac Arrest and the Need for Early Defibrillation, When Every Second Counts", Online. Available: http://www.americanheart.org/Heart/CPR/PAD/brouchure.html. Accessed: February 6, 2000.

[5] Ibid.

[6] Ibid.

[7] Ibid.

[8] City of Austin, Emergency Medical Services, "Austin/Travis County EMS Utstein Report on Cardiac Arrest Cases", Austin, Texas, December 1, 1997 to December 1, 1998, p. 1.

[9] Ray Bowman, "Calculation Spreadsheet", Personal email to Les Bunte, October 29, 1999.

[10] William Mendenhahl and Robert J. Beaver, *Introduction to Probability and Statistics*, (Belmont, California: Duxbury Press), p. 158.

[11] Traffic Engineers, Inc., "Emergency Response Management System Study, (Houston, Texas, April 1991) p. 2.

[12] City of Denver, Department of Safety, "Time Study Effectiveness of the Opticom Traffic Control System", Denver, Colorado, October 5, 1978, Table 5.

[13]Traffic Engineers, Inc., "Emergency Response Management System Study", p. 10.

[14] Piet Sybesma, "Signals and Opticoms", Personal email to Les Bunte, March 22, 2000.

Chapter 8. Discussion of Policy Implications

Many arguments can be made for or against public policies relating to traffic calming initiatives. Often, public policies are quickly adopted in the wake of highly emotional issues, reaction to perceived fears or threats, or in response to a small interest group that may not represent the interests of the remainder of the community. In many instances, traffic-calming initiatives have been instituted in a large number of communities under these circumstances.

Traffic calming programs are established generally to improve neighborhoods by reducing traffic speeds and volumes, lower accident rates, and improve pedestrian safety. Often the traffic danger within a neighborhood is generally a *perceived danger* by the residents, rather than an established one. Because they personally witness the extremes of the data, residents often convey an exaggerated depiction of the problem than what is borne out and validated by the field data analysis.

Unless policies and programs are well thought out, analyzed, planned, and appropriately implemented that meet the overall needs of the entire community, most citizens will not be thoroughly satisfied with the local government's actions for a particular issue. The intent of this research was to review all of the aspects surrounding the traffic calming issue and attempt to qualify and quantify the issues so that public and appointed policy makers could reach prudent decisions for their communities. These decisions would then be based on analytical processes rather than mere intuition or perceptions. Thus, this chapter should serve as the findings and interpretations of the content information reviewed herein. Chapter Nine, the final one, will contain policy recommendations from these findings, interpretations, and discussion.

Devices Useful When Warranted

Often, traffic-calming devices are used as a first, “knee jerk” reaction to a problem rather than a last resort. In many instances, there is quick response by the local government to the out crying of a few people who perceive there is a major problem. The local entity then records a quick set of speed and volume data, and devices are then put in place. As cautioned by Reid Ewing, a leading expert in traffic calming, speed, volume, and accident studies can be easily skewed. Therefore, full, in-depth, comprehensive analyses needs to be performed of the entire area to determine the problem. In addition there is often a lack of periodic efforts to increase enforcement by the police.

Most traffic control devices are effective for their intended use, i.e. slowing traffic or decreasing volume. However, their misuse is generally what comes under more scrutiny. There are certainly some situations where some type of traffic calming is warranted. The Rainey Street project in Austin serves as one good example.

This very small neighborhood did not have a collector street, nor were there other parallel streets within the neighborhood, or adjacent neighborhoods, for cut-through traffic to divert to. Cut through traffic and speeding were the main complaints of the Rainey Street neighborhood. A quick analysis was done showing there was high traffic volume and very little speeding over the established 30 mph speed limit. Little was done from an enforcement standpoint, because there was not truly a speeding problem, only one perceived by the residents.

The traffic volume however, was a legitimate issue as over 3,000 vehicles per day (vpd) passed through the neighborhood. The neighborhood location, in very close proximity to two major arterials, was truly a result of cut-through traffic.

By not fully analyzing the problem with an intensive, thorough traffic study to establish the best remedy, the City Public Works & Transportation Department and the neighborhood-working group responded with a plan that was less than desirable for all parties. Instead, the neighborhood adopted a much more expensive plan to ensure it received its “full entitlement” of the funds allocated for the project rather selecting the best option. This is a potential problem with the City of Austin Traffic Calming Program. Too many neighborhood-working groups focus on obtaining as many devices as the project budget will allow. Instead, the groups should be selecting the best options to solve the identified problem rather than solving the “spending problem.”

Several speed cushions were placed when speeding was not a major problem. Speeding actually increased in some areas afterwards, as drivers were attempting to “make up for lost time.” A traffic circle and two neck downs were placed to discourage traffic, which ended up having a limited effect on the volume. The volume was cut from 3,000 to 2,000 vpd, still a very high number of vehicles in a residential neighborhood. In fact, a portion of Rainey Street had a very dramatic increase in volume. Holding true to most traffic calming devices, the placement of a device on one street will generally move the problem to another street. In this case, it was further up the street rather than another parallel street.

Not being a major response route, this neighborhood would have been better served with a complete street closure. The cut-through traffic would have been totally eliminated and the perceived speeding problem would have disappeared with no traffic. All of the neighbors, instead of a few, would have benefited and none would have had a degradation of their current situation. More importantly, the overall goal would have been accomplished, as all of the cut-through drivers would have had to stay on the arterial streets, which is precisely the route they needed to stay upon.

In this case, the City of Austin was treating symptoms, rather than completing a formal examination to make an accurate diagnosis and prescribe the correct actions for a cure. As a result, the neighborhood did not get completely well and still has troubling side effects. Thus, one can understand how a neighborhood would be of the opinion that the City did not fully do what they said they would do.

Although traffic-calming devices slow some traffic they do not slow all traffic. When the 85th percentile methodology is used to establish speed limits, this means that 15 percent are going faster. Is it reasonable to assume that this 15 percent is going to slow down when they encounter devices? This is probably unlikely, because if they are likely to drive at a unsafe speed to begin with, they are just as likely to accelerate and brake harder "to make up for lost ground" in between the devices. As pointed out earlier, police cars responding to emergencies are not greatly impacted by the delay, because of their smaller size, higher horsepower to weight ratio, they can navigate quicker between the devices. With this being true, then the other 15 percent of the civilian traffic can easily do the same.

Another quandary is the perceived speeding problem and the 85th percentile rule. Traffic calming devices have been put on streets with 85th

percentile speeds less than 30 mph. This is contrary to state law, as the 30 mph speed limit is the minimum established by state law for all public streets except for special designated areas such as school and park zones. Recognizing this, law enforcement will generally not write citations for speeding unless the violation is 7 to 10 mph over the speed limit. This is due to most judges not considering a guilty verdict unless the overage establishes a clear violation of the fact beyond a reasonable doubt.

Transportation officials are generally hesitant to perform actual speed studies, as the 85^{th} percentile speed often exceeds the 30 mph limit, meaning that the speed limit should be increased to the newly field noted 85^{th} percentile. Thus, any citations for speeding in excess of the established 30 mph, but less than the newly established 85^{th} percentile speed, would have excellent grounds for dismissal.

Further, knowing this information, the local government is somewhat obligated to change the speed limit once it becomes aware the 85^{th} percentile speed has increased. For this reason, these transportation officials are always willing to apply devices in places where the 85^{th} percentile is below 30 mph, as this does not jeopardize the posted 30 mph speed limit. Again, under this scenario, devices are placed on streets when there is a perceived need, not a legitimate one, when speeds are below 30 mph.

Thus, devices are useful when their need is thoroughly analyzed and is warranted to solve the root cause of the problem. These devices should not be used to treat the symptoms of other community problems such as a lack of sufficient arterial and collector streets. Partial success leads only to partial fulfilled benefits, which increases public apathy. None of these outcomes lend themselves to good public policy.

Emergency Response Delays and Impacts

Many local governments fail to look at all of the impacts to traffic calming before making an affirmative decision to pursue such an initiative. Often these impacts outweigh the benefits. Numerous findings of the literature review and of the analytical processes contained in the previous chapters have demonstrated how traffic calming is detrimental to emergency services.

As proven with the five case studies presented, response times for fire and EMS emergency vehicles are definitely impacted. Delays in response time range from 2 to 10 seconds depending upon the type of vehicle and the type of device encountered. All of the studies showed that EMS units are in double jeopardy of their response times as they encounter delays to the emergency scene and on the return trip to the hospital when transporting patients.

There can be great financial impacts to cities with increased response times. As the response time is increased, the area of effective station coverage decreases. This situation would require local governments to build more stations to maintain the same coverage. At the very least, if traffic-calming initiatives continue, efforts should be made to modify the Austin fire station location criteria so that future stations will be closer to each other than what is presently done. Not only is this a great capital cost, a very expensive annual operational cost follows to put more firefighters and paramedics on the payroll to decrease the response times. Thus, the total cost of traffic calming goes far into the future than just the implementation costs for devices.

This is very true for the Austin Fire Department as their average annual response times for the last ten years has steadily increased. Even more critical, that average response time has been over four minutes for the last six years. Without a doubt, response times have increased with the tremendous growth rates. As a result, the Department has been unable to actively keep up with the growth curves. With projected growth rates to occur even more, it is doubtful that the Department can return to a sub-four minute response anytime soon.

Fire engine apparatus can cost up to $350,000 with ladder apparatus costing $600,000. Each has a front-line service life of about ten years if all goes well. That life is drastically reduced if the unit is very active. With repeated damage to these vehicles from the constant flexing of traversing speed humps, the expected life will diminish. This in turn increases the average capital cost per year as replacement apparatus are needed sooner than the expected ten year service life. Again, another increased direct cost for minimal gain.

The greatest impact on response times involves those of sudden cardiac arrest (SCA). As previously shown, a 14 percent increase in response times due to traffic calming devices can lead to an additional 37 lives being lost each year. Even on a lesser time delay scale for three speed humps, 18 people of Austin could have been expected to die from SCA compared to the history established. These all are very alarming numbers.

The bottom line to this negative impact is that the citizens of Austin are already seeing a tremendous increase in response times due to growth. Additional delays due to traffic calming only intensifies that situation and causes the efficiency of emergency services to decline. One has to severely question the reasonableness and accountability of maintaining public policies that expend over $100 million per year in operational costs (capital costs excluded) for fire and EMS service, yet at the same time spend $1.5 million to diminish the quality of those services. Not to mention, the supreme measure, the number of lives at stake.

Finally, this policy analysis reveals there is a severe imbalance of trying to maintain or improve response times while allowing those response times to erode in the traffic calmed neighborhoods. One analysis strongly supports efforts to improve response time through technological improvements of traffic signals. From a risk/benefit, and a predicted lives saved standpoint, a good public policy would include provisions for improving response times. At the very minimum, policy makers should ensure that any projects that degrade response times should be offset by projects, such as Opticoms™, to at least maintain current response time levels.

Environmental/Air Quality Impacts

As local elected officials might satisfy some residents of neighborhoods, they are likely to encroach upon the sentiments of environmentalists. Several studies were presented that demonstrated that traffic calming does increase air pollution. The findings show that air pollution increases with lower speeds of around 20 mph compared to 30 or 40 mph. Greater auto emissions occur with more activities of acceleration and braking for speed bumps compared to an evenly sustained speed without any obstacles. In addition, there was validated evidence that showed that fuel consumption also increased dramatically with traffic calming devices.

Failure to recognize this pollution contributor could cause the local government unexpected financial impacts and/or political embarrassment. Since the increased pollution is established, other non-related grants, such as other transportation or air quality grants and funding could be in jeopardy. This is particularly true if they contain clauses that the City of Austin should not implement programs that would lead to further air pollution. The episodes in Portland, Maine and Griffin, Georgia serve as examples that can easily happen to any local government if they fail to evaluate how their policy on traffic calming could affect other air quality or financial policies already in place.

Austin officials in particular, face a very similar related vulnerability. Currently, Austin is precariously perched on the threshold of being classified as a “non-attainment area” by the U. S. Environmental Protection Agency (EPA). Due to this, they are mandated to take certain steps to improve air quality within the region. As traffic-calming programs contribute to air pollution, the EPA may construe such action as not being proactive measures to meet air quality standards. Again, this could pose as great political embarrassment and possible funding implications.

Civil Liabilities

There is no doubt that local governments are at great risk for potential civil litigation with their traffic calming programs. Virtually, all local governmental laws, ordinances and regulations are based upon some type of authorizations or national standards. In the case of traffic calming, neither of these conditions exists. None of the nationally accepted traffic codes, used by transportation professionals, recognize traffic calming devices as traffic controls. The inability to rely on a national standard eliminates a commonly used defense platform used for many other government litigation cases involving policies and programs.

Because speed bumps have been previously banned, one has to reason that traffic calming devices of similar design, such as speed humps, would have to be teetering on the edge of legality. Other devices such as diverters and half closures were declared illegal in California. In a related speed hump case, a Florida court remained silent of declaring speed humps illegal, thus leaving the legality of speed humps unanswered. Because of the tone of these rulings, one can easily surmise that traffic-calming devices are on the cusp of being illegal. For Texas, the law pertaining to this issue is silent, as no cases have been established yet as a precedent.

Discrimination vulnerability indeed lies within the provisions of the American with Disabilities Act (ADA). This federal law is a clear mandate to eliminate discrimination against persons with disabilities. Eliminating transportation barriers is one such objective to ensure that those with disabilities do not suffer more than those without disabilities. As speed humps have been designed to principally cause discomfort, a strong case can be made for ADA discrimination.

All local governments have an affirmative duty to make reasonable modifications to their policies, programs, practices, and procedures to avoid disability discrimination unless the modifications would fundamentally alter the nature of the service or program. Since roads are a facility covered by the ADA, any alterations must conform to ensuring they do not discriminate those with disabilities. Obviously, traffic-calming devices fall into this situation. However, no precedent cases have been established at this time.

Austin, like other cities is at great risk here, because they have not performed any biomedical or engineering studies validating that the devices are safe for those with disabilities. Such an analysis should be done prior to the installation of the devices. In addition, such validations would need to occur not only for disabled drivers, but also for the disabled passengers riding in para-transit vehicles.

There are other issues that are ripe for litigation. Property and personal damages due to noise, failure to warn, vibration damages, and accidental air bag deployments are claims that can be made. Certainly, damage claims for personal injury and vehicle damage would be a common type of litigation.

Of great concern to local governments is the potential danger to their own employees and equipment. There have been ample documented cases presented where firefighters have been seriously injured while riding in fire trucks as they traversed speed humps. Workmen compensation settlements for an injury due to one traffic-calming device can far outweigh the benefits of that device. Again, the intent of traffic calming is to reduce injuries and make a safer environment, not increase the danger to individuals. This includes public safety workers.

