THE 1999 ANNUAL MOBILITY REPORT

INFORMATION FOR URBAN AMERICA

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ABSTRACT

The mobility provided by the nation's transportation system is the subject of discussion and debate every day. This report provides data on the performance of some elements of that transport system in 68 urban areas. The travel, demographic, facility and operational performance statistics in the study from 1982 to 1997 are oriented to the broad public interest. The report is designed to present technical information to non-technical audiences.

The primary performance measures are the travel rate index and travel delay. Both measures relate to the concerns of transport users—the amount of time required to travel. The travel rate index compares the time needed to travel during peak travel periods of the average day and the time needed to travel during free-flow conditions. The index is designed to be easy to understand and useful for a range of analyses and presentations. Travel delay is presented as an annual estimate of the amount of additional travel time caused by traffic congestion.

Various federal, state, and local agencies provided the information used to update and verify the primary database—the Federal Highway Administration's Highway Performance Monitoring System (HPMS).

ACKNOWLEDGMENTS

This is the first report of a new phase of a research study that builds on past congestion reports. The new study is sponsored by a coalition of states including the original study sponsor, the Texas Department of Transportation. The authors wish to thank the following members of the Urban Mobility Study Steering Committee for providing direction and comments:

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SUMMARY

The annual Urban Mobility study is an effort to monitor travel conditions in major urban areas in the United States. The comparisons to other areas and to previous experiences in each area are facilitated by a database that begins in 1982 and includes 68 urbanized areas.

The effects of congestion are widespread and affect the mobility of people and goods. The effects show up in increased travel time, increased fuel consumption in stop-and-go traffic and lost productivity of people and freight-moving vehicles. Congestion also affects the efficiency of just-in-time manufacturing processes—a crash or vehicle breakdown that increases travel time can mean that components do not arrive in time to be installed on schedule, or the business must keep more inventory to accommodate unreliable delivery schedules.

MORE MEASURES

The 1999 report evaluates travel conditions and operations of the freeway and principal arterial street networks in 68 urbanized areas from 1982 to 1997. The statistics are updated for the 68 areas included in previous studies.

The report provides information at the urban area level due to the consistent treatment that can be provided—only developed land with a density of greater than 1,000 persons per square mile is included in the boundary. The information is targeted for communication to general audiences and consistency is important if the comparisons and trend analyses are to be relevant.

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Past reports have, for the most part, focused on road congestion measures. Such measures have their limitations because of the broad range of transportation improvement options that cities and regions are pursuing. In addition to roadway capacity improvements, governments are working to make more efficient use of road space, manage travel demand, and make better use of the full range of transportation modes. Mobility measures—statistics that examine travel time and person movement—are more appropriate for the task than congestion measures.

One of the key mobility measures is the travel rate index. The travel rate index combines information that had been used in previous reports in a different way. The measure expresses mobility in a way that may be more relevant to travelers, essentially answering part of the "how long will it take me to get there?" question. A broader set of multimodal measures is needed to evaluate the relative effectiveness of the following types of "solutions" to urban mobility problems.

Add road space—This might be new roads or widened existing roads.

Lower the number of vehicles—Some of the techniques attempt to reduce the number of vehicles or increase the number of people in each vehicle. These include travel demand management strategies, improved and more available transit operations and land use patterns that seek to put jobs, shops and houses closer together and reduce the need for vehicle travel.

Change the time that vehicles use the road—This reduces the load on the system at peak travel times.

Get more vehicles past a spot on the road—More efficient operation of the roadway has the effect of adding capacity, although not usually of the same magnitude as adding a full lane.

Once again, this report was sponsored by several state departments of transportation outside Texas. DOTs from the states listed below participated in designing and funding this report. These states will also assist in developing and applying mobility measures to be used in expanded analyses in the coming years.

- California
- Colorado
- Maryland
- Minnesota
- New York
- Oregon
- Texas
- Washington
- Kentucky (partial sponsor)

THE REPORT AT A GLANCE

The report includes information on three general categories of mobility measures—measures of mobility related to an individual's experience, measures of areawide mobility and trend comparisons of measures over several years. These three categories each tell a different part of the mobility "story" for an area and have different uses. Comparisons between areas are difficult due to local system and travel pattern differences, but they do provide some perspective on the situation. Local trend data are very useful to illustrate the results of the investments made in transportation and whether that has been sufficient. A brief summary of the findings and measures in each category is included below. More extensive statistics are available for each city on the study web site (http://mobility.tamu.edu).

Individual Measures

Measures related to a traveler's experience with mobility include those that illustrate the amount of extra time each traveler spends on the road or the effects of that extra time. This may be measured with speed information that estimates the extra time on the road or with computer models that illustrate the effect of inefficient operation in terms of extra fuel used, including:

Travel Rate Index—amount of extra travel time during the peak period compared to free-flow travel
Delay per eligible driver—annual delay (extra travel time) per driver
Delay per capita—annual delay (extra travel time) per person
Wasted fuel per eligible driver—extra fuel due to congestion
Wasted fuel per capita—extra fuel due to congestion
Congestion cost per eligible driver—annual "tax" per driver
Congestion cost per capita—annual "tax" per capita

On a per trip basis, almost one-fifth (14) of 68 urban areas experience peak-period trips that take at least 30 percent more time due to congestion. Drivers in just under one-third of the urban areas (20) experience peak-period travel times that are 25 percent longer than the same off-peak trip.

In more than one-third (24) of those areas, the average delay per driver exceeds one work week per year in extra travel time.

Another 14 areas had annual delays between 30 and 40 hours per driver.

The congested driving conditions mean less efficient vehicle operation which wastes fuel. Drivers in 35 urban areas purchased the equivalent of four extra tanks of fuel per year due to congestion or enough fuel to almost fill a 50-gallon drum during the year.

The value of delay and fuel was estimated as a "congestion tax." This value was $500 or greater per eligible driver or larger in 40 of the 68 areas studied including areas in all population groups except the Small urban areas. It exceeded $1,000 per driver in six areas with the most intense congestion problems—the equivalent of about $4 per work day.

- **Travel Rate Index**

The TRI is a measure of the amount of extra time it takes to travel during the peak period. The travel rate (in minutes per mile) in the peak is compared to the free-flow travel time. A TRI of 1.20, for example, indicates that it will take 20 percent longer to travel to a destination during the peak than it will to travel at "speed limit" conditions. This measure estimates travel conditions on days without crashes or vehicle breakdowns, presenting delay due to high traffic volumes. The "least mobile" urban areas in 1997 are listed in Table S-1.

- **Delay Per Eligible Driver**
- **Delay Per Capita**

These measures express the extra travel time in a ratio with the number of eligible drivers and the population of an urban area. This measure estimates the amount of time each driver or person spends in congested traffic each year due to normal traffic volumes, crashes and vehicle breakdowns.

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Table S-1. Travel Rate Index for 1997—The Top 10

Population Group	Urban Area	Travel Rate Index	
		1997 Value	Rank
Vlg	Los Angeles, CA	1.51	1
Lrg	Seattle-Everett, WA	1.43	2
Vlg	San Francisco-Oakland, CA	1.42	3
Vlg	Washington, DC-MD-VA	1.41	4
Vlg	Chicago, IL-Northwestern, IN	1.37	5
Lrg	Miami-Hialeah, FL	1.34	6
Lrg	Atlanta, GA	1.34	6
Vlg	Boston, MA	1.32	8
Vlg	Detroit, MI	1.31	9
Lrg	San Diego, CA	1.31	9
Lrg	Las Vegas, NV	1.31	9

Vlg—Very Large urban areas - over 3 million population; Lrg—Large urban areas - over 1 million and less than 3 million population
Note: The index is defined as the travel rate (in minutes per mile) during the peak period divided by the rate in the off-peak.
A Travel Rate Index (TRI) of 1.30 indicates the average peak trip takes 30% longer than in uncongested conditions—a 20-minute trip becomes a 26-minute trip.

- **Wasted Fuel Per Eligible Driver**
- **Wasted Fuel per Capita**

These measures express the extra fuel consumed due to congestion in a ratio with the number of eligible drivers and persons in the urban area. This is a measure of the effect of slow speeds on the extra fuel needed each year to travel in congested conditions.

- **Congestion Cost Per Eligible Driver**
- **Congestion Cost per Capita**

The cost of congestion is estimated with a value for each hour of travel time and each gallon of fuel. The value of travel time used in this report is not based on the wage rate; it is based on research into the value that people demonstrate by their behavior. Paying tolls, erratic lane changing and traffic violations that risk accidents and traffic citations are some ways motorists illustrate they value their travel time. Fuel cost is estimated from state averages.

Areawide Measures

The size of an urban area—population and square miles—is related to another aspect of mobility—the magnitude of congestion impacts. While the level of individual mobility is not necessarily related to the size of an area, the total impacts are closely related to population. The magnitude effect can be measured by the impacts (the total hours and fuel wasted in traffic), the cost associated with those factors and by the magnitude of the remedies needed to improve mobility.

- **Areawide annual travel delay**
- **Areawide wasted fuel**
- **Areawide congestion cost**
- **Amount of roadway needed each year to address congestion**
- **Vehicle occupancy change needed each year to address congestion**

These measures estimate the impact that low mobility levels have on the entire urban area. Areas with large populations are generally ranked higher in these measures mostly by virtue of their size. The Very Large population group areas have a significant share of the congestion-related impacts in all categories—more than half of the delay in all 68 cities is in the nine areas with an urban area population over three million people. Where the intensity (individual) measures have a mixture of population sizes through the rankings, the delay, fuel and cost magnitude measures closely follow population.