Undoubtedly, the largest vulnerability lies with the negligence of service delivery. Local governments who intentionally place traffic calming devices, knowing that such devices increase the risk or cause life threatening delays, will be opening themselves to negligent death lawsuits. Such lawsuits are extremely likely to originate by those who lose family members when the emergency services encounters traffic calming devices while enroute to that emergency. As most elected officials know, the court assessed damages for such a negligent death suit can be astounding.

When traffic calming began, there was little quantifiable information defining the delay potentials. However, as more and more studies are conducted by fire departments, and more risk analyses are presented similar to the ones included in this research, a much clearer validation can then be presented by those who are damaged. Policy makers should also be keenly aware that no quantitative analyses has been performed thus far demonstrating the number of lives that can be saved from traffic calming devices. Thus, there have been limited quantitative or qualitative data, if any, to justify the needs for traffic calming.

Local Government Postures

Once what was in vogue within many communities is now in the closet. Due to most of the issues revealed in this document, many elected local officials throughout the U.S. have found themselves in the midst of a conflict that has little middle ground. As a result, the only option to keep from having to take a solid position is to put the traffic calming issue on hold in the form of moratorium. That condition best describes the postures of most cities today in regards to their traffic calming programs. Many are hoping it will go away, while others resort to the political policy death of no continued funding.

Austin has a full moratorium on the installation of speed humps except for those in an approved traffic calming project area. In effect, traffic-calming devices are still being implemented but only by a select few. Yet, when the neighborhood residents become fully notified, this issue has a tendency to falter or fail as occurred in Gwinett County, Georgia.

A Growing Public Sentiment

In an attempt to save the program, the City of Austin Public Works & Transportation Department changed its processes. Revised public type hearing formats were eliminated whereby full neighborhood debate could no longer be engaged and entered into for full public review and justification. As a end result, a neighborhood usually gets a traffic calming plan that does not fully meet its needs or is not wanted after it is implemented. Again, wasted resources for a partial benefit.

Two situations in Austin serve as examples of resident displeasure. Almost three years after the installation of speed humps on a major neighborhood street in Austin, some residents are expressing a desire to have the humps removed. This particular street, Floral Park Drive, is a primary response route for the local fire station.

As noted in an earlier chapter, fire and EMS personnel are responsible for taking the quickest routes to emergencies. Due to the numerous humps on this street, most fire apparatus operators avoid this thoroughfare for emergency responses and take a parallel side street to save time. This has been very upsetting to the residents of the parallel street as they are awakened at night by the associated noise with a responding emergency vehicle.

Residents have requested fire department administrators to direct the fire apparatus operators to take different routes. However, due to the selection of routes being a "judgment call" by the operator, the administrators cannot give such direction without tremendous liability potential. Resultantly, the only options for the neighbors of the parallel street are to work to get the humps removed or simply "live with the decision".

The second example comes from the Hyde Park neighborhood in central Austin. In this neighborhood numerous traffic circles were installed. These circles were placed on both the north/south and east/west streets that the fire station is located on. This means that virtually every emergency incident that this station responds to, the firefighters will encounter traffic calming devices.

Not only are the firefighters unhappy, there are indications that the residents did not fully receive what they expected. The comments from Hyde Park residents contained in a neighborhood newsletter confirms the displeasure of the neighborhood:

> The City of Austin recently completed the installation of traffic calming devices in the Hyde Park neighborhood. I asked both former HPNA [Hyde Park Neighborhood Association] traffic calming committee members and non-committee Hyde Park residents about their experiences with traffic calming. A summary of these interviews follows:

The traffic circles are charming, but may be dangerous to bicyclists and pedestrians, because drivers are NOT yielding the right of way. Apparently, the worst circle (as far as failure to yield right of way goes) is the one on 42nd and Speedway. If you would like to experience this circle firsthand, approach from 42nd street rather than from Speedway. The through traffic from Speedway is not slowing and yielding, which was what the circle was supposed to achieve. It was felt that 4-way stops would have been better and cheaper than circles, although the circles themselves were thought to be "charming". It was also pointed out that emergency vehicles such as fire trucks could not negotiate the circles safely. They ended up running over parts of the circles...

One HPNA member was still mad at the City because they did NOT follow the HPNA recommendations. She said the committee was "powerless" once the City took over...

…There is another circle at 43rd and Avenue B that has been very dangerous because 43rd street is too wide to make a circle an effective device.

There were also problems with the speed "cushions" on Duval and Speedway. They are supposed to be lined up so that the fire truck can straddle them swiftly and safely as needed for emergencies. An HPNA member said they were positioned incorrectly on the road and now force the fire trucks into either the bike lanes or into the center of the street towards oncoming traffic. The Hyde Park fire station is still complaining about them. The HPNA talked to a fire department administrator who thought the traffic calming devices wouldn't be a problem. HPNA recommended that WPNA[Windsor Park Neighborhood Association] check with the ACTUAL DRIVERS of emergency vehicles (those who are actually going through and responding to calls in our neighborhood) before putting in permanent devices like circles and speed cushions to slow traffic.

Finally, I informally polled several Hyde Park neighbors about their reactions to the traffic calming devices and most of them did not like the circles.

One problem mentioned was that pedestrians have no safe way to cross from corner to corner where there is a circle. Residents who live on corners where there are circles can no longer park on the street near their homes, because these areas are now designated "no parking" zones. Bicyclists are finding the circles to be dangerous because they have to compete for the narrowed street areas at the corners. Failure to yield right of way is a recurrent problem. One resident told me she once drove through one of the circles without even looking for other cars because she was distracted and in a hurry. She was glad that no other cars had been coming and was shook up to think what might have happened had there been another car.

> As to speed "cushions", several people thought they were probably a good idea, but they didn't like to travel on them on a daily basis.[1]

Although some may claim that traffic calming is supported by the neighborhood, there are strong indications that negative public sentiment is vastly growing and shifting against traffic calming programs. The trend in Austin, as illustrated by the above two situations, is that once the neighborhood residents become fully informed of the issue they generally disapprove of the initiatives. This is further supported by the earlier review of two other neighborhoods in Austin who have recently voted down proposed traffic calming plans for their neighborhoods.

All of these actions demonstrate for Austin, as is probable for other cities, that good, sound processes for validating that an overwhelming majority of the residents in a neighborhood truly desire traffic calming programs is lacking. This could also affirm that some residents truly perceive and exaggerate there is a problem when in actually one does not exist.

Been There, Done That!

During the 1990's, there was a terrific explosion of new innovative strategies for organizational development and business management. With so many new approaches, a lot of companies and businesses found themselves looking at different strategies only to find they had implemented a similar strategy before only it were now under another name. Somewhere during that time, a new catchphrase was coined "been there, done that"! That phrase describes very accurately the San Jose experience with traffic calming.

San Jose has a population of 783,000 and had a growth rate of nearly 25 percent in the early 1990's.[2] With the similarities that Austin currently is experiencing, as did San Jose about 20 years ago, the city officials of Austin may want to take heed from the "been there, done that" posture of San Jose. Their situation was best described as follows:

> In the 1970's, San Jose was the fastest-growing large city in the nation, as Silicon Valley blossomed in the former farm fields south of San Francisco. Major arteries and freeways did not keep up with growth, and traffic spilled into the old square-grid road system of San Jose's neighborhoods.
>
> City officials threw up signs announcing a host of new regulations, speed limits, turn prohibitions, truck bans, parking restrictions, [and] stop signs. Often, the new rules simply shunted traffic onto other residential streets.
>
> The city tried neighborhood watches and radar speed-display boards, but complaints kept mounting. The city adopted a

> comprehensive traffic-calming program, but in 1993 it was cancelled because of budget problems.
>
> In 1993, two major highways were finished, greatly helping to relieve congestion…The city saw a 70 percent drop in traffic complaints in the past six years, due in large to the new arterial connections and freeways.
>
> “Traffic calming, the city is discovering, is not just about installing speed humps or diverters in a roadway,” says Wayne K. Tanda, director of the city’s department of streets and traffic.
>
> “It’s about strategy: Enhancing arterial and freeway networks; rethinking land use and urban design; and using intelligent transportation systems to better manage traffic signals, inform people of traffic conditions and travel alternatives, and monitor speeding vehicles”. [Tanda]
>
> San Jose’s strategy frowns on devices like road bumps and street closures, which Tanda says are aimed at the minority of lawbreakers. San Jose decided to stop penalizing 95 percent of its drivers for problems caused by the other five percent.[3]

While many policy-makers grapple over what to do with increases in traffic volume and speeding on residential streets because of congested arterials, San Jose abandoned their traffic calming initiatives in favor of addressing the root problem of insufficient arterial roadways.

In addition to the highway and arterial improvements, traffic-calming programs were limited to only proven techniques that would keep cars on the major highways and out of the adjoining neighborhoods. Again, the Rainey Street Neighborhood Project in Austin would have been better off under this San Jose strategy.

With San Jose's inability to keep up with rapid growth, increased traffic speed and volume (*been there*); and their ineffective traffic calming programs (*done that!*); Austin should give strong consideration to observe and apply similar actions of the San Jose experience.

The Final Analysis

As noted in the beginning, there is truly a competition between the two public goods of traffic calming and emergency service response times. From the onset, various literature reviews, analyses, and research functions have been performed in an attempt to establish qualitative and quantifiable data to assist policy makers and elected officials in formulating and establishing good, sound public policy for this issue.

Although, many of the issues and impacts discovered with this process may very well apply to other communities, clear findings and trends were established for Austin. The overall risks for traffic calming programs far outweigh the gains. All together, traffic calming is counter-productive to many other public policies.

Response times continue to increase while fire stations are being built at a record rate to keep those times in check. As shown by the sudden cardiac and pedestrian analyses, more lives are being lost than those that could be saved from traffic calming. Traffic calming adds to air pollution which conflicts with the proactive steps taken by the City to prevent from becoming a "non-attainment" area for pollutants.

Like most other cities, Austin experiences a large amount of litigation, some frivolous and some legitimate. Although frivolous lawsuits can be easily filed, the current situation appears to be ripe for a legitimate Americans with Disability Act claim. Not having a national traffic-calming standard for Austin to rely upon compounds the risk. A detrimental court ruling could mean a tremendous loss to millions of tax dollars already or projected to be spent for roadways, by a magistrates' order to remove all traffic calming devices.

Growing general public apathy is a serious political atmosphere that elected officials certainly want to avoid. With the continuance of traffic calming programs being implemented without overwhelming support by the neighborhoods, an elected official can easily find himself/herself embroiled in a controversy where there appears to be minimal "middle ground".

What makes the traffic calming programs harder to justify, is that there have been no legitimate studies that can truly quantify or project that the programs save lives. Further, with the admission of a leading transportation expert, we have been cautioned as to the validity of local speed and accident surveys that denote improvements.

And finally, there is clear substantiation and reasoning that improvements to the emergency response times would clearly benefit the citizens of Austin, both in lives and costs. Rather than spending considerable public funds for a few to improve the perception of a neighborhood problem, a better value could be gained for the whole by improving response times.

As a final policy analysis and assessment, traffic calming programs should be reviewed at the local level with the greatest amount of introspect to identify all of the impacts to the community, rather than focusing on a perceived problem often exaggerated by a few. Austin's posture should be immediately reviewed using many of the methods, data and information contained in this report. Without a doubt, more extensive research needs to be conducted on the local level as well within the professional circles of public service officials.

From the perspective of this research, Austin should give serious consideration to abandoning the current "pilot program" and adopt the San Jose strategy of redirecting its traffic calming efforts towards addressing the real problem of improving the arterials and major thoroughfares.

For the immediate, legitimate and warranted problems identified within neighborhoods, Austin policy makers should install only those devices that have a profound effect upon the situation, rather than applying "band-aid" remedies to make residents feel good about a perceived problem. Full and partial street closures are two examples of responsive and effective devices. Most traffic control devices have very limited or marginal results. Installing such devices is only patronizing the residents, and jeopardizes the emergency services to the remainder of the community. Neither of which seems to be of good policy principles.

At the very least, the City of Austin policy should prescribe and include measures to ensure that emergency response times do not increase. By doing so, rather than there being a *competition* between two public goods, there would be a *balance* of two public goods. This would seem to be a prudent attribute for good, sound, public policy.

Notes

[1] Kate Anderson, "Information About Another Neighborhood's Experience", *Window on Windsor*, Vol. VVIII No. 2 (February 2000), pp. 4,8.

[2] Public Technology, Inc., *San Jose, CA, Taking the Highway*, http://pti.nw.dc.us/task_forces/transportation/docs/trafcalm/CASE18.htm. Accessed November 23, 1999

[3] Ibid.

Chapter 9. Recommendations

With quantitative and qualitative analytical processes, good public policy can be formulated to ensure that the overall needs of the public are met. This approach allows for all elements of the local government to rectify their policy differences prior to public introduction and implementation. In addition, citizens, residents, and policy makers can be provided with the results of the analyses so that they too are in a better position to make informed, prudent and reasonable decisions. Comprehensive analyses ensures that sound public policy, rather than conflicting policy, is rendered for the citizens and eliminates embarrassment to the policy makers.

A set of recommendations has been formulated from the findings and discussion of this professional report for the City of Austin policy makers as well as the policy makers of other communities who have been or likely will be embroiled in this debate. These recommendations are not listed in any particular order of priority or preference.

Recommendation #1:

Avoid other policy conflicts prior to adopting a traffic calming policy/program by requiring each local government department to conduct a comprehensive policy analysis containing their respective impact statements.

An in-depth review by all the affected service departments of the proposed policy at the incipient stage is extremely critical. Too often, many cities have hastily approved and implemented traffic calming programs that resulted in a policy controversy they did not expect. Unfortunately, many of these conflicts originated within another service department of the same local government after implementation.

Such an analysis should weigh all of the positive and negative impacts of the policy as included in pre-established departmental impact statements. From these identified impacts, analytical methodologies should be developed to measure the impacts. Policy approvals should be obtained, at a minimum, from the departments of public works, law, risk management, environmental protection, and the emergency services

Recommendation #2:

Verify that a legitimate problem exists, not a perceived problem.

Often there is a *perceived* danger by residents within neighborhoods when in fact the traffic characteristics fall within in the norm. Due to this, care should be taken to not prematurely respond to a small vocal group based solely upon their observations. Extensive field analyses should be performed to properly validate the problem. Aggressively responding to small groups without verification can cause a much greater opposition group to arise in the end.