- **Areawide annual travel delay**

The total hours lost due to delay during the peak travel periods is estimated from travel speed estimates on the freeways and principal arterial streets. Total delay is related to the average speed and the number of travelers; the areawide rankings closely track the population estimates with very few areas from one population group rising or falling into another.

- **Areawide wasted fuel**

The fuel lost due to inefficient operation can be totaled just as the travel delay is, and the relationship is very similar. Most of the areas have excess fuel consumption rankings very near to their population rankings. Large areas are not necessarily more difficult places to travel, but the size is a particularly important determining factor for any of the magnitude measures.

- **Areawide congestion cost**

The cost of congestion is estimated by applying a value of time to the amount of travel time delay and a cost per gallon of fuel wasted in congested travel. The areawide "congestion tax" may be thought of as one expression of the cost of congestion to residents of an urban area.

- **Amount of roadway needed each year to address congestion**

Another expression of the costs associated with congestion is the amount of roadway that would be needed every year to maintain a constant level of mobility. As a very simple measure, the rate of traffic growth (in percent of additional traffic volume per year) has to equal the rate of freeway and arterial street expansion (in percent of the system added per year). Comparing the two growth rates yields an estimate of the amount of additional road system expansion needed every year to keep a constant congestion level if traffic continues to grow at the present rate. This presentation does not address the existing mobility difficulties, only the growth of further problems. This measure is not meant to imply that road-only solutions are the answer in all cases. In some areas, however, providing enough roadway to keep the mobility level constant or to keep delay from growing, may be an achievable alternative. The data demonstrates, however, that in large or fast-growing areas it has been difficult to afford the road construction budget and address the public and environmental concerns. On average, 45 percent of the roadway needed to keep pace with this "road-only" solution were added between 1994 and 1997 (Table S-2). While the number of lane-miles needed is smaller in the small population urban areas, the "success" rate was much lower than in the other population groups.

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Table S-2. If Road Expansion were the Only Congestion Reduction Technique

Population Group	1994-1997	
	Annual Traffic Growth (%)	Percent Added[1]
68 Area Average	2.5	45
Very Large	2.0	47
Large	2.8	42
Medium	3.5	49
Small	3.5	32

[1]Additional lane-miles divided by lane-miles "needed to address traffic growth."

Note: Assumes that all added lane-miles would be roadway expansion since no reliable data exist concerning the addition of lane-miles through changing urban boundaries.

- **Vehicle occupancy change needed each year to address congestion**

Another solution to the mobility problem is to increase the number of people in each vehicle. By increasing occupancy levels, vehicle-trips can be removed from the roadway system thus lowering congestion levels or at least slowing the growth. The change in vehicle occupancy levels that would be needed to maintain a constant level of mobility were calculated based on the annual traffic growth. This measure is similar to the additional capacity measure except this measure focuses on the demand side rather than supply. This measure does not imply that all new trips could be handled with some form of ridesharing or transit. It demonstrates that in fast growing areas and many others, it would be very difficult to achieve the occupancy levels. The measure uses the rate of traffic growth to determine additional passenger-miles of travel. These new passenger-miles are "placed into" the existing vehicle-miles to determine what occupancy level would be needed to accommodate the additional demand. On average in the 68 urban areas, vehicle occupancy would have to increase by 0.04 persons per vehicle to keep pace with the growing demand (Table S-3). While this sounds relatively minor, 99,000 new carpools would be needed **each year.** And the trend in commuter vehicle occupancy level is downward—they declined from 1.18 in 1970 to 1.09 in 1990 (1).

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Table S-3. Illustration of Occupancy Increase to Prevent Mobility Decline

Population Group	Growth in Person Travel[1] (%)	1997 Occupancy Levels Needed to Maintain the 1996 Mobility Level[2]
68 Area Average	2.8	1.29
Very Large	2.2	1.28
Large	3.2	1.29
Medium	4.0	1.30
Small	2.9	1.29

[1]Annual growth in person-miles of travel between 1992 and 1997.
[2]Based on an average of 1.25 persons per vehicle in 1996.

Trend Measures

Most of the measures quantified in this report relate to the change in mobility—the database extends from 1982 to 1997. The change of both the individual and areawide mobility measures provides comparisons of the growth in population, vehicle travel and the increase or decline of mobility levels. These trends show that there are not many large population areas – Houston, Buffalo and Pittsburgh are the exceptions -- which are successful at maintaining travel time or congestion level. The trends indicate that it takes more time and fuel to reach destinations than just a few years ago.

The amount of peak period travel at speeds near the speed limit continues to decline (Exhibit S-1). Travel speed is estimated with traffic volume per lane data using the levels indicated in Exhibit 1. In 1982, almost two-thirds of the peak-period travel (65 percent) in the 68 urban areas was uncongested. By 1997, this had dropped to about one-third of travel (36 percent). The greatest decline in mobility came in the most congested categories (severe and extreme), where the greatest delay occurs. The percentage of travel in the most severely congested conditions more than doubled from about 14 percent in 1982 to about 36 percent in 1997.

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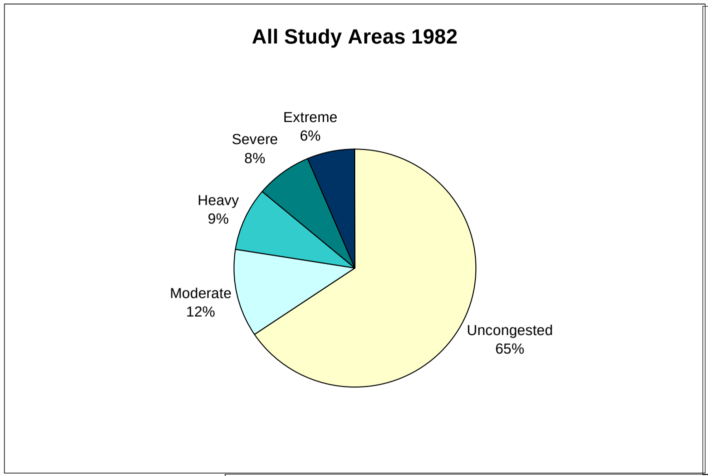
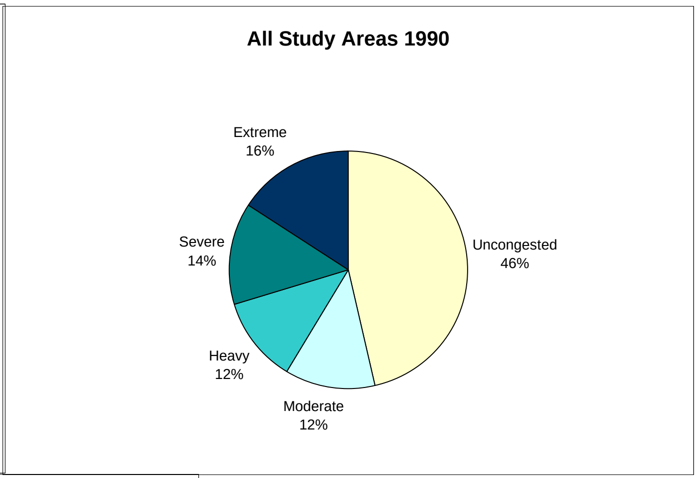
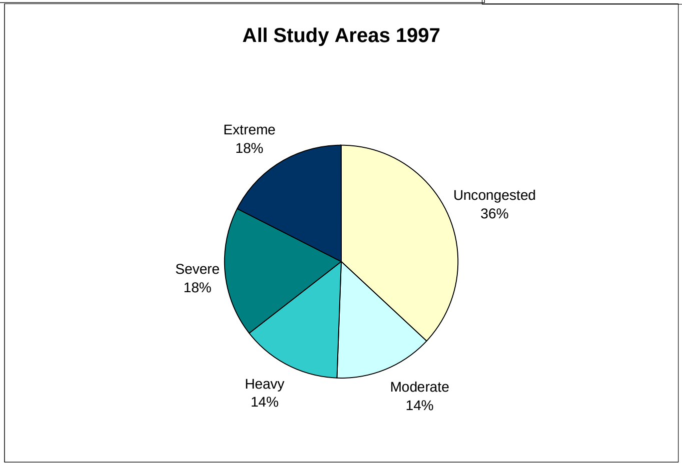
Exhibit S-1. Growth of Congested Travel, 1982 to 1997







Traffic Volume Range and Congestion Level

Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

This trend points out that many areas, especially the large and very large areas, may pursue a strategy of reducing the amount of travel in the severe and extreme congested categories. Travel conditions are much slower and less reliable in these categories because on a percentage basis, delay increases much faster than traffic volume. While this may not substantially reduce the amount of congested facility miles, it may improve the travel time and reliability that the transportation network can provide.

What is Happening and What are the Solutions?

This report presents several mobility measures that are relevant to transportation planners and designers, the general public and policy decision-makers. **It does not presume to decide for each area what projects should be selected, but the data are fairly clear—not enough transportation system improvements are being made to stop the decline in mobility.** Mobility—as measured by individual's travel speed—might be increased by projects such as additional general purpose lanes, bus/carpool lanes, transit improvements, coordinating traffic signals, incident management activities and demand management strategies. An example of the effects from high-occupancy vehicle lanes in Houston is included in this year's report as a case study of how these improvements affect mobility.

In summary, congestion cost travelers in 68 urban areas 4.3 billion hours of delay, 6.6 billion gallons of wasted fuel consumed and $72 billion of time and fuel cost in 1997. A single "silver bullet" technology or treatment will not address this problem—a range of strategies must be pursued. **If an area wishes to pursue only road additions as the way to stop the growth in congestion and improve travel speed, for instance, the recent record is not encouraging.** From 1994 to 1997, only 45 percent of the lane-miles needed to maintain congestion at the existing level were added in the 68 urban areas. New lane-miles constructed is even less than this, however, because the 45 percent figure includes existing roads brought into the urbanized area boundary by growth and land development.

The range of improvements include projects such as new or widened freeways and streets, bus/carpool lanes, transit operating and capital improvements, coordinating traffic signals to speed traffic and removing crashes and vehicle breakdowns from the traffic stream. The possible solutions also include managing demand through variable work hours or telecommuting, and rearranging the land use patterns to decrease the reliance on motor vehicle travel. These solutions cannot rely on one agency or level of government. They cannot proceed without public support for funding the projects or programs. Some solutions also require more than project approval and funding—some require lifestyle changes and different land use patterns.

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CHAPTER I. INTRODUCTION

Congestion and mobility issues have been discussed and debated for a long time—probably for as long as there have been urbanized areas. The Urban Mobility Study attempts to provide some information about one part of those issues in ways that both the public and professional groups can understand. Ultimately the quality of public information is measured by its usefulness; in the transportation issues context there are several "information markets" that must be addressed. These are being examined in a variety of studies; this one is only a part of the literature.

BRIEF REVIEW OF THE STUDY HISTORY

The Urban Mobility Study attempts to develop useful statistics from generally available sources and provide information on trends in mobility levels. To this end, the study began several years ago by identifying the road congestion levels in relatively large urbanized areas. The Texas Department of Transportation identified the need for a technique that allowed them to communicate with the public about the effect of increased transportation funding. The Texas Transportation Institute developed and applied a method to assess road congestion levels at a relatively broad scale—the urbanized area. Over the years, the study has expanded the list of measures and the list of urban areas. The urban areas included in the study are shown in Table 1. In the 1998 report, 70 urban areas were included in the study. At the request of the Pennsylvania DOT, which decided to withdraw from study sponsorship because other projects to study mobility were underway within the DOT, the Harrisburg and Allentown urban areas were not studied in 1999.

Table 1. Urban Area Information

Population Group	Urban Area	1997 Population	Population Growth 1982 to 1997 Change (%)	Population Growth 1982 to 1997 Rank	Population Growth 1992 to 1997 Change (%)	Population Growth 1992 to 1997 Rank	1997 Urban Area Size (sq. mi.)	1997 Urban Area Population Density (pers/sq. mi.)
Vlg	Boston, MA	3,015	6	60	2	58	1,155	2,610
Vlg	Houston, TX	3,100	29	30	7	34	1,695	1,830
Vlg	Washington, DC-MD-VA	3,465	28	33	5	41	1,000	3,465
Vlg	San Francisco-Oakland, CA	3,900	19	48	2	58	1,065	3,660
Vlg	Detroit, MI	4,015	5	61	0	66	1,310	3,065
Vlg	Philadelphia, PA-NJ	5,270	29	30	5	41	1,505	3,500
Vlg	Chicago, IL-Northwestern, IN	7,980	13	51	6	38	2,740	2,910
Vlg	Los Angeles, CA	12,300	24	39	4	49	2,250	5,465
Vlg	New York, NY-Northeastern, NJ	17,160	3	65	1	64	3,550	4,835
Lrg	Indianapolis, IN	1,010	17	49	6	38	495	2,040
Lrg	Oklahoma City, OK	1,010	58	10	30	3	680	1,485
Lrg	Columbus, OH	1,015	22	43	7	34	480	2,115
Lrg	Norfolk, VA	1,020	32	27	6	38	840	1,215
Lrg	Orlando, FL	1,070	75	2	22	4	530	2,020
Lrg	Buffalo-Niagara Falls, NY	1,075	0	66	0	66	570	1,885
Lrg	New Orleans, LA	1,120	4	62	2	58	370	3,025
Lrg	Las Vegas, NV	1,150	156	1	39	1	280	4,105
Lrg	San Antonio, TX	1,230	29	30	4	49	515	2,390
Lrg	Sacramento, CA	1,235	49	13	4	49	395	3,125
Lrg	Milwaukee, WI	1,255	4	62	2	58	565	2,220
Lrg	Cincinnati, OH-KY	1,270	12	54	4	49	650	1,955
Lrg	Fort Worth, TX	1,300	20	45	8	28	975	1,335
Lrg	Portland-Vancouver, OR-WA	1,340	33	25	20	7	500	2,680
Lrg	Kansas City, MO-KS	1,355	24	39	13	14	800	1,695
Lrg	San Bernardino-Riverside, CA	1,360	44	16	5	41	525	2,590
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	1,500	41	18	17	9	500	3,000
Lrg	San Jose, CA	1,620	35	23	8	28	480	3,375
Lrg	Denver, CO	1,800	33	25	13	14	955	1,885
Lrg	Cleveland, OH	1,870	7	59	4	49	800	2,340
Lrg	Pittsburgh, PA	1,875	4	62	1	64	950	1,975
Lrg	Seattle-Everett, WA	1,960	36	21	7	34	815	2,405
Lrg	St. Louis, MO-IL	2,030	10	56	2	58	890	2,280
Lrg	Miami-Hialeah, FL	2,070	20	45	8	28	550	3,765
Lrg	Baltimore, MD	2,150	26	37	5	41	740	2,905
Lrg	Minneapolis-St. Paul, MN	2,290	31	29	9	24	1,215	1,885
Lrg	Dallas, TX	2,320	28	33	12	17	1,610	1,440
Lrg	Phoenix, AZ	2,400	68	4	19	8	1,090	2,200
Lrg	Atlanta, GA	2,580	60	9	13	14	1,790	1,440
Lrg	San Diego, CA	2,610	47	15	5	41	755	3,455
Med	Fresno, CA	540	57	11	10	20	180	3,000
Med	Omaha, NE-IA	560	12	54	5	41	225	2,490
Med	Albuquerque, NM	565	28	33	8	28	275	2,055
Med	Charlotte, NC	575	64	6	15	11	320	1,795
Med	Tacoma, WA	590	40	19	8	28	340	1,735

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Table 1. Urban Area Information, continued

Population Group	Urban Area	1997 Population	Population Growth 1982 to 1997 Change (%)	1982 to 1997 Rank	1992 to 1997 Change (%)	1992 to 1997 Rank	1997 Urban Area Size (sq. mi.)	1997 Urban Area Population Density (pers/sq. mi.)
Med	El Paso, TX-NM	610	36	21	8	28	235	2,595
Med	Rochester, NY	620	-3	68	0	66	335	1,850
Med	Austin, TX	630	66	5	12	17	400	1,575
Med	Nashville, TN	630	26	37	7	34	585	1,075
Med	Hartford-Middletown, CT	640	13	51	4	49	380	1,685
Med	Tucson, AZ	650	44	16	14	13	295	2,205
Med	Honolulu, HI	705	24	39	3	56	185	3,810
Med	Jacksonville, FL	825	34	24	9	24	665	1,240
Med	Tampa, FL	830	54	12	16	10	530	1,565
Med	Louisville, KY-IN	845	10	56	4	49	400	2,115
Med	Providence-Pawtucket, RI-MA	900	9	58	3	56	520	1,730
Med	Salt Lake City, UT	900	32	27	5	41	495	1,820
Med	Memphis, TN-AR-MS	970	28	33	10	20	460	2,110
Sml	Boulder, CO	110	38	20	10	20	45	2,445
Sml	Beaumont, TX	140	22	43	12	17	105	1,335
Sml	Brownsville, TX	145	61	8	21	6	45	3,220
Sml	Laredo, TX	165	74	3	32	2	50	3,300
Sml	Salem, OR	185	16	50	9	24	75	2,465
Sml	Eugene-Springfield, OR	215	13	51	10	20	105	2,050
Sml	Corpus Christi, TX	310	24	39	9	24	195	1,590
Sml	Spokane, WA	330	20	45	5	41	170	1,940
Sml	Bakersfield, CA	375	63	7	15	11	180	2,085
Sml	Colorado Springs, CO	415	48	14	22	4	235	1,765
Sml	Albany-Schenectady-Troy, NY	500	0	66	2	58	370	1,350

Vlg — Very Large urban areas - over 3 million population
Lrg — Large urban areas - over 1 million and less than 3 million population
Med — Medium urban areas - over 500,000 and less than 1 million population
Sml — Small urban areas - less than 500,000 population

SO WHAT IS THE FOCUS OF THIS STUDY?

This report broadens the coverage of previous reports by including more information on mobility measures. The study began several years ago with a few measures, a few urban areas and a focus on roadway congestion measures. All of these have been expanded to more completely address urban mobility in the U.S.

As a more diverse set of solutions are pursued in urban areas, the measurement techniques must also evolve. The study will continue to include a few basic elements, including:

- Urban area information—to be used as a benchmark of the mobility changes that have been experienced—not as a guide to which project, corridor or mode should be selected for funding.
- Public information—another source of data that citizens and transportation professionals can use to discuss which projects, programs and policies should be pursued.
- Trend information—which inevitably means that as new information becomes available, it has to be meshed with the existing database to form consistent measures and a comparable database.
- Free-flow speed comparisons—used for consistency between urban areas. Individual areas may wish to use some other standard, but for the speed and delay measures in this study, free-flow or "speed limit" speeds appear appropriate.