A full-scale validation should include, but not be limited to the following:

- Traffic volume analysis: This should be measured for a wide area in order to determine what volume levels exist and to evaluate if the traffic will shift to another area.
- Traffic Speed Analysis: This should verify that there is a substantial amount of traffic exceeding the posted speed limits. New 85th percentile surveys should also be conducted during this process. Local governments should not rely on data surveys older than two years old to properly assess the current situation.
- Accident Studies: These should be conducted, but verified with caution as there are many factors that contribute to accidents that are not related to traffic calming. This is particularly true as accidents occur infrequently on neighborhood streets.

- Significant Sample Sizes: All data collections should have large sample sizes to ensure statistical soundness. Caution for data inferences should be exercised with small samples.
- Limited Confidence Inferences: Contributing factors to accidents, along with speed and volume data, varies from locale to locale; approach with limited confidence in drawing safety impact improvements; do not rely heavily on other jurisdictional studies.
- Before & After Studies: Be sure that the parameters of the "before" data is exactly the same for measuring the "after" data, i.e. traffic count locations, radar locations, time and day of week, etc. Failure to follow precise measurement parameters lead to skewed and questionable results.
- Establish Pedestrian Accident Frequencies: The infrequency of these accidents within neighborhoods is often not factored into the scope of the problem. Specifically, pedestrian accident rates occurring only upon residential streets should be evaluated. Pedestrian accident data involving major thoroughfares should be discarded and not included in an analysis. Failure to remove this data will lead to exaggerated reporting of the actual situation within neighborhoods.

Recommendation #3:

Require neighborhoods to submit a petition with at least 60 to 75 percent of the residents confirming their desire for traffic calming devices.

Many times the effort to obtain traffic calming relief is spearheaded by the leadership figures of local neighborhood associations. Soon after they start the process, opposition begins to develop to a level greater than anticipated. Some people quickly find themselves opposing the plan when they find out a device will be placed in front of their house rather than someone else's house. To ensure there are no "neighborhood backfires", local governments would be well advised to require these neighborhood associations to strongly commit "up front" to this effort. Signatures on a petition of an overwhelming number, such as 60 to 75 percent of the neighborhood, would help bind residents of their stance. Such an endorsement also serves to protect the policy maker from undue scrutiny.

Recommendation #4:

Evaluate the full impact to emergency response times to all citizens.

It is imperative that local governments fully know and predict what will happen to their emergency services response times. Several fire department studies have documented the delays due to specific traffic calming devices. Most cities have the data available to conduct a medical service analysis for cardiac arrest identical or similar to the Bowman model. With these tools, policy researchers can now establish good baseline measurements for the delays and predict potential impacts that could be expected for the community.

In addition, more information is now becoming available regarding the extent of injuries to firefighters and paramedics. Strong consideration must be given to ensuring that their work environment, like the neighborhoods, is as safe as possible. The aspect of predicted fleet damage should also be included in the emergency response assessment.

Recommendation #5:

Evaluate the full environmental impact to the air quality of the area.

Traffic calming devices contribute to air pollution. Prior to implementing a traffic-calming program, each local government should obtain verification from their respective state agency that this program will not violate any of the air standards established by that agency or other state or federal agencies. In addition, the local government should evaluate all of their air quality grant funded programs to ensure they are not in violation of any previous agreements. By accepting the funding, most local governments also agree to adopt policies and programs that do not contribute to air pollution within their area. Failure to receive any of these confirmations could jeopardize existing funding and cause undue fiscal hardship upon the citizens as well as political embarrassment.

Recommendation # 6:

If a traffic-calming program is established, ensure that a "working group" of residents from the neighborhood is assembled to work with City staff to develop a traffic plan.

Working by the side of City staff members, neighborhood residents can help identify problem areas as well as establish alternatives to rectifying the problem. The City staff should include public works officials as well as representatives from the emergency services. The neighborhood group should consist of more than just the leadership group of the neighborhood association. This group should be a cross section of the neighborhood with representatives from different streets, and with a limitation of those from the same street, as well as those who would not necessarily be proponents of traffic calming devices. These have to be *consensus* people, meaning not those in the majority who agree, but rather, those who *accept* the plan even though they may not fully agree with the plan.

Recommendation #7:

Conduct thorough legal risk assessments, not just authorizations.

Too often questions of legality are limited to verifying that the local government has the authority to implement traffic calming devices. The local governments rarely properly evaluate other potential jurisprudence issues. As more and more risk studies are developed, as the one contained in this report for Austin, Texas, there is a clearer confirmation that response delays do occur. Knowingly and voluntarily continuing to contribute to a deteriorating situation can only lead to increased liability risks for the emergency services.

Local governments who elect to install traffic calming devices should take extra measures to ensure safe legal ground regarding the Americans with Disabilities Act. These governments should conduct bio-medical and engineering studies to validate that traffic calming devices are safe and pose no hazard to those with disabilities.

Recommendation #8:

Traffic calming devices should not be used for treating symptoms of traffic problems. Take actions to eliminate the root cause of the traffic problem.

A good analysis will reveal the primary cause of the traffic concern. Once identified, permanent remedies should be incorporated to fully remove the problem. If a problem truly exists, then drastic measures such as a street closing may be the cure in order. Speed humps and diverters will not be the best answer to a continuing nagging problem. Failure to effectively eliminate the problem will result in disappointment from most residents.

If drastic measures are not taken, then traffic calming measures should be limited to severely warranted locations, such as neighborhoods close to freeways. Neighborhoods of high crime are other good candidates for traffic calming, as the benefit of reducing the crime and restoring the neighborhood has a greater justified benefit than those of low crime areas.

Policy makers should make sure that a traffic solution on one street doesn't move the problem to an adjacent street. Perhaps a better-cost benefit would be utilizing traffic-calming funding to expedite the construction of larger arterials. This directly addresses the root problem, as commuters would stay off the neighborhood streets in preference for adequate arterials.

Recommendation #9:

Emergency service departments should have the authority to disallow traffic calming plans that will adversely impact their response service delivery.

Emergency service officials should not be allowed to reject traffic calming plans just because "they don't like traffic calming." Reasonable justifications should be given. However, local governments should refrain from restricting emergency service officials from having the ability to disallow plans when warranted.

Presently, the City of Austin emergency service departments are not allowed to "veto" any traffic-calming plan. If a proposed traffic calming plan causes a severe negative impact to service delivery, these departments currently must abide by the desires of a few citizens, which subsequently impacts the whole community. This situation erases all accountability to the remainder of the public. Good policy development should have checks and balances to ensure the overall benefit to the society.

In addition, this condition sets up a natural conflict within the local government, whereby the public works department can dictate their engineering designs for the placement of devices for traffic effectiveness, yet the fire or EMS department is not allowed to modify a plan that jeopardizes their service delivery.

Recommendation #10:

When a traffic calming policy is adopted, make sure that it is balanced.

As resources are allocated for traffic calming projects that increase response times, equal resources should also be implemented for improving response times. Local governments should ensure that visible actions are taken to offset the downsides of traffic calming. Funding the remote electronic traffic control systems, such as the Opticom™ systems, is a good alternative to counter slower response times. Revising station location policies, by making them closer to each other, also compensates for the delays caused by the devices.

Recommendation #11:

Prohibit the installation of traffic calming devices on streets of fire station locations or primary response routes.

The greatest controversy erupts when devices are placed upon streets of fire station locations and the respective primary emergency response routes. The concern here is that one neighborhood's desire is negatively impacting someone who lives in an adjacent neighborhood now with a longer response time for emergency service. Restricting traffic calming devices on primary response routes does not impact the service to other neighborhoods and thus, greatly diminishes this debate, which in turn reduces opposition. Therefore, traffic calming devices should be allowed on streets whereby one does not have to travel upon to get to another neighborhood.

Although there are no national standards for traffic calming devices, there is a published guideline by the Institute of Traffic Engineers that addresses the installation of these devices. That guideline specifically recommends that traffic calming devices not be but upon the roadways or streets of fire station locations or primary response routes. City of Austin officials should move to adopt that position.

Recommendation # 12:

Require that traffic-calming programs for neighborhoods be voted upon and approved by a super majority of the residents.

To ensure a high level of public support, and a diminished level of dissatisfaction with the local government, all proposed traffic calming programs of neighborhoods should be approved with an overwhelming majority of residents. If the problem is legitimate and validated, then a large majority of residents will be willing to endorse the plan. If the problem is not as severe as perceived, then the chance of passage is much less. Based on this, local governments should require that approval for all neighborhood plans should be based on a two-thirds or three-fourths approval.

In many instances, less than 25 percent of the ballots are returned casting a vote. One can easily see that only a few people casting an affirmative or negative vote can well control the balloting. Establishing super majority approval levels helps reduce any controversy that could develop later whenever a simple majority threshold is tabulated. Such a large approval margin helps reveal the true sentiments of the residents, again allowing for better policy acceptance.

Recommendation #13:

Require objective evidence of material traffic problems before using traffic calming devices.

Most communities use the 85^{th} speed percentile mark to measure acceptable speed limits. Local governments should tie their installation requirements to pre-established thresholds for speed and volume. For example, a city might not install any devices unless the 85^{th} percentile was at least 5 mph over the posted speed limit. Another example may be 2,000 vehicles per day would make a street eligible for some type of diversion device. The establishment of these types of standards would allow traffic calming devices only where they would be fully warranted.

Recommendation #14:

Do not allow neighborhood project areas to have an established entitlement budget for a project.

Local governments that choose to have traffic calming programs should not allow citizens to pick and choose devices with accompanied budget limitations. Rather, they should obtain the device(s) that will yield the best result. When finance entitlements are introduced or revealed, citizen groups of neighborhoods have a tendency to try and solve the money problem "of making sure we get all that we are entitled to" by attempting to get the most devices rather than properly selecting and solving the traffic problem.

Recommendation #15:

Ensure that true public hearings are held for proposed traffic calming plans within neighborhoods to ensure openness for public debate and decision-making.

A formal public hearing format should be conducted within the neighborhood prior to residents voting upon a traffic-calming plan. This type of an established forum should be presented so that residents can hear first hand the advantages and disadvantages of traffic calming. Local government staff and policy makers should be on hand to help answer questions. Although one can expect tremendous debate at such a hearing, the resident will be exposed to more information to make an informed decision with, whether that information be pro or con.

Local governments should not adopt the "open house" forum used by the City of Austin. This forum allows only those with specific questions to come and visit with City staff or the members of the neighborhood committee who formulated the plan. They are not offered the opportunity to hear from those who may support/oppose the plan, nor is there an opportunity for those directly supporting/opposing the plan to address the remainder of undecided residents. A true public hearing forum, allowing all sides to be heard, is a basic principle of a free, open, participative, and democratic government.

Recommendation #16:

Evaluate and manage traffic calming programs with meaningful performance measurements.

Quality public policy programs of today must be constantly measured to determine their effectiveness and benefit. Traffic calming programs should be no exception. Traffic calming may be effective for the first six months or year after installation, but how does it compare two or three years later? This monitoring should be on going.

Of greater importance, is the establishment of success thresholds. What makes a successful traffic-calming program? Local governments should establish definitive methodologies that establish meaningful results. For example, the City of Austin desperately needs to modify their current measurement tool of reducing speed in project neighborhoods by 20 percent. At a posted speed of 30 mph, that is 6 mph. One would be hard pressed to consider that a meaningful result since the legal speed is set at 30 mph. However, this performance measurement could be meaningful when speeds are 40 mph on a neighborhood street instead of the posted 30 mph. Care should be taken to only report the reductions where they are above the speed limit.

Recommendation #17:

Conduct follow-up surveys one year after the installation of devices to determine the satisfaction level of the residents.

One of the central goals of traffic calming is to improve the quality of life and livability of the neighborhoods. However, very few cities if any attempt to measure this value. Failure to collect such data, could lead to continuance of a program that is viewed as another local government program that does not meet the needs of the people. Conversely, if the results of these surveys are positive, then strong reinforcement is established for the program to continue. Sustained public approval is a cornerstone for good public policy. Therefore, it is extremely important to measure resident satisfaction long after "newness" of the project wears off.

Recommendation #18:

Policy makers, whether appointed or elected, should base their public policy/program decisions upon fact not emotions.

Too many times, policy makers allow emotions from stakeholders to greatly influence their actions rather than relying on analytical facts and findings. Many local government staff members, as well as concerned citizens, whether pro or con, often commit an immense amount of time and effort to establish facts of a situation so that reasonable decisions can be deduced from these work products. The analyses conducted should be heavily incorporated into governance decisions.

If the data reveals that traffic calming is a better benefit than longer emergency service response times, then traffic calming should be adopted. Conversely, if more lives can be saved with unchanged or reduced emergency response times, then traffic calming initiatives should not be implemented.

In the case of Austin, Texas, there is clear evidence much more overall harm to the citizens would result from traffic calming than from the very limited benefits, if any, that it might produce. With emotion to the side, one can reasonably and prudently justify a policy decision to suspend the current traffic-calming program.

This recommendation can also be applied for other cities only after they have conducted a comprehensive policy analysis similar to the one contained in this report.

Appendix A

City of Boulder, Colorado

Neighborhood Traffic Mitigation Program

Tool Kit

(Adapted)

TRADITIONAL ENFORCEMENT

Definition
Sporadic monitoring of speeding and other violations by police.
Police officers can come out to a neighborhood for short periods of time to issue tickets.
Additionally, police officers can "take a neighborhood under their wing", and monitor traffic on a regular basis.

Temporary
Enforcement is always temporary.

Street Types
Enforcement can be performed on any street.
Logistics make some locations problematic or ineffective.
Mitigation can be initiated.

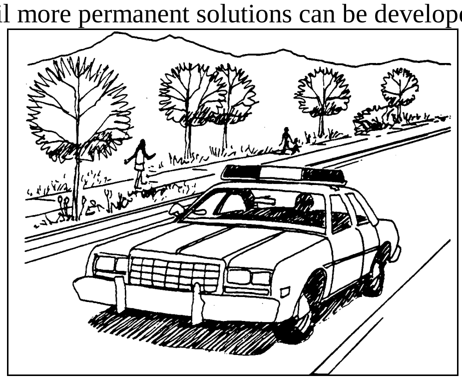
Best Used If
Excessive speed on a street and there is an urgent need for quick action.
Neighborhood is undertaking a Speed Watch program, is using the radar trailer or has newly installed mitigation measures.
Neighborhood is in design phase and needs interim assistance.

Benefits
Temporary good public relations tool.
Serves to inform public that speeding is an undesirable behavior for which there are consequences.

Don't Use If
Locations where it's physically impossible to pull vehicles over without creating a hazard.

Negatives
Effect is not permanent. Enforcement is an expensive tool (currently total cost recovery for enforcement does not exist).

Considerations
Enforcement should be regarded as supplemental to other measures, not the sole solution.
Enforcement should not be considered a permanent form of mitigation.
Used as a "quick fix" until more permanent solutions can be developed and implemented.