One significant change in this report is the use of the Travel Rate Index (TRI)—a comparison of travel time in the peak to travel time in free flow conditions—instead of the Roadway Congestion Index (RCI). The TRI can illustrate the effect of a broader range of transportation improvements and addresses a central concern of urban residents – the time it takes to travel in the peak periods.

For the first time in this report series, the effectiveness of an operational improvement (HOV lanes in Houston) was included in the analysis. Additionally, the effectiveness will be shown both at the areawide and individual freeway level. The versatility of the new methodology will also be shown in the case study of the Houston HOV lanes with speed data collected from the freeways in Houston substituted for results of the speed estimation portion of the methodology. The hope for future reports is, that with more and better travel speed data being collected, more real speed data can be substituted into the existing database to replace estimated data.

WHAT FACTORS INFLUENCE URBAN TRAVELER DECISIONS?

Travelers and businesses use a number of factors to evaluate their trip and the transport system. This report evaluates some but not all of these. Here are some questions that people ask about travel to give the reader an idea of how broad the topic is and to place the report in the proper context

- Can I get there?—This is often the first question asked by those without ready access to a personal vehicle. It may also include questions about parking near the destination.
- How long is the trip?—Sometimes this is related to distance, but usually it is a time measure. It includes, for example, time spent waiting for transit service or walking from a parking place to a destination.
- What are my travel mode options?—How many ways are there to make the trip that satisfy my needs?
- What route do I take?—What roads, paths or transit routes do I use? And do these change depending on when I'm traveling?
- When do I leave?—This relates to trip time and to the variability in trip time for the mode and route chosen. Travel time variability is particularly important to freight shippers involved in just-in-time manufacturing.
- Will I be comfortable and safe?—Many times the uncertainty in these two factors will be an incentive to take a known mode/route rather than experiment.
- Is the trip convenient?—This relates to a mix of route, mode and time choices and frequently explains why driving alone is chosen even when it costs more.
- How much will it cost?—Frequently users seem to view their time, vehicle operating costs and out-of-pocket expenses (e.g., tolls, fares) differently even though all can be expressed in monetary terms.
- Do I need to make this trip?—In the context of urban areas, this is often thought of as a question that leads to an "electronic trip" to telecommute or "teleshop." It is also a significant question for those without easily available travel options and in areas with climatic extremes.

The information in this report may assist in identifying whether the existing system performance and the improvements that might be made are adequate to meet the needs of the traveling public. At best this report can provide some statistics that compare the mobility trends in urban areas and allow the public, the decisions-makers and the transportation professionals to discuss where transport issues fall in the range of other societal concerns. No matter the transport improvement solutions that are pursued, measuring congestion and mobility is one part of the participation and decision-making process.

WHAT IS THE SOURCE OF DATA FOR THIS REPORT?

This research study uses data from federal, state, and local agencies to develop planning estimates of the level of mobility within an urban area. The analyses presented in this report are the results of previous research (2-5) conducted at the Texas Transportation Institute (TTI). The methodology developed by the previous research provides a procedure that yields a quantitative estimate of urbanized area mobility levels, utilizing generally available data, while minimizing the need for extensive data collection.

The methodology primarily uses the Federal Highway Administration's Highway Performance Monitoring System (HPMS) database, with supporting information from various state and local agencies (6). The HPMS database is used because of its relative consistency and comprehensive nature. State departments of transportation collect, review, and report the data. Since each state classifies roadways in a slightly different manner, TTI reviews and adjusts the data, and then state and local agencies familiar with each urban area review the data. Special studies of issues or areas provide more detailed information and the Urban Mobility Study procedures have been modified to take advantage of some of these.

This process is of particular importance when urban boundaries are redrawn due to realignments or when local agencies update the boundary to account for urban growth. These changes may significantly change the size of the urban area, which also causes a change in system length, travel and mobility estimates. When the urban boundary is not altered every year in fast growth areas, some data items take on a "stair-step appearance." Significant changes thus caused by the data compilation methods, are addressed by altering statistics to present a trend closer to actual experience for each year.

Sometimes the trends change, however, and in this year's report many of the urban areas have some slight data changes to their input data to make the Urban Mobility Study statistics more consistent with the original HPMS data. This may cause some areas to move up or down in the rankings in some of the measures. A list of the urban areas and changes to their input and output data resulting from this updating process is included in Appendix B (which can be found on the Urban Mobility Study website: http://mobility.tamu.edu).

WHAT IS IN THIS REPORT?

The database developed for this research contains vehicle travel, population, urban area size, and lane-miles of freeway and principal arterial streets from 1982 to 1997. The Travel Rate Index (TRI) and travel delay are used as the basis of measuring urban mobility levels and comparing areawide roadway systems.

The most significant change to the current methodology is the addition of a fifth congestion level labeled "extreme." Because of the inclusion of the extreme category, some shifts in the estimated speeds for each of the congestion levels has occurred. These new estimated speeds have caused the average calculated speed in some areas to fall from previous levels and other urban area calculated speeds to increase from previous levels, depending on the traffic density of the sections of roadway within each urban area.

This report includes many of the statistics reported in previous renditions of this report series. Some new measures are presented and the formats of some statistics have been altered. While most of the large urban areas in the United States are included in the study, it would be incorrect to assume that the totals represent an estimate of national congestion impacts. The report presents data in either a ranking format or in population groups. The population group comparisons are not without inconsistencies, given the diversity of land use patterns, community goals, fiscal capacity, etc., between cities. Analyzing trends for areas of different sizes does, however, provide some information regarding the extent and growth of congestion.

The measures are organized in report chapters that include both 1997 data and trend information from 1982 to 1997.

- Chapter II – What is the Urban Area Mobility Level?
  - 1997 Statistics for travel rate index (TRI) and travel delay.
- Chapter III – What is the Trend?
  - 1982 to 1997 Statistics for travel rate index (TRI), travel delay and the percentage of congested travel.
- Chapter IV – What Can We Learn About Mobility Trends?
  - Findings from studies of the relationship between road additions and mobility.
- Chapter V – What are the Alternatives to Declining Mobility?
  - An examination of the impact of current roadway operations, building and widening roads, high-occupancy vehicle lane operation and improving mobility by increasing auto occupancy.
- Chapter VI – Conclusions
  - Findings about using mobility measures and a summary of ways to address mobility problems.

- Appendix A
  - Percent congested travel and lane-miles
  - 1982 to 1997 statistics for roadway congestion index (RCI)
- Appendix B (website – http://mobility.tamu.edu)
  - Contains information about changes to the methodology and input variables.
- Appendix C (website – http://mobility.tamu.edu)
  - Summarizes the methodology utilized to calculate many of the statistics shown in the Annual Mobility Report.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

CHAPTER II. WHAT IS THE URBAN AREA MOBILITY LEVEL?

SUMMARY

The Travel Rate Index (TRI) is an indicator of the additional travel time that is necessary for an individual to make a trip during the peak period because of congestion. The index is defined as the travel rate (in minutes per mile) during the peak period divided by the rate in the off-peak. A TRI of 1.30 indicates the average peak trip takes 30 percent longer than a trip in free-flow conditions—a 20-minute trip becomes a 26-minute trip.

Fourteen urban areas have TRIs of 1.30 or higher (Table 2). Thirty-five urban areas have TRIs of 1.20 or higher. This means that in about half of the urban areas studied, it takes an average of at least 20 percent longer to make a trip during peak travel times; keep in mind that some corridors may be much worse. The urban areas with the highest travel rate index in 1997 for each population group are:

Very Large	*Los Angeles, CA*	*TRI: 1.51*
Large	*Seattle-Everett, WA*	*TRI: 1.43*
Medium	*Tacoma, WA*	*TRI: 1.26*
Small	*Colorado Springs, CO*	*TRI: 1.10*

Examining the range of TRI values gives the reader the conclusion that traveling the same distance in large areas takes more time than in smaller areas. While not an earth-shattering conclusion, it does speak to the difficulty that growing areas face in developing transportation facilities and programs.

Drivers in six urban areas spent the equivalent of more than 1.5 work weeks (60 hours) stuck in traffic in 1997 (Table 2). Drivers in 24 urban areas spent the equivalent of at least one work week stuck in traffic, while drivers in 51 of the 68 urban areas studied spent at least one-half of a work week (20 hours) stuck in traffic.

Los Angeles had the greatest amount of delay per driver with about 82 hours per year while Brownsville had the least amount of delay per driver in the study with about three hours per year (Table 2).

The highest ranked areas for delay per driver in each of the population groups is:

Very Large	*Los Angeles, CA*	*82 hours per driver*
Large	*Seattle-Everett, WA*	*69 hours per driver*
Medium	*Austin, TX*	*53 hours per driver*
Small	*Colorado Springs, CO*	*16 hours per driver*

BACKGROUND

The Travel Rate Index (TRI) is one way of looking at travel conditions in the peak period; it focuses on time rather than the more traditional measure—speed. The TRI indicates how much longer it takes to make a trip than would be the case if the trip occurred in free-flow conditions. A TRI value of 1.30 indicates that it takes 30 percent longer to make a trip than it would take if the travel occurred at free-flow speeds.

The TRI equation, shown below, is a weighted average of the peak period travel rates on the freeway and principal arterial streets. Lower TRI values indicate less travel in congested conditions and, thus, higher mobility levels. The TRI calculation currently used includes an estimate of only the delay due to high traffic volumes that typically occur in the peak period on weekdays. This is often referred to as recurring delay.

$$\text{Travel Rate Index} = \frac{\left(\dfrac{\text{Freeway Peak Period Travel Rate}}{\text{Freeway Free Flow Travel Rate}} \times \text{Freeway Peak Period VMT}\right) + \left(\dfrac{\text{Principal Arterial Street Peak Period Travel Rate}}{\text{Principal Arterial Street Free Flow Travel Rate}} \times \text{Principal Arterial Street Peak Period VMT}\right)}{\left(\text{Freeway Peak Period VMT} + \text{Principal Arterial Street Peak Period VMT}\right)}$$

Another component of delay is that due to incidents—crashes, breakdowns or other occurrences that temporarily decrease roadway capacity. Incident delay is related to high traffic volumes, but also varies according to other factors. High traffic per lane provides more opportunity for conflicts and, thus, incidents. When those occur and block traffic flow, the effect is to dramatically increase delay upstream of the blockage. This effect can last for a long period of time after the blockage is removed due to the system's inability to handle the traffic volume.

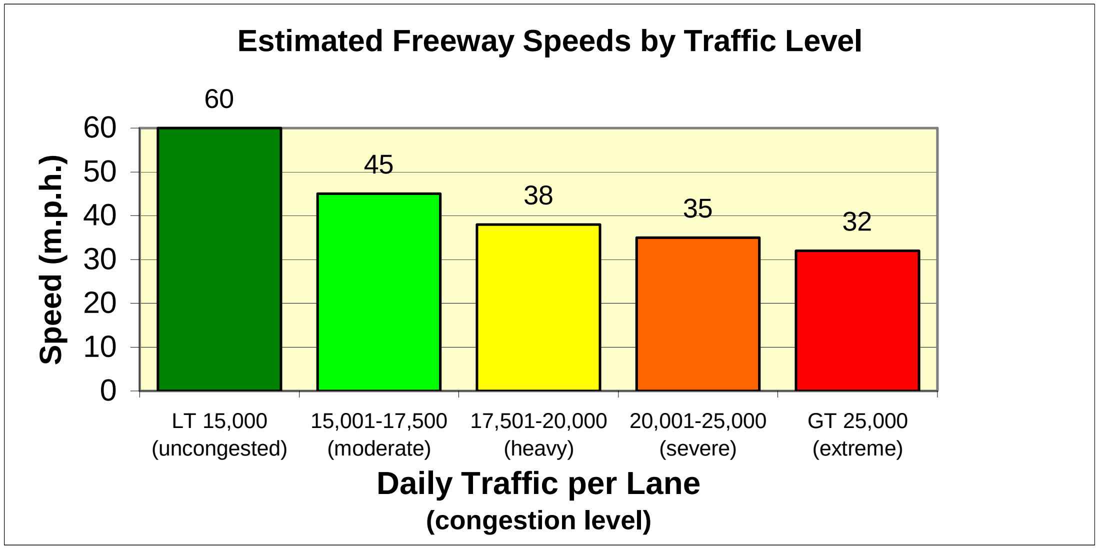
The percentage of total delay—incident and recurring—that is composed of incident effects may also be very high when recurring delay is low; the only time there is congestion is when there is an accident.

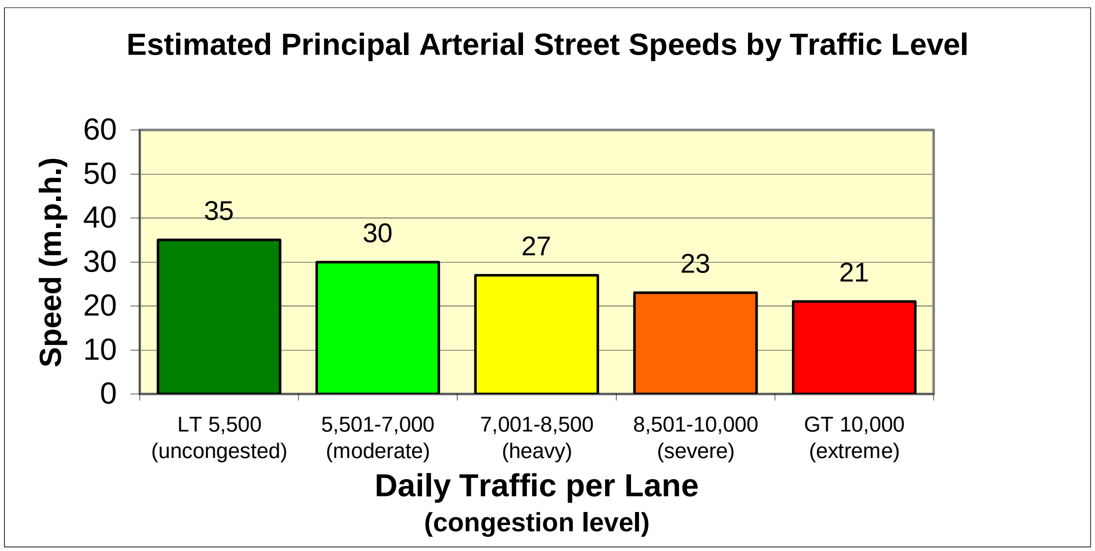
To calculate the amount of delay or additional travel time that occurs on a roadway, the travel speed is estimated for each roadway link using the daily traffic per lane values. Each link is categorized as uncongested or placed in one of four congested levels, according to the values shown in Exhibit 1. The speed shown for each ADT/lane range represents the average speed for both roadway directions during the peak period. Areawide freeway and principal arterial street speeds are calculated by assigning one of the estimated speeds to each roadway link and weighting all of the links by the amount of vehicle travel on each link.

Another way of looking at the amount of roadway congestion is to look at the supply side of the transportation system. The percentage of the freeway and principal arterial street system operating with congested conditions is another description of mobility levels. A lane-mile of freeway that has 15,000 vehicles per day or arterial street lane carrying 5,500 vehicles per day would be considered congested during some portion of the peak period. The level of congestion, again, depends on just how far above the lower threshold the traffic volume is. By focusing on the amount of the roadway that is congested, one can understand the amount of the roadway system that is causing the majority of the mobility problems. Locations that act as “bottlenecks” on a roadway—possibly just a few miles of facility—may be identified as prime targets for mobility improvement efforts.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

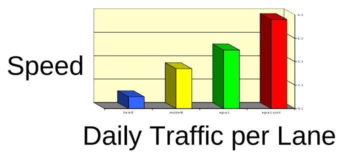
Exhibit 1. Estimated Speeds for Freeway and Principal Arterial Streets by Daily Traffic per Lane





TABLES AND EXHIBITS

- Estimated Speeds for Freeway and Principal Arterial Streets by Daily Traffic per Lane (Exhibit 1)

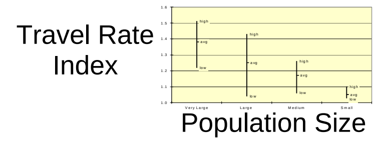


- Shows the estimated speeds that are assigned to individual roadway links based on the daily traffic per lane.
- Contains speeds for
  - ✶Uncongested
  - ✶Moderate congestion
  - ✶Heavy congestion
  - ✶Severe congestion
  - ✶Extreme congestion

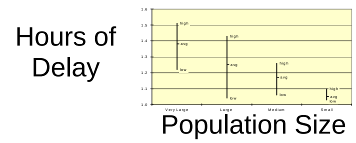
Table 2—1997 Urban Mobility Conditions

- Travel Rate Index is a measure of how long it take to travel in the peak period.
- Delay per Drive is a measure of the time lost in congestion.
- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1997 Travel Rate Index values
  - ✶ 1997 Rank of Travel Rate Index
  - ✶ 1997 Delay per Eligible Driver
  - ✶ 1997 Rank of Delay per Driver

- How much does travel time vary from city to city? (Exhibit 2)

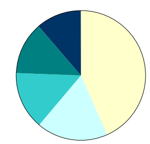


- How much does delay vary by city size? (Exhibit 3)



Other Exhibits

- Congestion Levels for Urban Area Groups—1997 (Exhibit 4)



- Shows the severity of congestion on the freeway and principal arterial streets.
- Contains these statistics
  - ✶Population group
  - ✶Uncongested percentage
  - ✶Moderate percentage
  - ✶Heavy percentage
  - ✶Severe percentage
  - ✶Extreme percentage