RADAR SPEED MONITORING TRAILER

<u>*Definition*</u>
Mobile radar display advises motorists of their speed.

<u>*Temporary*</u>
In place for several hours or days in given location.

<u>*Street Types*</u>
Acceptable for use of high or low volume two lane streets.

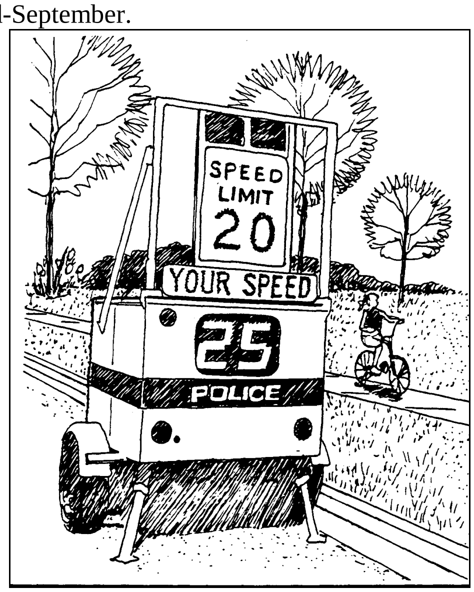
<u>*Best Used If*</u>
Excessive speed occurring.

<u>*Benefits*</u>
An educational tool.
Useful especially in school and construction zones where spot speed reduction is important.
Very good public relations tool.

<u>*Don't Use If*</u>
Very remote location. Extremely heavy traffic volume.

<u>*Negatives*</u>
Requires periodic enforcement.
Effective for limited duration.
Units moved frequently which requires manpower.

<u>*Considerations*</u>
Boulder has purchased a radar speed monitoring trailer.
Delivery is scheduled for mid-September.



EDUCATION

Definition:
Activities that change people's minds. Reading informative text, meetings & workshops with city staff, interaction with neighbors, signing campaign, enforcement activities, neighborhood speed watch, school programs, parent outreach, etc.

Brochures
Letters to the Editor
Newspaper ads & notices
Public Service Announcements
Bus Cards
Neighborhood Workshops/Discussions

Temporary
Education efforts can be flexible in duration.

Streets Types
Education can be applied in almost any situation.

Don't Use If
Education has already been seriously attempted with no significant results.

Negatives
May be difficult to measure effectiveness.
Can be expensive.
May take time to be effective.
May wear off over time.

Best Used For
A traffic problem that involves human behavior.

Benefits
Can be very effective, is relatively inexpensive, involves and empowers citizens, works well with other mitigation tools.

Considerations
Neighborhoods should share experiences with education methods.

NEIGHBORHOOD SPEED CONTROL PROGRAM

Definition
A neighborhood education process in which neighbors become more aware of the specifics of their speeding problems. Neighborhood representatives are loaned radar guns by the Police Department, to monitor speed and identify chronic speeders. The City will then send letters to offending drivers calling their attention to their behavior and requesting them to change it.

Temporary
Should be in place for two months or longer in order to gain maximum educational benefit.

Streets
More likely to be effective on local streets.

Best Used If
Neighborhood willingness to participate.
Most traffic is local traffic.
Neighborhood Speed Watch has not yet been attempted.

Benefits
Can effectively address traffic problems that are caused by neighbors.
Can heighten general awareness of neighborhood traffic concerns.
Can serve to unify neighborhoods.
Can be a good first step toward building consensus on physical mitigation measures.

Don't Use If
No willingness on the part of the neighborhood to participate.

Negatives
Not likely to be as effective on non-local traffic.
May make neighbors feel "spied on" by one another.

Considerations
Participation in Neighborhood Speed Watch will be limited to two neighborhoods at a time.
Training in use of the radar gun will be provided by the Police Department.
Neighborhoods representatives will be asked to sign an agreement to take proper care of the equipment and to use it only as specified by program guidelines.

Neighborhood
Speed
Watch

SPEED LIMIT SIGNS

Definition
Signs that inform drivers of the maximum safe driving speed under normal conditions.

Temporary
Can be tried for six months to test effectiveness.

Street Type
Any streets, but may be unnecessary on many low volume residential streets.

Best Used If
Clear need to inform drivers of the speed limit.

Benefits
Inexpensive.

Don't Use If
Neighborhood doesn't want the "visual pollution".

Negatives
Unattractive in neighborhoods. Does not effect vehicle speed.

Consideration
Posting of artificially low speed limits will require constant enforcement and breed disrespect for traffic control devices.

STOP SIGNS

Definition
Red hexagonal signs displaying the word "STOP". Stop signs are used to designate the right of way at intersections.

Temporary
Stop signs can be tried on a temporary basis. Before the signs are installed, the objectives for installation should be clearly defined. After 6 months, if the goals have been met and the neighborhood still wants the sign(s), the installation can be made permanent. If the objectives have not been adequately met, the signs will be removed.

Street Types
Stop signs are primarily used at low volume street intersections with high volume streets, or on all four approaches of an intersection with relatively equal volumes and/or a significant, correctable accident history.

Maintenance
Low maintenance.

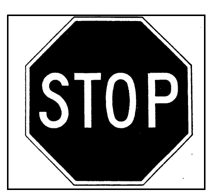
Best Used If
An unusually high number of accidents involving right of way.
Significant cross traffic at the intersection.

Benefits
Very inexpensive.
If there is a lot of cut though traffic, stop signs might work as a diversion.
Insignificant traffic volumes.

Don't Use If
Steep grades. Insignificant traffic volumes or insignificant history of correctable accidents.
Need and intention is for speed control.

Negatives
If there is not a significant amount of cross traffic at the intersection, compliance will not be compelled.
Cyclists and pedestrians relying on stop signs can be hurt, and accidents may increase.
Excessive use of stop signs renders them meaningless.
Stop signs don't decrease average speed. Increase noise and pollution.

Considerations
Most stop signs that are warranted for right-of-way control are already installed.
Neighborhoods can consider an appropriate use *of* stop signs as a possible mitigation tool in limited circumstances, but widespread installation *of* stop signs for speed control is ineffective and will not be supported.



PSYCHO-PERCEPTION

Definition

Any material or message placed around or in a street that heightens driver response or induces the desired behavior. Example is transverse markings (striping) with inconsistent spacing that gives the illusion of increased speed. Novelty signs and use of landscaping are other examples.

Street Type:

Can be tried on any type of street, although not all methods are appropriate to all streets.

Maintenance

Depends on technique.
Low for signs, higher for pavement markings and landscaping.

Best Used If

Neighborhood desire to try them.

Benefits

Gives the neighborhood an opportunity to be creative with their response to traffic concerns.
Can be aesthetically pleasing to the neighborhood.

Don't Use If

Specific technique has been proven dangerous or ineffective.

Negatives

Most psycho-perception tools are not likely to be effective in the long run, due to their dependence on novelty.

Considerations

It is important that psycho-perception tools make driving fast on the street seem less safe, but that they don't actually increase danger.

NEIGHBORHOOD IDENTIFICATION ISLAND, SIGN OR OBELISK

Definition
An island in the center of a street that includes a monument identifying a neighborhood and marks the entrance to the neighborhood or a sign, banner or other structure that helps to communicate a sense of neighborhood identity.

Temporary
Can be temporary but removal unlikely.

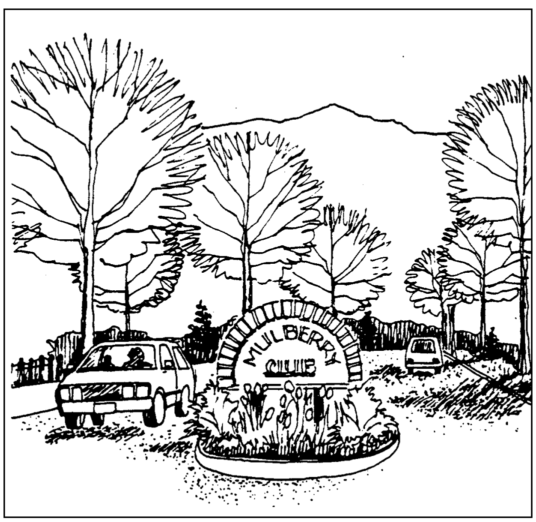
Street Type
Collector street or local street neighborhood entrance off of collectors or arterials.

Works Best If
Neighborhood boundary definition is desired.

Maintenance
Depends on type of installation.

Benefits
Alerts drivers that a change in their driving behavior is being requested.
Helps give neighborhood more of a sense of identity.
Allows neighborhoods creativity and participation in design.

Considerations:
A Neighborhood identification island is an entryway treatment that can be used most effectively in conjunction with other tools, if speed reduction is desired.



STREET CLOSURE

Definition
Street closed to motor vehicles using planters, bollards, or barriers, etc. Pedestrian and bike access maintained.

Best Used If
Other mitigation devices, i.e., speed humps, diverters would be inadequate.

Benefits
Eliminates cut-through traffic.

Don't Use If
Residents of immediate and adjacent neighborhood will not support restricted access.
Cannot substantially, adversely impact emergency vehicle response time.
Boulder's 1989 Transportation Master Plan opposes street closure unless extraordinary circumstances exist.
Conversion of street from public to private requires legal action; may need to grant easements for utilities, municipal services, etc.

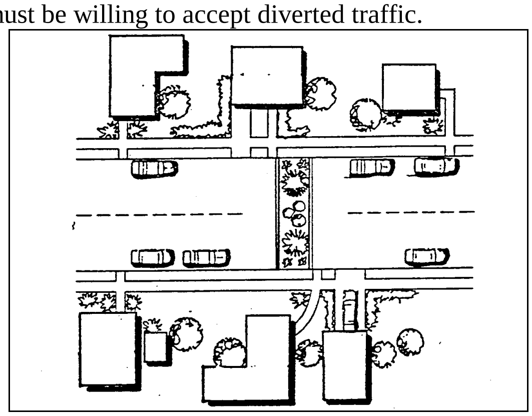
Negatives
May be perceived as inconvenience by some neighbors and an unwarranted restriction by general public.

Temporary
Can be installed temporarily.

Street Types
Low volume streets where alternative access to homes can be provided (i.e., by alleys) and a clearly more desirable and feasible route exists.

Maintenance
Landscaping.

Considerations
A large percentage of immediate neighborhood must want it.
Adjacent neighborhoods must be willing to accept diverted traffic.



DIAGONAL DIVERTERS

Definition
A barrier placed diagonally across a four legged intersection, interrupting traffic flow across the intersection. These barriers can be used to create a maze-like effect in a neighborhood.

Temporary
Can be tried on a temporary basis for 6-12 months.

Street Types
Neighborhood (local) streets.

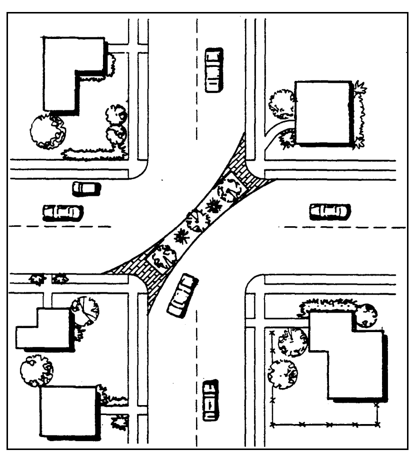
Best Used When
Cut-through traffic is the primary problem for the neighborhood.

Benefits
Practically eliminates cut-through traffic.
Maintains continuous routing opportunities (unless a cul-de-sac or street closure).

Don't Use If
No reasonable alternate routes available for both emergency response vehicles and through traffic.
Cut-through traffic is not a significant issue.

Negatives
People can turn at higher speeds because there is no opposing traffic.
May reduce emergency routing opportunities.
May increase trip length for some residents.

Considerations
These barriers should be traversable for bikes and pedestrians.
Likely to increase traffic on adjacent streets, so should be considered only where appropriate alternatives are available.



TRAVERSABLE BARRIERS

Definition
A barrier placed across any portion of a street that is traversable for bikes, pedestrians, roller bladers, and emergency vehicles, but not for other motor vehicles.

Temporary
Can be tried on a temporary basis for 6-12 months.

Street types
Low volume streets with cut-through traffic.

Maintenance
Landscaping.

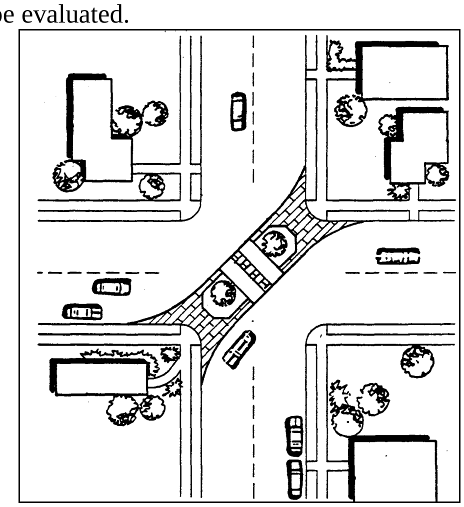
Best Used If
Cut-through traffic on a street that should be low volume.

Benefits
Reduces cut-through traffic..

Don't Use lf
No appropriate facility for diverted traffic.

Negatives
If not enforced regularly, parked cars may block access.
Depending on design, may be subject to violation by unauthorized vehicles.
Altered traffic patterns may increase trip length.

Considerations
Diversion onto neighboring streets needs to be analyzed.
Cut-through traffic needs to be evaluated.



ONE-WAY STREETS

Definition
Self-explanatory.

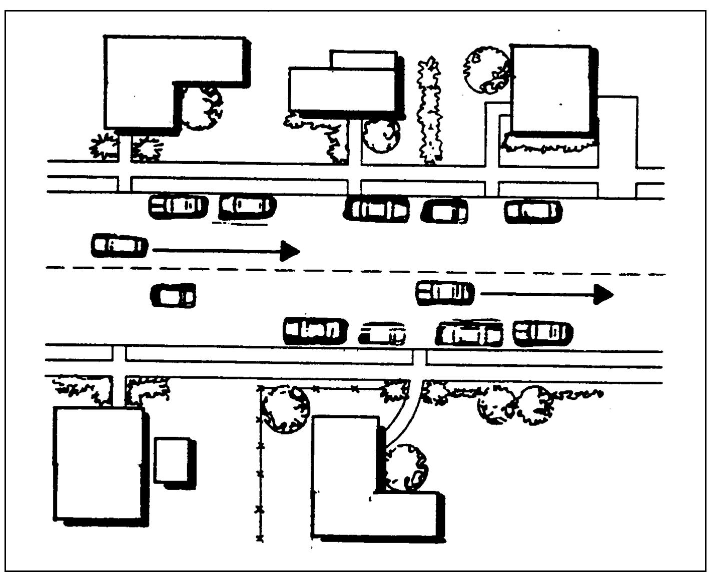
Temporary
Can implement on temporary basis (6 mo.) to ascertain if benefits outweigh disadvantages.