Table 2. 1997 Urban Mobility Conditions

Population Group	Urban Area	Travel Rate Index		Annual Delay per Driver	
		1997	Rank	Person-Hours	Rank
Vlg	Los Angeles, CA	1.51	1	82	1
Lrg	Seattle-Everett, WA	1.43	2	69	3
Vlg	San Francisco-Oakland, CA	1.42	3	58	7
Vlg	Washington, DC-MD-VA	1.41	4	76	2
Vlg	Chicago, IL-Northwestern, IN	1.37	5	44	20
Lrg	Miami-Hialeah, FL	1.34	6	57	10
Lrg	Atlanta, GA	1.34	6	68	4
Vlg	Boston, MA	1.32	8	66	5
Vlg	Detroit, MI	1.31	9	62	6
Lrg	San Diego, CA	1.31	9	36	29
Lrg	Las Vegas, NV	1.31	9	34	32
Lrg	Portland-Vancouver, OR-WA	1.30	12	52	12
Vlg	New York, NY-Northeastern, NJ	1.30	12	38	26
Vlg	Houston, TX	1.30	12	58	7
Lrg	San Jose, CA	1.29	15	45	18
Lrg	San Bernardino-Riverside, CA	1.28	16	47	15
Lrg	Phoenix, AZ	1.28	16	35	30
Lrg	Denver, CO	1.28	16	45	18
Med	Tacoma, WA	1.26	19	29	39
Lrg	Minneapolis-St. Paul, MN	1.26	19	34	32
Lrg	Sacramento, CA	1.24	21	38	26
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	1.24	21	31	35
Lrg	Dallas, TX	1.24	21	58	7
Lrg	St. Louis, MO-IL	1.24	21	52	12
Lrg	Baltimore, MD	1.23	25	47	15
Med	Charlotte, NC	1.23	25	41	21
Med	Austin, TX	1.23	25	53	11
Lrg	Cincinnati, OH-KY	1.22	28	31	35
Med	Honolulu, HI	1.22	28	29	39
Lrg	Indianapolis, IN	1.22	28	52	12
Vlg	Philadelphia, PA-NJ	1.22	28	27	44
Med	Salt Lake City, UT	1.22	28	23	48
Lrg	Columbus, OH	1.21	33	30	38
Lrg	Milwaukee, WI	1.21	33	25	46
Lrg	Orlando, FL	1.20	35	41	21
Med	Tampa, FL	1.19	36	41	21
Med	Albuquerque, NM	1.19	36	39	25
Med	Louisville, KY-IN	1.19	36	40	24
Med	Tucson, AZ	1.19	36	28	42
Lrg	New Orleans, LA	1.19	36	25	46
Lrg	Cleveland, OH	1.18	41	20	51
Lrg	Norfolk, VA	1.18	41	34	32
Med	Memphis, TN-AR-MS	1.17	43	29	39
Med	Omaha, NE-IA	1.16	44	31	35
Lrg	Fort Worth, TX	1.16	44	38	26

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 2. 1997 Urban Mobility Conditions, continued

Population Group	Urban Area	Travel Rate Index		Annual Delay per Driver	
		1997	Rank	Person-Hours	Rank
Lrg	San Antonio, TX	1.15	46	26	45
Med	Jacksonville, FL	1.14	47	35	30
Med	Nashville, TN	1.13	48	46	17
Med	Fresno, CA	1.13	48	19	52
Med	Providence-Pawtucket, RI-MA	1.13	48	21	50
Sml	Colorado Springs, CO	1.10	51	16	54
Med	Hartford-Middletown, CT	1.09	52	23	48
Lrg	Oklahoma City, OK	1.09	52	18	53
Lrg	Kansas City, MO-KS	1.09	52	28	42
Med	El Paso, TX-NM	1.08	55	12	57
Sml	Salem, OR	1.08	55	15	55
Lrg	Pittsburgh, PA	1.08	55	15	55
Sml	Eugene-Springfield, OR	1.06	58	8	61
Sml	Spokane, WA	1.06	58	11	59
Med	Rochester, NY	1.06	58	11	59
Sml	Beaumont, TX	1.05	61	12	57
Sml	Boulder, CO	1.05	61	6	66
Sml	Bakersfield, CA	1.05	61	8	61
Sml	Laredo, TX	1.05	61	6	66
Lrg	Buffalo-Niagara Falls, NY	1.04	65	7	65
Sml	Brownsville, TX	1.04	65	3	68
Sml	Albany-Schenectady-Troy, NY	1.03	67	8	61
Sml	Corpus Christi, TX	1.03	67	8	61
	68 area average	1.29		34	
	Very large area average	1.38		54	
	Large area average	1.25		40	
	Medium area average	1.17		31	
	Small area average	1.05		10	

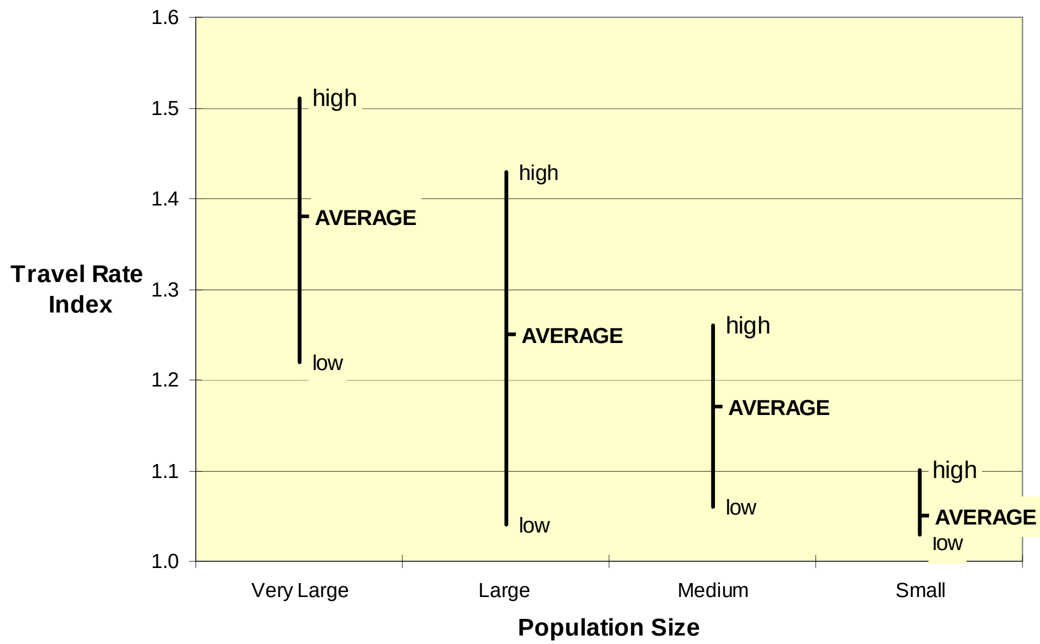
Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

- On average, it takes over 29 percent longer to make a peak trip than the same off-peak trip.
- The largest urban areas suffer greater penalties for making peak period trips (about 38 percent additional time to make the trip).
- Small urban areas only have about 5 percent additional time for a peak trip.
- Los Angeles tops the list with over 50 percent more time needed for a peak trip as compared to the same off-peak trip.
- Albany and Corpus Christi are at the bottom with about 3 percent additional time required for a peak trip over a free-flow trip.
- On average, drivers spend about 34 hours per year stuck in traffic. This equates to the time that it takes to:
    - Watch 11 NFL football games,
    - complete 35 percent of the 1999 Tour de France,
    - watch Gone with the Wind over 9 times, or
    - listen to over half of the audio version of War and Peace.
- Drivers spent the equivalent of more than one work week stuck in traffic in 24 of the urban areas.
- Drivers spent the equivalent of more than one-half of a work week stuck in traffic in 51 of the 70 urban areas.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 2

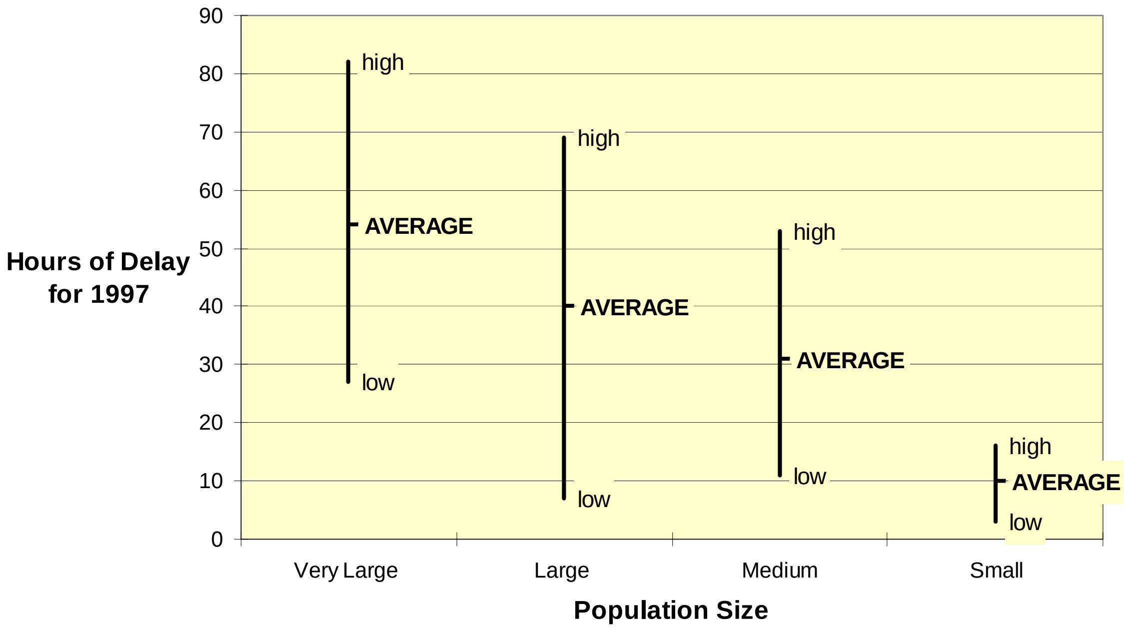
How much does travel time vary from city to city?



- Travel times vary significantly, even for urban areas of similar size.
- The Large urban area group has the widest range of TRI values, with 0.39 separating the High and Low values.
- The Small urban area group has the narrowest range of TRI values, with 0.07 separating the High and Low values.