Best Used If
There's a need for parking on both sides of a narrow street. Pedestrian safety is a significant concern.

Benefits
Tend to be safer due to lack of friction from opposing traffic flow.
Can facilitate traffic flow through an area.
Can open up narrow street for more resident parking.
Increases pedestrian safety. Maintain reasonable access for emergency vehicles.
Maze effect of one-way streets can discourage through traffic.

Don't Use If
Generally need to provide one way streets in pairs, which is frequently not possible in a neighborhood setting.

Negatives
Can lead to increased vehicle speeds.
May result in longer trip length.
May increase emergency response time.



DROP-OFF ZONE FOR SCHOOLS

Definition
A zone placed at least two blocks from a school for parents to drop their kids off, in order to reduce traffic congestion around the school. Each school should have several zones to disperse traffic.

Temporary
May be tried on a temporary basis.

Street Types
Streets surrounding schools.

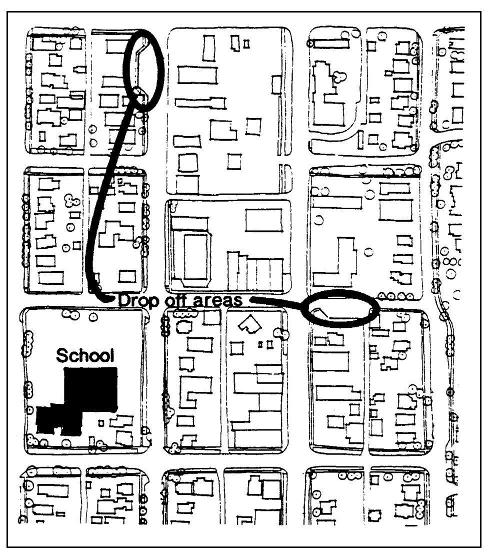
Best Used If
Problems with traffic congestion around schools.
Feasible, safe drop off locations.

Benefits
Would decrease congestion immediately adjacent to the school, increasing safety.
Would encourage walking.

Don't Use If
No drop off areas available that don't pose significant hazards for children or drivers.

Negatives
If not well considered, could simply displace congestion/hazards to another location.

Considerations
Adequate communication and support for parents and kids to make the change would be essential to the success of this concept.



SPEED HUMPS

Definition
Speed humps are wave-shaped paved humps in the street. The height of the speed hump . determines how fast it can be navigated without causing discomfort to the driver or damage to the vehicle. Discomfort increases as speed over the limit increases.

Temporary
Speed humps are impractical to install on a temporary basis.

Street Types
Speed humps are generally considered local street tools.
Applications on collector streets need to be very carefully evaluated.

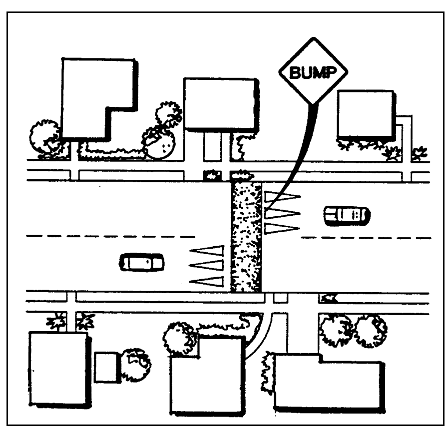
Maintenance
Well constructed humps should maintain their shape for several years, however the striping associated with them must be maintained biennially.

Best Used If
The street has a documented speeding problem.
"Soft" approaches have proven ineffective.

Benefits
Slows traffic.
Few drivers travel over speed humps with excessive speed more than once.
"Self enforcing."
Relatively inexpensive.

Don't Use If
The street is on a major emergency vehicle route and no reasonable alternative is available.
Steep grades.

Negatives
Can increase voice and air pollution by the hump (however, less negative impact than a stop sign).



RAISED INTERSECTIONS

Definition
A raised plateau of roadway where roads intersect. The plateau is generally about 4' higher than the surrounding streets.

Temporary
No temporary installations of raised intersections.

Street Types
Can be used on high or low volume streets.

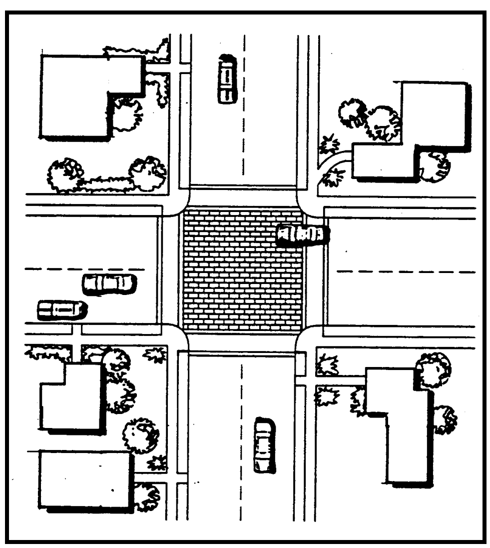
Best For
High pedestrian volumes with significant safety concerns.
Significant, excessive vehicle speed.

Benefits
Effective speed reduction, better for emergency vehicles than speed humps..
Aesthetically pleasing if well designed.
Excellent pedestrian safety treatment.

Don't Use If
Critical emergency vehicle route.

Negatives
Expensive.
Not as good as a flat street for emergency vehicles.

Considerations
Transit concerns will need to be identified and worked through.



RAISED CROSSWALKS

Definition
A speed hump designed as a pedestrian crossing.

Temporary
No.

Street Type
Can be used on medium and low volume streets.

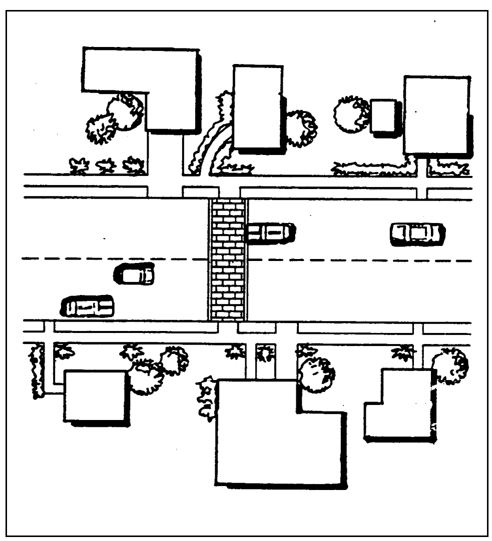
Don't Use If
Important emergency vehicle route.

Negatives
Negative impact on emergency vehicles if on primary emergency vehicle routes.

Best Used If
High volume of pedestrians.
Vehicle speed is a concern.

Benefits
Effective speed control at the installation.
Excellent pedestrian amenity.

Considerations
City will need to negotiate with RTD for acceptance of speed humps, raised crossings and intersections on bus routes. Not immediately implementable on these streets, but expect to be used in the future.



RUMBLE STRIPS

Definition
Patterned sections of rough pavement, which alert drivers to a dangerous condition of traffic control measure.

Temporary
No feasible temporary installation.

Street Types
Use of high or low volume streets.

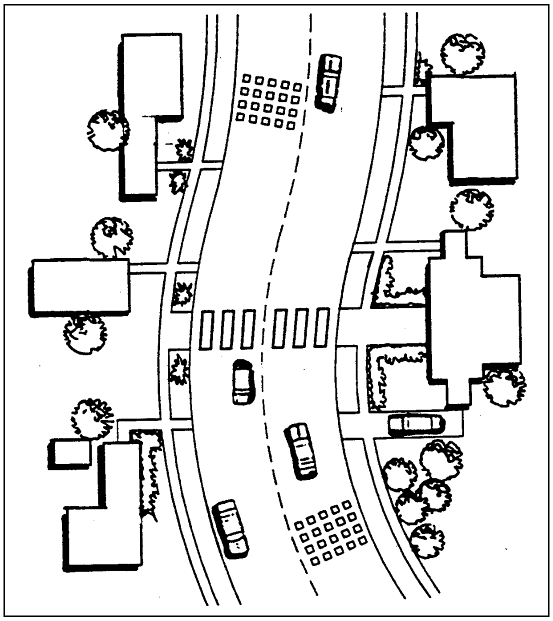
Maintenance
Snow removal equipment tends to damage them.

Best Used At
Concealed stop sign or pedestrian crossing.

Benefits
Relatively inexpensive to install.

Don't Use If
Rarely will rumble strips be the most appropriate tools.

Negatives
High maintenance. Adversely impact bicyclists. Generally ineffective in reducing vehicle speeds. Rumble strips are noisy by design, and not recommended for neighborhood settings.



DEVIATIONS

Definition:
Deviations redraw the path of travel so that the street is not straight (by the installation of offset curb extensions).

Temporary
May be tried on a temporary basis for 6-12 months.

Street Types
Any street with adequate right-of-way.

Maintenance
Landscape maintenance will constitute an ongoing expense.

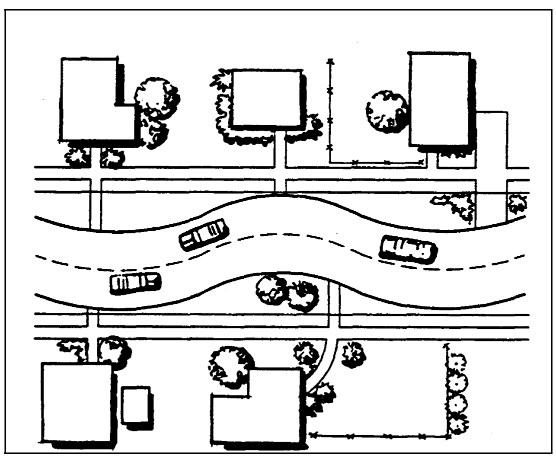
Best Used For
Excessive speed on straight street.
Adequate right-of-way exists to alter curbline.

Benefits
Accepted by public as speed control devices.
Aesthetically pleasing.
Reduce speed without significantly impacting emergency response.

Don't Use If
Roadway is already narrow.

Negatives
Expensive.

Considerations
Deviations are not very effective unless significant offsets are created.
Neighbors may be responsible for landscape maintenance.



LANE NARROWING

Definition
A lane physically narrowed to nine to eleven feet, expanding sidewalks and landscaped areas, adding medians, 'sideians', on street parking, etc.

Temporary
Can be tried on a temporary basis for 6-12 months.

Street Types
Appropriate for most street type

Maintenance
Landscape maintenance. (May need to involve neighborhood participation.)

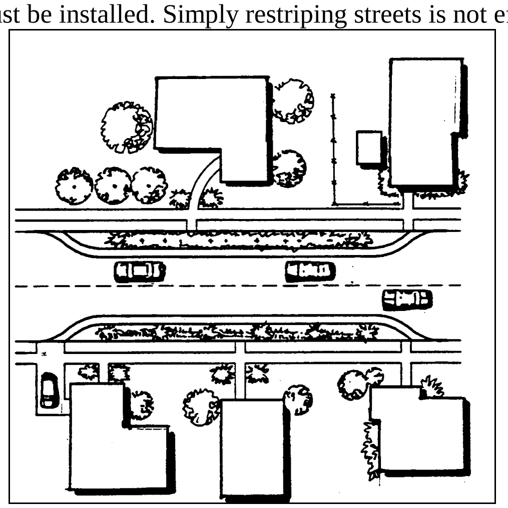
Best Used If
Excessive speed due primarily to street width.

Benefits
Good for pedestrians due to shorter crossing distance.
Slows traffic without seriously affecting emergency vehicle response time.

Don't Use If.
No possibility of eliminating on street parking.
Inadequate right-of-way to do a safe, effective treatment.

Negatives
Can be dangerous for bikes.

Considerations
For lane narrowing to slow cars, it helps to include visual distractions, such as bushes, trees, transverse markings, and other psycho perception techniques.
May increase accident potential because opposing vehicle streams are brought closer together.
Physical restrictions must be installed. Simply restriping streets is not effective.



CHOKERS: (TRAVEL BOTH WAYS)

Definition
Large lamb chop-shaped islands installed at the intersection to reduce speed. Two lanes of travel are maintained, but lanes are narrow. Bike lanes are maintained outside of the choker, on both sides.

Temporary
Chokers can be tried on a temporary basis for 6-12 months.

Street Types
Chokers will work best on low to medium volume neighborhood streets.

Maintenance
Care needs to be taken by maintenance to keep snow out of the bike and ped lanes.

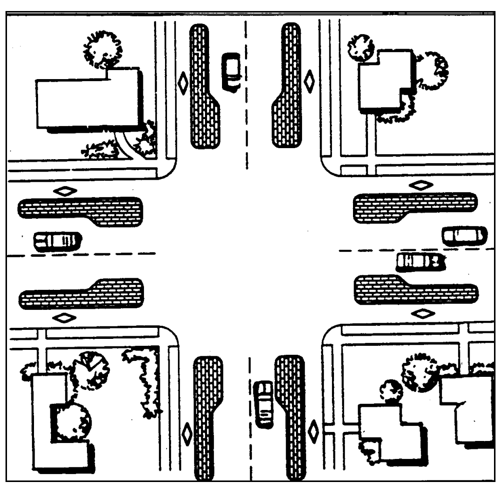
Best For
Neighborhood that desire significant slowing at an intersection.
Pedestrian safety concern at the intersection.
Bike safety concern at the intersection.

Don't Use If
The street is a snow route.

Benefits
Straight access for bikes.
Crossing distance is reduced for pedestrians.
Traffic is slowed at the intersection, possibly reducing accidents.

Negatives
Snow removal is complicated, especially in the bike lanes.

Considerations:
The bike lanes and choker should be well marked. The bike lanes should be wide enough for bike trailers.



LANE ELIMINATING CHOKER (mid-block)

Definition
Large lamb chop shaped islands placed mid-block on either side of a street to reduce street width to one lane. Cars may travel in either direction, but must queue and takes turns. Bike lanes are maintained on the outer sides of the choker.

Temporary
Chokers can be tried on a temporary basis for 6-12 months.

Street Types
Chokers will work best on low volume neighborhood streets.

Maintenance
Care needs to be taken by maintenance workers to keep snow out of the bike/ped areas.