Exhibit 3

How much does delay vary by city size?
(annual delay per driver)

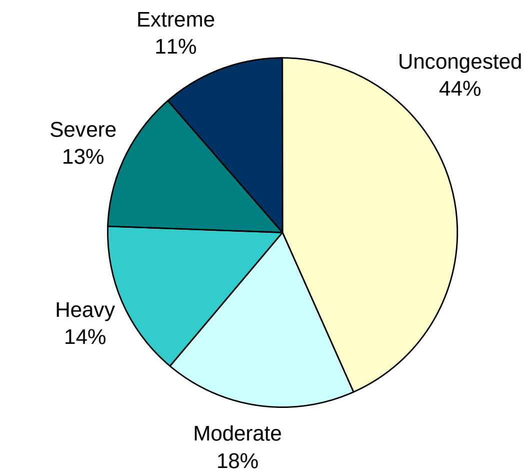


- ➢ Average annual delay per driver ranges from nine hours per year in the Small urban areas to about 59 hours per year in the Very Large urban areas.
- ♦ While average total delay (measured in millions of hours) in the Very Large urban areas is over five times that of the Large urban areas, delay per driver is only about 50 percent greater in the Very Large urban areas than the Large urban areas.
- ♦ The average delay per driver value in the Small urban areas is 10 hours per driver, about ¼ work week.
- ♦ The average delay per driver value in the Medium urban areas is 31 hours per driver, about ¾ work week.
- ♦ The average delay per driver value in the Large urban areas is 40 hours per driver, about one work week.
- ♦ The average delay per driver value in the Very Large urban areas is 54 hours per driver, almost 1½ work weeks.

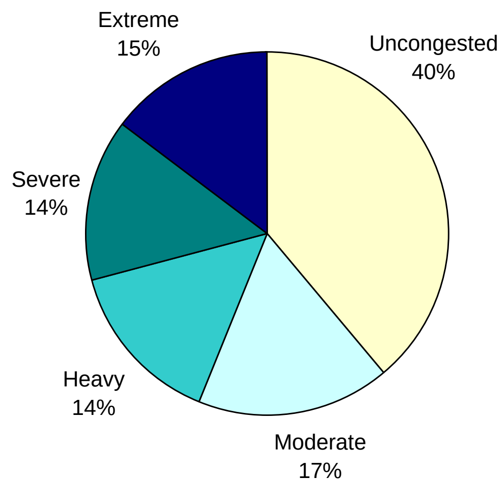
CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 4. Congestion Levels for Urban Area Groups—1997

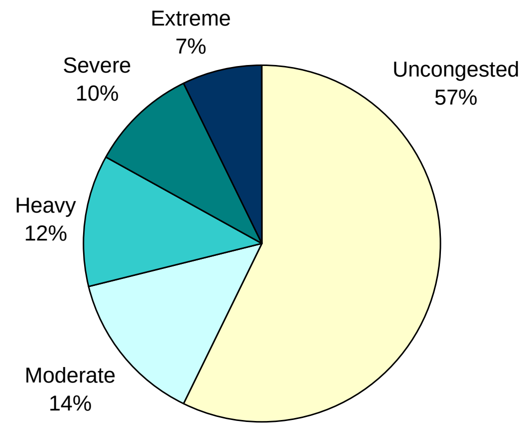
All Areas



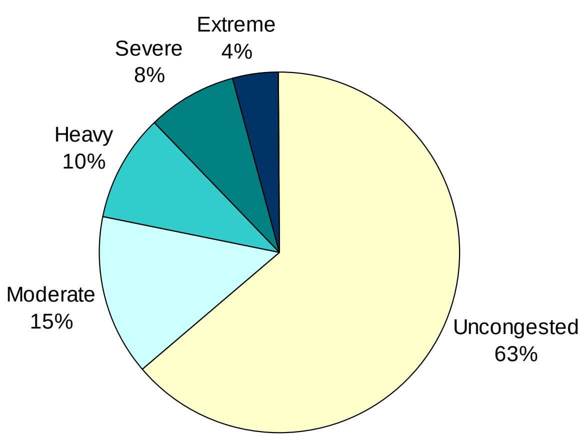
Very Large Urban Areas



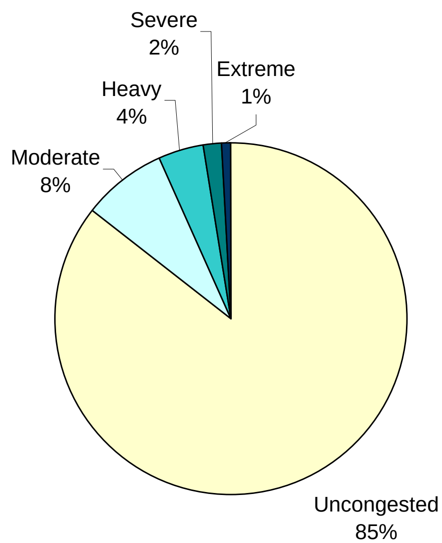
Large Urban Areas



Medium Urban Areas



Small Urban Areas



Traffic Volume Range and Congestion Level

Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

- In general, there are more congested lane-miles in large urban areas and the congestion is more intense.
- Uncongested lane-miles comprise just under half (44 percent) of the roadway system, on average, in the 68 urban areas.
- Uncongested lane-miles range from 40 percent in the Very Large urban areas up to 85 percent in the Small urban areas.
- The larger population groups have more congested lane-miles in the severe and extreme levels.

CHAPTER III. WHAT IS THE TREND?

SUMMARY

Fifty-eight of the urban areas had estimated peak-period travel time penalty increases of more than 100 percent between 1982 and 1997 (Table 3). The average increase in the peak period time penalty for all 68 urban areas between 1982 and 1997 was 107 percent. The largest increase in travel time penalties occurred in the Small urban areas, with 400 percent growth between 1982 and 1997. The smallest average increase occurred in the Very Large urban areas with a growth of about 81 percent in travel time penalties between 1982 and 1997.

While the magnitude of the percentage increase is something different, the trend is generally the same for delay per driver values. The inclusion of incident effects in the delay per driver calculation accounts for much of the difference.

The average increase in delay per driver for all 68 urban areas was 181 percent between 1982 and 1997 and 29 percent between 1992 and 1997 (Table 4). Only five urban areas (Brownsville, Hartford, Honolulu, San Francisco-Oakland and San Jose) in the study showed no increase in delay per driver between 1992 and 1997, but these areas did have increases in delay per driver over the long-term (between 1982 and 1997). Additionally, there were only four urban areas where delay per driver did not at least double between 1982 and 1997.

The percent of congested peak period travel on the freeways in all 68 areas increased by about 22 percentage points between 1982 and 1997 to include about 68 percent of travel (Table A-2 in Appendix A). The amount of congested peak period travel in the two most severe categories (severe and extreme) more than doubled between 1982 and 1997 in the 68 urban areas (14 percent to 36 percent) (Exhibit 9).

The percent of congested peak period travel on the freeways at least tripled between 1982 and 1997 in 18 urban areas (Table A-2 in Appendix A). The percent of congested peak period freeway travel at least doubled in another 17 other urban areas between 1982 and 1997. In total, 51 of the 68 urban areas showed increases of at least 50 percent in the percentage of freeway travel that occurred in congested conditions between 1982 and 1997.

BACKGROUND

As discussed in Chapter II, the TRI provides a means of looking at what effect recurring delay has on travel time during the peak period. Similarly, delay per driver shows the effect of both heavy traffic demands (recurring delay) and incidents (accidents, breakdowns, etc.) on travel time during the peak periods. This chapter focuses on how these two measures have changed over the years in each urban area and the general study trends.

The severity of traffic congestion is also investigated in this chapter. The analysis shows the change in the amount of travel that must endure congested conditions. It also indicates the rise in travel on the most congested sections of roadway.

TABLES AND EXHIBITS

Table 3—Travel Rate Index, 1982 to 1997

- A measure of how long it takes to travel in the peak
- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1982 to 1997 data
  - ✶ Travel Rate Index values
  - ✶ Percent Change in Time Penalties, Long-Term and Short-Term

- Does city size affect the increase in travel times? (Exhibit 5)

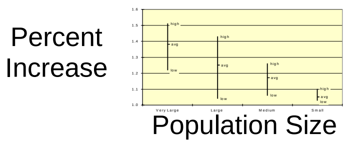
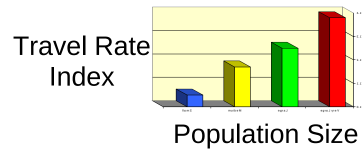


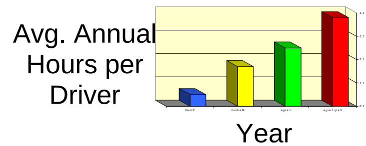
Table 4—Annual Delay per Driver, 1982 to 1997

- A measure of how the time lost in congestion
- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1982 to 1997 data
  - ✶ Annual Delay per Eligible Driver values
  - ✶ Percent Change, Long-Term and Short-Term

- How did travel times change from 1982 to 1997? (Exhibit 6)

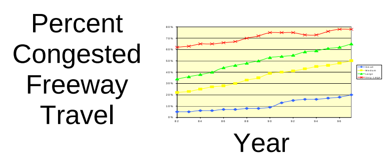


- How has driver delay grown? (Exhibit 7)

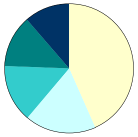


Other Exhibits

- How much freeway travel is congested? (Exhibit 8)



- Travel conditions in all study areas (Exhibits 9 through 13)
  - ✶ Congested levels by population groups
  - ✶ 1982 to 1997 data



CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 3. Travel Rate Index, 1982 to 1997