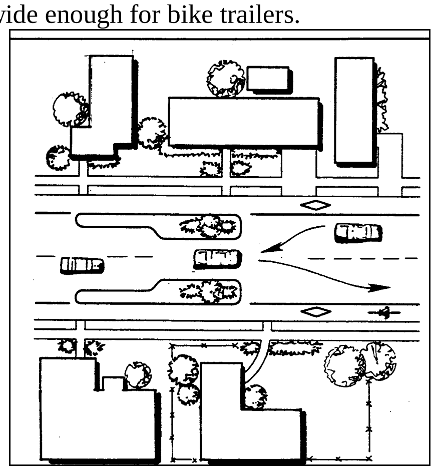
Best Used On
Low volume neighborhood streets with speed and/or cut-through traffic problems.

Benefits
Straight access for bikes.
Crossing distance is reduced for pedestrians.
Likely to reduce cut-through traffic and speed.

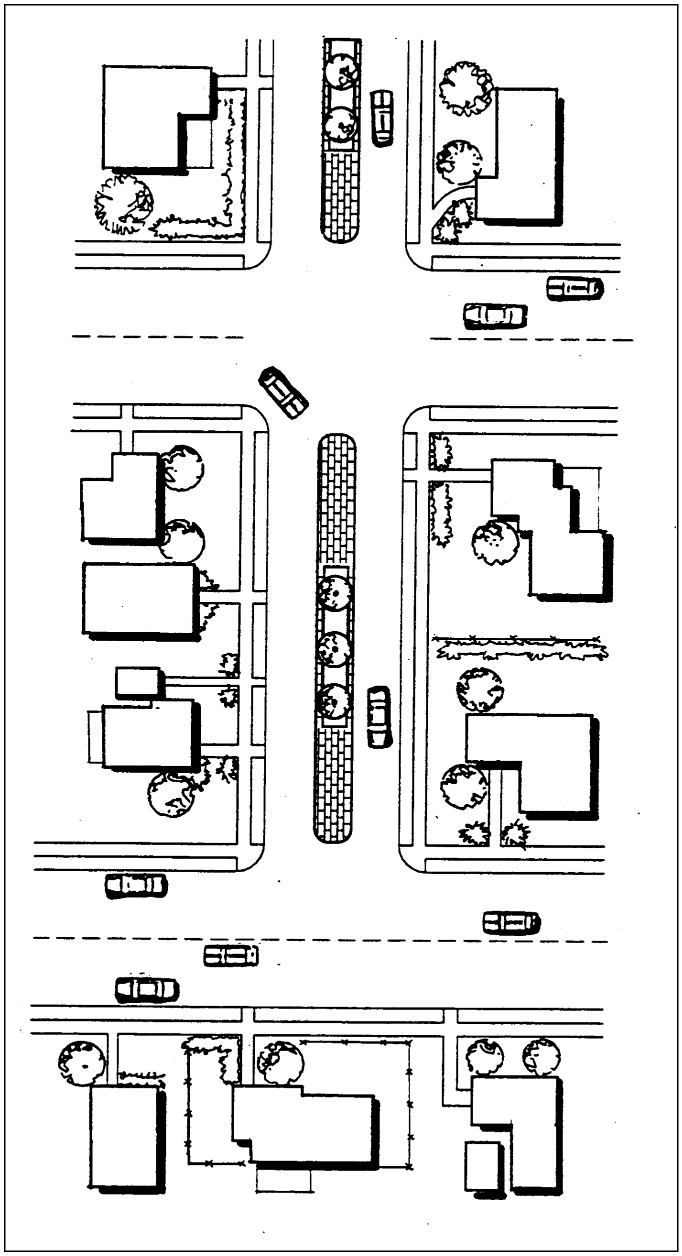
Don't Use If
High volume location.
The street is a snow route.

Negatives
Expensive if drainage issues involved.

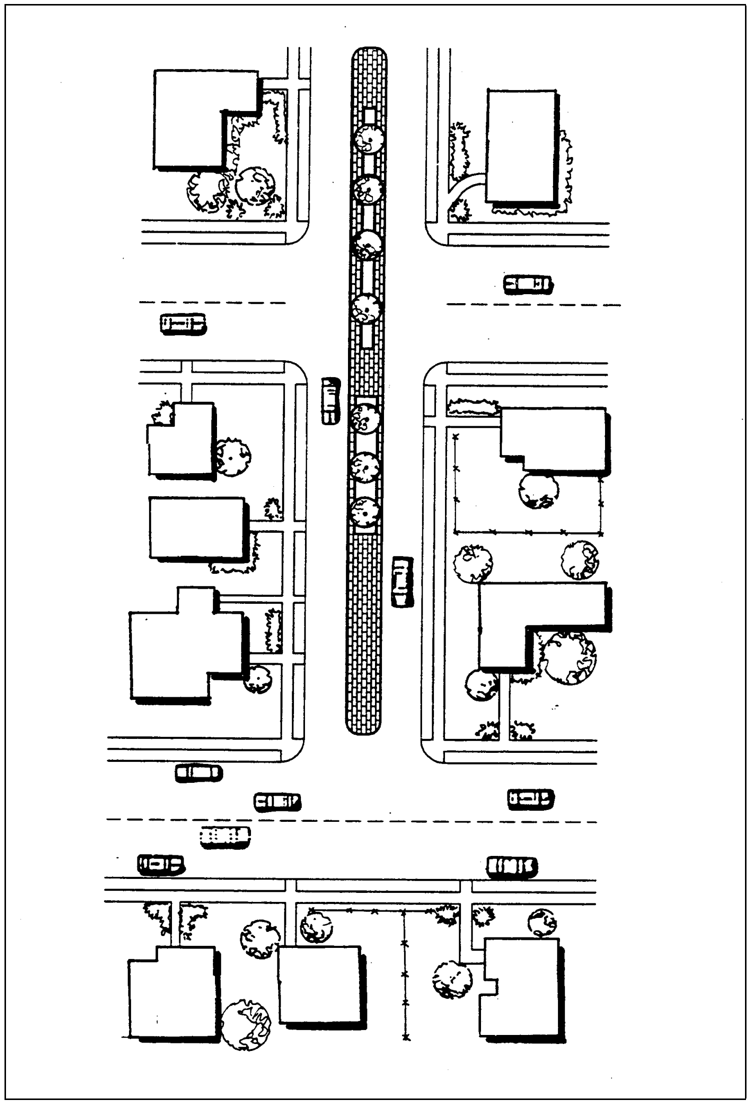
Considerations:
Adequate public information should be provided, since this is a new treatment for Boulder.
The bike lanes and choker should be well marked.
The bike lanes should be wide enough for bike trailers.

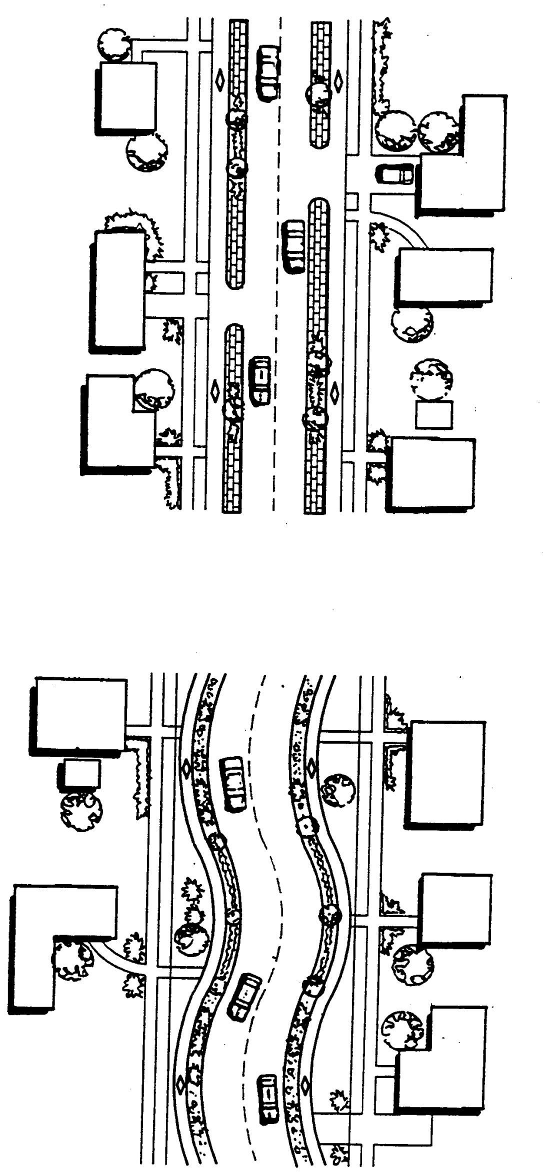


Median at center of roadway



Median barrier





NECKDOWNS

Definition
Physical reduction of road width at intersections or mid block. Neckdowns differ from chokers in that they are attached to the curb and do not maintain an 'at grade" bike lane lateral to the neckdown.

Temporary
Can be tried on a temporary basis.

Street Types
Appropriate for most street types.

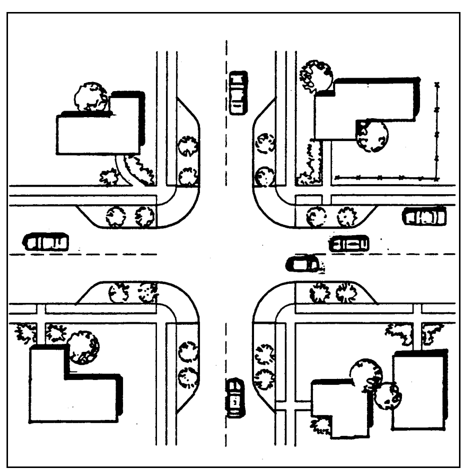
Best Used
Where speed and/or volume make pedestrian safety a concern.
In conjunction with other physical mitigation tools.

Benefits
Reduce road surface/ crossing distance.
Can add aesthetically if landscaped.

Don't Use If
The street is an established bike route.

Negatives
Can be bad for cyclists, if not designed to accommodate them. Unless the neckdown significantly reduces road width (i.e. not just eliminates parking spaces or bike lanes) neckdowns do not affect speed.

Considerations
Neckdowns alone are a pedestrian amenity, however they must be used in conjunction with other mitigation tools to be effective for speed reduction.



REALIGNED INTERSECTIONS

Definition
Starting with a T intersection of a side street into a larger through street, the realigned intersection interrupts the traffic flow on the larger street by curving it into the side street.

Temporary
Not feasible as a temporary installation.

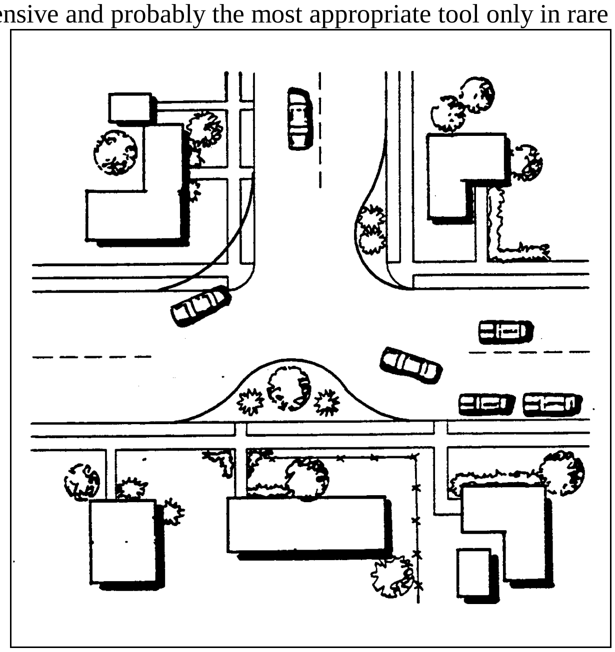
Best Used If
Enough traffic to reprioritize traffic flow.

Benefits
Slows traffic when realignment is significant.

Don't Use If
No level of additional traffic on the side street is acceptable.
Low volume street.

Negatives
Much more expensive than a stop sign.
May encourage increased traffic volume on the affected side street.
If not drastic enough, cyclists and cars may ignore the stop signs at the realigned intersection.

Considerations
Treatment is very expensive and probably the most appropriate tool only in rare conditions.



TURN PROHIBITIONS

Definition:
Physical barriers or signs ("No Right Turn," "No Left Turn," "Do Not Enter") that prohibit a particular turning movement.

Temporary
Can be installed experimentally or used during limited hours, such as rush hours or school hours.

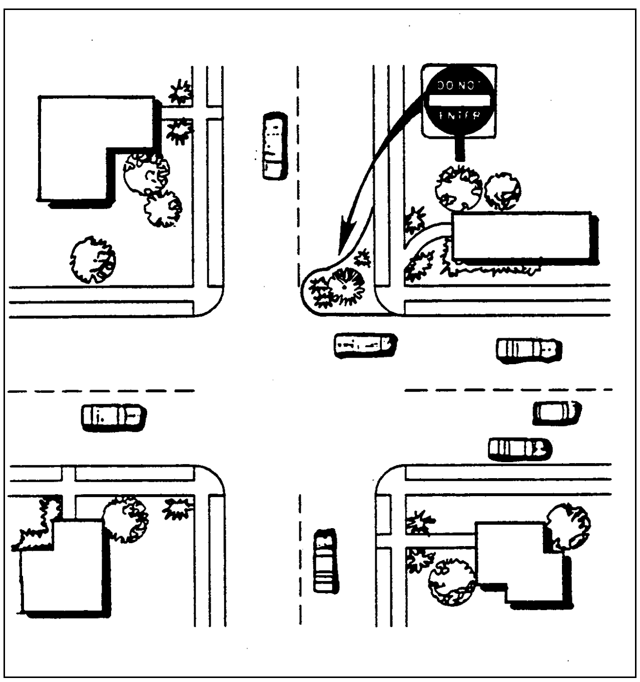
Street Tunes
Local streets or major, paired arterials.

Best Used If
Significant cut-through traffic.
Need to eliminate two way conflicts.

Benefits
Reduces cut-through traffic in neighborhoods.

Don't Use If
Neighborhood unwilling to limit its own access. No appropriate alternative facility.

Negatives
May increase trip length due to revised trip patterns.



SEMI-DIVERTERS

<u>*Definition*</u>
Physical blockage of one direction of traffic at one point on an otherwise two way street. The open lane of traffic is signed "One way", that is, traffic from the blocked lane is not allowed to go around the barrier through the open lane.

<u>*Temporary*</u>
Semi-diverters can be tried on temporary basis.

<u>*Street Types*</u>
Better on low volume streets.

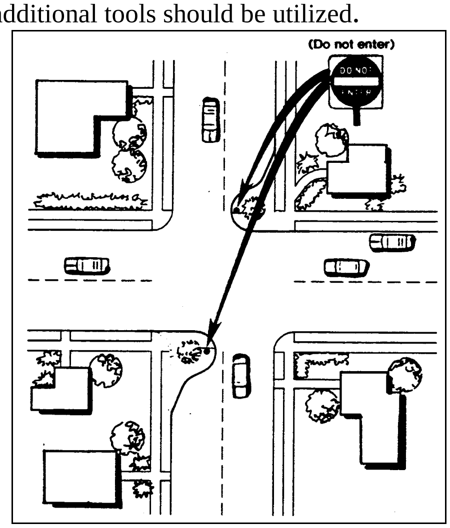
<u>*Best Used If*</u>
Neighborhood has cut through traffic, and there is an appropriate alternative route for blocked cut through traffic.

<u>*Benefits*</u>
Do not present a significant obstacle to emergency vehicles.
Good for limiting one-way cut-through traffic.
Can be designed to provide two-way access for bicycles.

<u>*Don't Use If*</u>
No cut-through traffic.
No good alternate route for diverted traffic.

<u>*Negatives*</u>
Compliance with semi-diverters is not 100%.
May increase trip length for some residents.

<u>*Considerations:*</u>
If speed reduction is desired, additional tools should be utilized.



FORCED TURN BARRIERS

Definition
Traffic islands installed to prevent or ensure certain turning movements at an intersection.

Temporary
May be tried on a temporary basis for 6-12 months.

Street Types
Primarily used to direct traffic off of local streets.

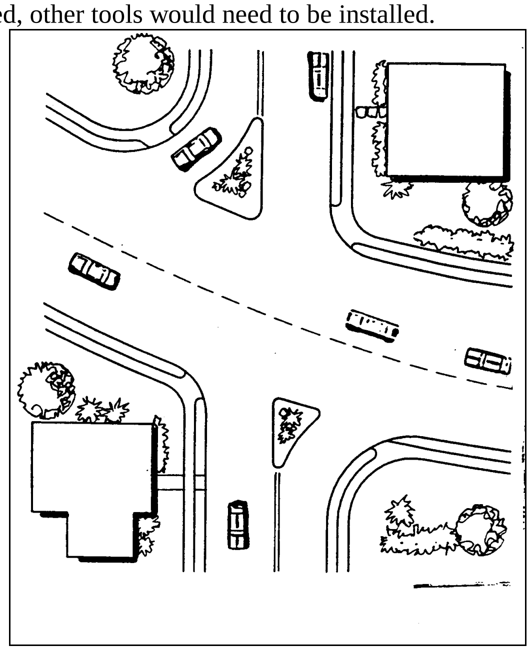
Best For
Cut-through traffic.

Benefits
Changes driving patterns. May significantly reduce cut-through traffic.

Don't Use If
Emergency response access is unacceptably hampered.

Negatives
May increase trip length for some drivers.

Considerations
If speed reduction is desired, other tools would need to be installed.



TRAFFIC CIRCLES

Definition
Traffic circles are raised circular areas (like medians) placed in an existing intersection. Drivers travel in a counter-clockwise direction around the circle. Traditional circles are “yield upon entry,” meaning that cars in the circle have the right of way and cars entering the circle must wait to do so until the path is clear. When a traffic circle is placed in an intersection, no automobile can travel in a straight line.

Temporary
Can be tried on a temporary basis, using essentially "portable" materials. The traffic circle should be made permanent or removed within 12 months.

Street Types
Traffic circles can be use on high and low volume streets.

Best Used If
Insufficient gaps for cross street traffic to traverse or access the higher volume street.
A speeding problem exists.

Benefits

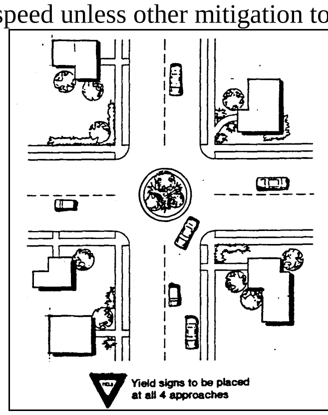
Reprioritizes traffic to increase accessibility for local residents.
Cross traffic may become a mitigation tool in itself.

Don't Use If
Creation of gaps is the primary motivation for pursuing mitigation.

Negatives
May make pedestrian crossing more confusing at the intersection

Considerations
Special consideration to bike and pedestrian safety must be given if traffic circles are installed in high volume intersections .

Traffic circles may not reduce speed unless other mitigation tools are present on the street.



Appendix B

Environmental Impacts to Air Quality

Summary Results From Automobile Emission Case Studies

Related to Traffic Calming Devices

Table B.1

Automobile Emission Case Studies

For Area Wide Traffic Calming Schemes

Area Wide Calming							
			Changes in Vehicle Emissions				
Country	***Measures***	***Vehicle Type***	***NOx***	***HC***	***CO***	***FC***
Germany	Area with extensive traffic calming	Non-catalyst	-38 to 60%	-10 to –25%	+71 to +7%	+19 to +7%
	30 km/h zone	Non-catalyst	-5 to –31%	+2 to –23%	+28 to –20%	+14 to –6%
Holland	Road humps	N/A	Decrease	No Change	Slight increase	N/A
	Extensive Calming	N/A	Decrease	Increase	Increase	N/A

Notes:
NOx: Nitrous Oxide
HC: Hydrocarbon compound
CO: Carbon Monoxide
F.C. Fuel Consumption

Source: Adapted from P.G. Boulter and D.C. Webster, "Traffic calming and vehicle emissions: A literature review, TRL Report 307", (Crowthorne, UK: Transport Research Laboratory, 1997), p.26.

Table B.2

Automobile Emission Case Studies

For Single Road Traffic Calming Schemes

Single Road Sections			Changes in Vehicle Emissions			
Country	***Measures***	***Vehicle Type***	***NOx***	***HC***	***CO***	***FC***
United Kingdom	Road humps, 75 m spacing, 30 mph "before"	Catalyst & Non-Catalyst	0 to –20%	+110 to +70%	+80 to +70%	+60 to +50%
Sweden 1	30 km/h limit	N/A	+1%	N/A	+2%	+<1%
Sweden 2	1 Road hump constant "before" speed	Catalyst	+18%	N/A	+20%	+4%
		Non-catalyst	+22%	N/A	+11%	+5%
	10 Road humps constant "before" speed	Catalyst	Three-fold increase	N/A	Three-fold increase	+37%
		Non-catalyst	Three-fold increase	N/A	Two-fold increase	+51%
Denmark	40 km/h limit, various calming	N/A	N/A	N/A	N/A	-9%
Austria	6 Road humps, 200 m spacing, 30 km/h "before"	Catalyst	Ten-fold increase	N/A	Three-fold increase	+25%
Australia	5 Road humps, 100 m spacing, 50 km/h "before"	N/A	N/A	N/A	N/A	+73 to +36%
	2 Traffic Circles, 250 spacing 50 km/h	N/A	N/A	N/A	N/A	+33%

Source: Adapted from P.G. Boulter and D.C. Webster, "Traffic calming and vehicle emissions: A literature review, TRL Report 307", (Crowthorne, UK: Transport Research Laboratory, 1997), p.26.

Appendix C

City of Austin, Texas

Pedestrian/Bicyclist Fatality Data

1997-1999

Table C.1

1997 Pedestrian Fatalities

Austin, Texas

Date	Offense No.	Location	Circumstances	Classification	Sex	Age
3/9/97	970680431	9300 blk US Hwy 290 E	Pedestrian in Roadway	Pedestrian	Male	
5/9/97	971290205	70 blk N IH 35 SB	Pedestrian in Roadway	Pedestrian	Male	21
5/17/97	971371776	1800 blk E Ben White Blvd	Unsafe movement-left	Pedestrian	Female	45
6/11/97	971620455	200 blk Robert T Martinez Jr	Pedestrian in Roadway	Pedestrian	Female	88
8/3/97	972150883	9414 blk N Lamar Blvd	Alcohol- speed	Pedestrian	Male	40
8/6/97	972180246	4800 blk N IH 35 WF	Failure to control speed-follow too closely	Pedestrian	Female	21
8/15/97	972271876	2200 blk Airport Blvd	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	34
8/25/97	972370998	9000 Burnet Rd	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	27
9/4/97	972470257	2203 W 35th St	Inattention pedestrian in roadway	Pedestrian	Female	56
10/13/97	972861251	4800 blk S Congress Ave	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	43
10/24/97	972971552	500 blk Bastrop Hwy	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	60
11/10/97	973141358	8100 blk US 290 East	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	49
11/11/97	973151198	9700 blk Greathills Trail	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	54
12/12/97	973461187	Lamplight Village and Alderbrook	Defective equipment	Pedestrian	Male	21
12/19/97	973531627	2300 blk E Riverside Dr	Failure to control speed	Pedestrian	Male	35
	Denotes Neighborhood Street					

Source: Austin Police Department, Planning & Research Section

Table C.2

1998 Pedestrian Fatalities

Austin, Texas

Date	Offense No.	Location	Circumstances	Classification	Sex	Age
1/3/98	980031570	30 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	33
1/25/98	980251693	6500 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	16
1/31/98	980311406	4700 blk E Ben White	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	77
3/22/98	980811446	4500 blk S IH 35 WF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	31
3/25/98	980840267	12100 blk N IH 35 EF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	6
6/14/98	981651499	S IH 35 EF and E Riverside Dr	Ran Red light	Bicyclist	Male	24
7/4/98	981850238	E 7th and Chalmers	Alcohol- speed; failure to control	Bicyclist	Male	35
7/13/98	981940268	1600 blk E Parmer Lane	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	49
8/12/98	982241204	E 10th and Chicon	Failure to yield ROW from stop sign	Bicyclist	Female	11
10/2/98	982751413	West MLK and Lavaca	Failure to yield ROW red light	Bicyclist	Male	24
10/17/98	982901179	4100 blk Victory Dr	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	67
10/23/98	982961489	12000 blk N IH 35 WF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	59
10/24/98	982971382	4700 blk S Congress	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	37
11/15/98	983191499	7200 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	43
11/21/98	983251254	2500 blk Parmer Lane	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	43
12/12/98	983461341	8700 blk N Lamar Blvd	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	49
12/16/98	983501392	8600 blk N Mopac	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	63
	Denotes Neighborhood Street					

Source: Austin Police Department, Planning & Research Section

Table C.3

1999 Pedestrian Fatalities

Austin, Texas

Date	Offense No.	Location	Circumstances	Classification	Sex	Age
1/1/99	990010526	7500 blk SW Pkwy	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	34
2/14/99	990451600	7600 blk S IH 35 SB	Pedestrian in Roadway	Pedestrian	Male	42
2/19/99	990500904	2100 blk Burton Dr	Alcohol- speed	Pedestrian	Female	8
2/28/99	990590062	8500 blk S IH 35 EF	Unsafe movement-fsra	Pedestrian	Male	46
3/18/99	990770025	8700 blk S IH 35 EF	right	Pedestrian	Male	34
3/22/99	990811190	4600 blk W. Wm Cannon	Failure to yield ROW to ped in crosswalk	Pedestrian	Female	79
3/27/99	990860318	500 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	
4/10/99	991001434	Parmer/ Lamplight Village	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	38
4/17/99	991071431	2600 blk S IH 35	Pedestrian crossing where prohibited	Pedestrian	Male	34
4/29/99	991190175	6300 blk S IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	39
6/5/99	991560087	4000 block N IH 35	Pedestrian crossing where prohibited	Pedestrian	Male	23
6/7/99	991581496	700 E. Rundberg La	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	52
8/9/99	992210753	1000 Bastrop Hwy	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	37
8/10/99	992221295	Dr	Pedestrian crossing against light	Pedestrian	Male	49
	Denotes Neighborhood Street (Note: No fatalities occurred on neighborhood streets in 1999)					

Source: Austin Police Department, Planning & Research Section

Table C.4

Pedestrian Fatalities For Analysis Period

December 1, 1997 thru November 30, 1998

Austin, Texas

Date	Offense No.	Location	Circumstances	Classification	Sex	Age
12/12/97	973461187	Lamplight Village and Alderbrook Dr	Defective equipment	Pedestrian	Male	21
12/19/97	973531627	2300 blk E Riverside Dr	Failure to control speed	Pedestrian	Male	35
1/3/98	980031570	30 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	33
1/25/98	980251693	6500 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	16
1/31/98	980311406	4700 blk E Ben White	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	77
3/22/98	980811446	4500 blk S IH 35 WF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	31
3/25/98	980840267	12100 blk N IH 35 EF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	6
6/14/98	981651499	S IH 35 EF and E Riverside Dr	Ran Red light	Bicyclist	Male	24
7/4/98	981850238	E 7th and Chalmers	Alcohol- speed; failure to control	Bicyclist	Male	35
7/13/98	981940268	1600 blk E Parmer Lane	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	49
8/12/98	982241204	E 10th and Chicon	Failure to yield ROW from stop sign	Bicyclist	Female	11
10/2/98	982751413	West MLK and Lavaca	Failure to yield ROW red light	Bicyclist	Male	24
10/17/98	982901179	4100 blk Victory Dr	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	67
10/23/98	982961489	12000 blk N IH 35 WF	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Female	59
10/24/98	982971382	4700 blk S Congress	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	37
11/15/98	983191499	7200 blk N IH 35	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	43
11/21/98	983251254	2500 blk Parmer Lane	Pedestrian failure to yield ROW to motor veh.	Pedestrian	Male	43

Denotes Neighborhood Street

Source: Austin Police Department, Planning & Research Section

Appendix D

Austin/Travis County Zip Code Data

Sudden Cardiac Arrest Frequency

&

Austin Fire Department

Medical Emergency Response Times

Table D.1

Austin/Travis County Zip Code Data

Data for Zip Codes Complety Inside The Austin City Limits

SCA Cases	*Zip Codes*	*Response Time*
8	78701	2.46
25	78702	3.44
10	78703	3.52
25	78704	3.24
11	78705	2.83
15	78721	3.54
10	78722	3.61
38	78723	3.81
14	78731	3.88
22	78741	3.89
6	78751	2.99
16	78752	3.67
8	78756	2.61
17	78757	3.44
22	78758	3.74
247	**Total Inside City**	

Data for Zip Codes Partially Inside The Austin City Limits

SCA Cases	*Zip Codes*	*Response Time*
2	78610	9.60
0	78613	4.27
11	78617	4.44
2	78652	7.18
4	78653	3.32
8	78660	5.06
0	78717	5.70
3	78719	3.88
9	78724	4.34
2	78725	5.32
1	78726	6.79
10	78727	3.49
4	78728	4.77
2	78729	4.45
4	78730	4.81
1	78732	14.15
2	78733	5.18
2	78735	4.98
2	78736	4.92
3	78737	7.65
1	78739	7.23
2	78742	5.13
17	78744	3.85
37	78745	3.54
12	78746	4.59
5	78747	4.60
6	78748	4.32
5	78749	4.43
8	78750	4.72
16	78753	3.90
4	78754	4.58
20	78759	4.13
205	**Total Partially in City**	

(10 of these SCA cases are not AFD responses)

Data for Zip Codes Complety Outside The Austin City Limits

SCA Cases	*Zip Codes*	*Response Time*
4	78641	No Data
7	78645	No Data
1	78654	No Data
1	78706	No Data
3	78734	No Data
2	78738	No Data
16	No Zip	No Data
34	**Total Outside City**	

Summary of Austin Fire Department Responses to SCA

247	**Total Inside City**
195	**Total Partially in City**
442	**TOTAL AFD RESPONSES**

***Average Austin Fire Department Response Times* for All Zip Codes**

3.62 ***Minutes***

Notes:
SCA Data from Austin/Travis County EMS Utstein Report on Cardiac Arrest (12-1-97 11-30-98)
All Response Times are for the AFD;reported by the AFD Administration Division (12-1-97 to 11-30-98)
"No Data" - this zip code was not in the response area of AFD; first responder by County FD's

Appendix E

Response Time Model Analyses

For the City of Austin, Texas

Table E.1 Summary of All SCA Models

Risk Analysis Model for Victims of Sudden Cardiac Arrest
From Response Delays Due to Traffic Calming Devices

Name of Emergency Service Agency	***Date of Analysis***	***Analysis Period***
Austin Fire Department	*03/01/00*	*12-7-97 to 11-30-98*

Current FD Incident Information		**Cardiac Arrest**	**Installation of Traffic Calming Devices and Changes in Arrival Time**						**Estimated Risk Utilizing Arrival Probability X Survival Probability**				
Midpoint	**1998**	**Probable**	*By Percentage*		*By Devices On Route*				*1998*	*% Changes*		*Device Delays*	
of Arrival Interval	**Arrival Fraction**	**Survival Fraction**	14%	-14%	0.085	A	0.085	B	*Arrivals*	14%	-14%	A	B
						#		#				0.085	0.085
0.50	0.018	0.91	0.070	-0.070	0.26	3	0.43	5	0.016	0.016	0.016	0.016	0.016
1.50	0.067	0.86	0.210	-0.210	0.26		0.43		0.058	0.057	0.059	0.056	0.055
2.50	0.205	0.77	0.350	-0.350	0.26		0.43		0.157	0.149	0.165	0.151	0.147
3.50	0.269	0.62	0.490	-0.490	0.26		0.43		0.167	0.134	0.190	0.151	0.139
4.50	0.209	0.33	0.630	-0.630	0.26		0.43		0.070	0.035	0.111	0.053	0.044
5.50	0.107	0.11	0.770	-0.770	0.26		0.43		0.012	0.008	0.028	0.010	0.009
6.50	0.054	0.07	0.910	-0.910	0.26		0.43		0.004	0.002	0.006	0.003	0.003
7.50	0.027	0.03	1.050	-1.050	0.26		0.43		0.001	0.000	0.002	0.001	0.001
8.50	0.015	0.01	1.190	-1.190	0.26		0.43		0.000	0.000	0.001	0.000	0.000
9.50	0.009	0.00	1.330	-1.330	0.26		0.43		0.000	0.000	0.000	0.000	0.000
10.50	0.020	0.00	1.470	-1.470	0.26		0.43		0.000	0.000	0.000	0.000	0.000
					Total:	3	Total:	5					
	1.000		Average Survival Probability for All Cases:						0.486	0.401	0.577	0.443	0.414

Yearly Number of SCA Cases:	442	**Predicted Lives Saved:**	**215**	**177**	**255**	**196**	**183**
		Change from Present:	0	-37	41	-19	-31

NOTES: Arrival Times and Delays are in minutes

The "Probable Survival Fraction" is computed from a curve-fit formula from the American Heart Association

All Yellow Cells to be filled with local FD histogram data for response times

Table E.2

SCA Impact for General Increase in Response Times

Risk Analysis Model for Victims of Sudden Cardiac Arrest
For Response Delays Due to Traffic Calming Devices

Agency:	*Austin Fire Department*
Date of Analysis:	*03/01/00*
Analysis Period:	*12-1-97 to 11-30-98*
Analysis Type:	*General Increase in Response Time*

Response Times				
Current Response Time:	3.62	*Minutes*		
Risk % Delay:	14%	*is equal to a*	0.51	*Minute Delay*
Delayed Response Time:	4.13	*Minutes*		

Current FD Incident Information		***Cardiac Arrest***	*General Delay*	*Current Local*	*Traffic Calming Adjusted*
Midpoint of Arrival Interval	***1998 Arrival Fraction***	***Probable Survival Fraction***	*Response Fraction* 14%	*Survival Rates*	*Survival Rates* 14%
0.50	0.018	0.91	0.070	0.016	0.016
1.50	0.067	0.86	0.210	0.058	0.057
2.50	0.205	0.77	0.350	0.157	0.149
3.50	0.269	0.62	0.490	0.167	0.134
4.50	0.209	0.33	0.630	0.070	0.035
5.50	0.107	0.11	0.770	0.012	0.008
6.50	0.054	0.07	0.910	0.004	0.002
7.50	0.027	0.03	1.050	0.001	0.000
8.50	0.015	0.01	1.190	0.000	0.000
9.50	0.009	0.00	1.330	0.000	0.000
10.50	0.020	0.00	1.470	0.000	0.000
		Overall Survival Rates:		0.486	0.401

Annual SCA		**Predicted Lives Saved:**	215	177
Cases:	442	Change from Present:	0	-37

Notes:
Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte
AFD Response Times obtained from the AFD Adminsitration Division
AFD Arrival Fractions obtained from the AFD Administration Division
Cardiac Arrest Fractions from the American Heart Association
Annual SCA Cases obtained from Austin Emergency Medical Services

Table E.3

SCA Impact to Response Delays for Three Calming Devices

Risk Analysis Model for Victims of Sudden Cardiac Arrest
For Response Delays Due to Traffic Calming Devices

Agency:	*Austin Fire Department*
Date of Analysis:	*03/01/00*
Analysis Period:	*12-1-97 to 11-30-98*
Analysis Type:	*Response Delay per Number of Devices*

Response Times				
Current Response Time:	3.62	*Minutes*		
Risk % Delay:	0.085	*Minute Delay per Device X*	3	*Devices =*
Total Delay	0.26	*Minute Delay*		
Delayed Response Time:	3.88			

Current FD Incident Information		***Cardiac Arrest***	*Device Delay*	*Number of*	*Current Local*	*Traffic Calming Adjusted*
Midpoint of Arrival Interval	***1998 Arrival Fraction***	***Probable Survival Fraction***	*Response Fraction*	*Devices On Route*	*Survival Rates*	*Survival Rates*
			0.085			8.5%
0.50	0.018	0.91	0.26	3	0.016	0.016
1.50	0.067	0.86	0.26		0.058	0.056
2.50	0.205	0.77	0.26		0.157	0.151
3.50	0.269	0.62	0.26		0.167	0.151
4.50	0.209	0.33	0.26		0.070	0.053
5.50	0.107	0.11	0.26		0.012	0.010
6.50	0.054	0.07	0.26		0.004	0.003
7.50	0.027	0.03	0.26		0.001	0.001
8.50	0.015	0.01	0.26		0.000	0.000
9.50	0.009	0.00	0.26		0.000	0.000
10.50	0.020	0.00	0.26		0.000	0.000
		Overall Survival Rates:			0.486	0.443

Annual SCA Cases:	442	**Predicted Lives Saved:**	215	196
		Change from Present:	0	-19

Notes:
Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte
AFD Response Times obtained from the AFD Adminsitration Division
AFD Arrival Fractions obtained from the AFD Administration Division
Cardiac Arrest Fractions from the American Heart Association
Annual SCA Cases obtained from Austin Emergency Medical Services

Table E.4

SCA Impact to Response Delays for Five Calming Devices

Risk Analysis Model for Victims of Sudden Cardiac Arrest						
For Response Delays Due to Traffic Calming Devices						
	Agency:	*Austin Fire Department*				
Date of Analysis:		*03/01/00*				
Analysis Period:		*12-1-97 to 11-30-98*				
Analysis Type:		*Response Delay per Number of Devices*				
Response Times						
Current Response Time:		3.62	*Minutes*			
Risk %Delay:		0.083	*Minute Delay per Device X*		5	*Devices =*
	Total Delay	0.42	*Minute Delay*			
Delayed Response Time:		4.04				
Current FD Incident Information		***Cardiac Arrest***	*Device Delay*	*Number of*	*Current Local*	*Traffic Calming Adjusted*
Midpoint of Arrival Interval	***1998 Arrival Fraction***	***Probable Survival Fraction***	*Response Fraction*	*Devices On Route*	*Survival Rates*	*Survival Rates*
			0.083			8.3%
0.50	0.018	0.91	0.42	5	0.016	0.016
1.50	0.067	0.86	0.42		0.058	0.055
2.50	0.205	0.77	0.42		0.157	0.147
3.50	0.269	0.62	0.42		0.167	0.140
4.50	0.209	0.33	0.42		0.070	0.045
5.50	0.107	0.11	0.42		0.012	0.009
6.50	0.054	0.07	0.42		0.004	0.003
7.50	0.027	0.03	0.42		0.001	0.001
8.50	0.015	0.01	0.42		0.000	0.000
9.50	0.009	0.00	0.42		0.000	0.000
10.50	0.020	0.00	0.42		0.000	0.000
		Overall Survival Rates:			0.486	0.416
Annual SCA		**Predicted Lives Saved:**			215	184
Cases:	442	Change from Present:			0	-31
Notes:						
Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte						
AFD Response Times obtained from the AFD Adminsitration Division						
AFD Arrival Fractions obtained from the AFD Administration Division						
Cardiac Arrest Fractions from the American Heart Association						
Annual SCA Cases obtained from Austin Emergency Medical Services						

Table E.5

SCA Impact to Improvement in Response Times

Risk Analysis Model for Victims of Sudden Cardiac Arrest
For Response Delays Due to Traffic Calming Devices

Agency:	*Austin Fire Department*
Date of Analysis:	*03/01/00*
Analysis Period:	*12-1-97 to 11-30-98*
Analysis Type:	*General Response Time Improvement*

Response Times				
Current Response Time:	3.62	*Minutes*		
Risk (-%) Improvement:	-14%	*is equal to a*	-0.51	*Minute Delay*
Delayed Response Time:	3.11	*Minutes*		

Current FD Incident Information		***Cardiac Arrest Probable Survival Fraction***	*Desired Improvement To Response Time*	*Current Local Survival Rates*	*New Improved Survival Rates*
Midpoint of Arrival Interval	***1998 Arrival Fraction***		-14%		-14%
0.50	0.018	0.91	-0.070	0.016	0.016
1.50	0.067	0.86	-0.210	0.058	0.059
2.50	0.205	0.77	-0.350	0.157	0.165
3.50	0.269	0.62	-0.490	0.167	0.190
4.50	0.209	0.33	-0.630	0.070	0.111
5.50	0.107	0.11	-0.770	0.012	0.028
6.50	0.054	0.07	-0.910	0.004	0.006
7.50	0.027	0.03	-1.050	0.001	0.002
8.50	0.015	0.01	-1.190	0.000	0.001
9.50	0.009	0.00	-1.330	0.000	0.000
10.50	0.020	0.00	-1.470	0.000	0.000
		Overall Survival Rates:		0.486	0.577

Annual SCA		**Predicted Lives Saved:**	215	255
Cases:	442	Change from Present:	0	41

Notes:
Risk Analysis Model Spreadsheet created by R. R. Bowman; layout modified by Les Bunte
AFD Response Times obtained from the AFD Adminsitration Division
AFD Arrival Fractions obtained from the AFD Administration Division
Cardiac Arrest Fractions from the American Heart Association
Annual SCA Cases obtained from Austin Emergency Medical Services

Bowman Model Statistician Verification

1635 Mariposa Ave.
Boulder, Colorado 80202
March 19, 1997

Mr. Ray Bowman
Pacemark Inc.
5455 Spine Rd.
Boulder, Colorado 80301

Dear Ray:

I have checked your method for estimating the probability of surviving a heart attack when treated by the emergency services of the Boulder Fire Department and have found it to be correct. Your use of numerical integration is formalized below.

Let S = the event that a person survives a heart attack due to emergency action of the BFD.

T_1 = time interval in which the BFD arrives.

Now $S = (S \cap T_1) \cup (S \cap T_2) \cup \cdots\cdots \cup (S \cap T_n)$

I am using a discrete model rather than a continuous one to avoid curve fitting and to simplify calculations.

Let P(S) = Probability that a given individual survives due to BFD action.

Then $P(S) = P(S/T_1)P(T_1) + \qquad + P(S/T_n)P(T_n)$

This equation correspods to the righthand four columns in your table: "Consequences of Emergency Response on Cardiac Arrest Survival".

To obtain the average or expected number of survivors, E(S), multiply the number of cases, n, by P(S). E(S) = nP(S). Let Q(S) be the probability that one does not survive emergency treatment; ie is a fatality. Then the expected number of fatalities, E(F) is

$$E(F) = nQ(S) = n - E(S).$$

Sincerely yours,

Irving Weiss, PhD

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VITA

Leslie W. Bunte Jr. was born in Austin, Texas on April 5, 1954, the son of Leslie W. Bunte Sr. and Doris Reimers Bunte. After completing his work at Georgetown High School, Georgetown, Texas, in 1972, he entered Southwest Texas State University in San Marcos, Texas.

In 1973, he joined the Austin Fire Department (AFD) as a probationary firefighter. He quickly rose through the ranks at AFD, serving in many capacities such as Fire Inspector, Lieutenant Training Officer, Lieutenant Arson/Fire Investigator, and Fire Captain of Operations. In February 1994, he was appointed Assistant Fire Chief, a position he still holds today.

Concurrently, with his service at AFD, he also served in a part-time capacity as Fire Chief for the Georgetown Fire Department for 17 years. During his tenure with the City of Georgetown, he was also called upon to serve six months as Interim Police Chief in Georgetown while a search was conducted for a permanent chief. After being appointed Assistant Fire Chief in Austin, he subsequently relinquished his duties with the City of Georgetown.

During his fire service career, he reentered college as a part-time student. In 1978, he was awarded an Associate of Science Degree in Fire Protection Technology from Austin Community College. Later in 1980, he received a Bachelor of Science Degree from Southwest Texas State University. A 1995 graduate of the four-year

National Fire Academy's (NFA) Executive Fire Office Program, he was awarded the 1994 NFA Outstanding Research Award, which was selected from over 200 other student research programs conducted that year.

In 1995, he entered the graduate program of the LBJ School of Public Affairs at The University of Texas at Austin.

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