Population Group	Urban Area	Travel Rate Index							Percent Change in Peak Period Time Penalty			
									Long-Term 1982 to 1997		Short-Term 1992 to 1997	
		1982	1986	1990	1992	1995	1996	1997	Percent	Rank	Percent	Rank
Sml	Laredo, TX	1.02	1.02	1.03	1.02	1.04	1.05	1.05	150	52	150	1
Lrg	Indianapolis, IN	1.02	1.04	1.07	1.09	1.20	1.21	1.22	1,000	1	144	2
Lrg	Atlanta, GA	1.09	1.16	1.14	1.15	1.27	1.30	1.34	278	32	127	3
Lrg	Cleveland, OH	1.03	1.04	1.07	1.08	1.14	1.16	1.18	500	10	125	4
Lrg	Kansas City, MO-KS	1.02	1.03	1.04	1.04	1.07	1.07	1.09	350	24	125	4
Lrg	Oklahoma City, OK	1.01	1.02	1.04	1.04	1.06	1.08	1.09	800	4	125	4
Sml	Eugene-Springfield, OR	1.01	1.01	1.02	1.03	1.03	1.04	1.06	500	10	100	7
Lrg	Minneapolis-St. Paul, MN	1.03	1.07	1.11	1.13	1.21	1.22	1.26	767	5	100	7
Sml	Salem, OR	1.01	1.02	1.03	1.04	1.06	1.07	1.08	700	6	100	7
Med	Albuquerque, NM	1.02	1.05	1.08	1.10	1.15	1.17	1.19	850	3	90	10
Med	Memphis, TN-AR-MS	1.03	1.04	1.07	1.09	1.15	1.16	1.17	467	14	89	11
Lrg	San Antonio, TX	1.05	1.10	1.08	1.08	1.12	1.14	1.15	200	42	88	12
Med	Nashville, TN	1.04	1.05	1.08	1.07	1.11	1.12	1.13	225	36	86	13
Lrg	St. Louis, MO-IL	1.07	1.09	1.12	1.13	1.23	1.23	1.24	243	33	85	14
Med	Salt Lake City, UT	1.03	1.03	1.08	1.12	1.20	1.22	1.22	633	7	83	15
Sml	Bakersfield, CA	1.01	1.02	1.03	1.03	1.04	1.04	1.05	400	19	67	16
Sml	Beaumont, TX	1.01	1.01	1.02	1.03	1.04	1.04	1.05	400	19	67	16
Sml	Boulder, CO	1.01	1.02	1.03	1.03	1.04	1.04	1.05	400	19	67	16
Sml	Colorado Springs, CO	1.01	1.02	1.04	1.06	1.09	1.09	1.10	900	2	67	16
Med	Austin, TX	1.08	1.11	1.12	1.14	1.17	1.18	1.23	188	47	64	20
Lrg	Columbus, OH	1.04	1.05	1.11	1.13	1.19	1.18	1.21	425	16	62	21
Med	Louisville, KY-IN	1.03	1.05	1.07	1.12	1.16	1.18	1.19	533	9	58	22
Lrg	Denver, CO	1.07	1.10	1.16	1.18	1.24	1.26	1.28	300	28	56	23
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	1.05	1.08	1.10	1.16	1.19	1.21	1.24	380	22	50	24
Lrg	Norfolk, VA	1.06	1.11	1.13	1.12	1.14	1.17	1.18	200	42	50	24
Med	Rochester, NY	1.01	1.02	1.04	1.04	1.06	1.06	1.06	500	10	50	24
Sml	Spokane, WA	1.01	1.02	1.03	1.04	1.05	1.05	1.06	500	10	50	24
Lrg	Las Vegas, NV	1.06	1.09	1.23	1.21	1.32	1.33	1.31	417	17	48	28
Med	Tucson, AZ	1.07	1.06	1.13	1.13	1.14	1.15	1.19	171	51	46	29
Med	Charlotte, NC	1.07	1.08	1.14	1.16	1.17	1.18	1.23	229	35	44	30
Lrg	Portland-Vancouver, OR-WA	1.07	1.13	1.18	1.21	1.29	1.31	1.30	329	26	43	31
Lrg	Dallas, TX	1.08	1.16	1.16	1.17	1.21	1.21	1.24	200	42	41	32
Vlg	Houston, TX	1.26	1.31	1.24	1.22	1.22	1.25	1.30	15	67	36	33
Lrg	Baltimore, MD	1.08	1.11	1.19	1.17	1.22	1.22	1.23	188	47	35	34
Sml	Brownsville, TX	1.01	1.01	1.03	1.03	1.04	1.04	1.04	300	28	33	35
Lrg	Buffalo-Niagara Falls, NY	1.02	1.02	1.03	1.03	1.04	1.04	1.04	100	58	33	35
Lrg	Fort Worth, TX	1.05	1.09	1.12	1.12	1.14	1.15	1.16	220	40	33	35
Lrg	Phoenix, AZ	1.12	1.19	1.19	1.21	1.22	1.27	1.28	133	53	33	35
Med	Fresno, CA	1.04	1.07	1.11	1.10	1.11	1.10	1.13	225	36	30	39
Med	Providence-Pawtucket, RI-MA	1.04	1.07	1.12	1.10	1.12	1.13	1.13	225	36	30	39
Lrg	Cincinnati, OH-KY	1.05	1.07	1.14	1.17	1.20	1.20	1.22	340	25	29	41
Vlg	Philadelphia, PA-NJ	1.14	1.16	1.17	1.17	1.19	1.22	1.22	57	63	29	41
Vlg	Boston, MA	1.10	1.15	1.23	1.25	1.30	1.31	1.32	220	40	28	43
Med	Jacksonville, FL	1.05	1.06	1.10	1.11	1.14	1.15	1.14	180	50	27	44
Lrg	Sacramento, CA	1.05	1.09	1.20	1.19	1.23	1.24	1.24	380	22	26	45

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 3. Travel Rate Index, 1982 to 1997, continued

Population Group	Urban Area	Travel Rate Index							Percent Change in Peak Period Time Penalty			
									Long-Term 1982 to 1997		Short-Term 1992 to 1997	
		1982	1986	1990	1992	1995	1996	1997	Percent	Rank	Percent	Rank
Vlg	New York, NY-Northeastern, NJ	1.16	1.18	1.26	1.24	1.27	1.28	1.30	88	59	25	46
Med	Omaha, NE-IA	1.04	1.06	1.11	1.13	1.16	1.17	1.16	300	28	23	47
Vlg	Chicago, IL-Northwestern, IN	1.16	1.27	1.31	1.31	1.33	1.36	1.37	131	54	19	48
Vlg	Detroit, MI	1.14	1.17	1.25	1.26	1.26	1.29	1.31	121	56	19	48
Lrg	Milwaukee, WI	1.05	1.08	1.14	1.18	1.20	1.21	1.21	320	27	17	50
Med	El Paso, TX-NM	1.02	1.04	1.05	1.07	1.08	1.07	1.08	300	28	14	51
Vlg	Washington, DC-MD-VA	1.20	1.27	1.35	1.36	1.38	1.41	1.41	105	57	14	51
Med	Tacoma, WA	1.04	1.10	1.19	1.23	1.23	1.24	1.26	550	8	13	53
Lrg	Orlando, FL	1.07	1.11	1.12	1.18	1.16	1.18	1.20	186	49	11	54
Lrg	San Bernardino-Riverside, CA	1.05	1.11	1.22	1.26	1.28	1.29	1.28	460	15	8	55
Lrg	Miami-Hialeah, FL	1.15	1.20	1.28	1.32	1.32	1.30	1.34	127	55	6	56
Med	Honolulu, HI	1.12	1.16	1.21	1.21	1.21	1.21	1.22	83	60	5	57
Lrg	Seattle-Everett, WA	1.13	1.22	1.36	1.41	1.38	1.39	1.43	231	34	5	57
Lrg	San Diego, CA	1.06	1.17	1.30	1.30	1.31	1.31	1.31	417	17	3	59
Vlg	Los Angeles, CA	1.31	1.41	1.51	1.50	1.50	1.50	1.51	65	61	2	60
Sml	Albany-Schenectady-Troy, NY	1.01	1.02	1.03	1.03	1.03	1.03	1.03	200	42	0	61
Sml	Corpus Christi, TX	1.03	1.03	1.03	1.03	1.03	1.03	1.03	0	68	0	61
Med	Hartford-Middletown, CT	1.03	1.05	1.09	1.09	1.07	1.08	1.09	200	42	0	61
Lrg	Pittsburgh, PA	1.05	1.06	1.08	1.08	1.08	1.08	1.08	60	62	0	61
Vlg	San Francisco-Oakland, CA	1.29	1.43	1.44	1.42	1.43	1.43	1.42	45	65	0	61
Lrg	San Jose, CA	1.09	1.17	1.29	1.30	1.30	1.30	1.29	222	39	-3	66
Lrg	New Orleans, LA	1.13	1.20	1.22	1.20	1.21	1.20	1.19	46	64	-5	67
Med	Tampa, FL	1.14	1.16	1.17	1.20	1.20	1.19	1.19	36	66	-5	67
	68 area average	1.14	1.19	1.25	1.25	1.27	1.28	1.29	107		16	
	Very large area average	1.21	1.29	1.35	1.34	1.36	1.37	1.38	81		12	
	Large area average	1.07	1.12	1.17	1.18	1.22	1.23	1.25	257		39	
	Medium area average	1.05	1.07	1.11	1.12	1.15	1.16	1.17	240		42	
	Small area average	1.01	1.02	1.03	1.04	1.04	1.05	1.05	400		25	

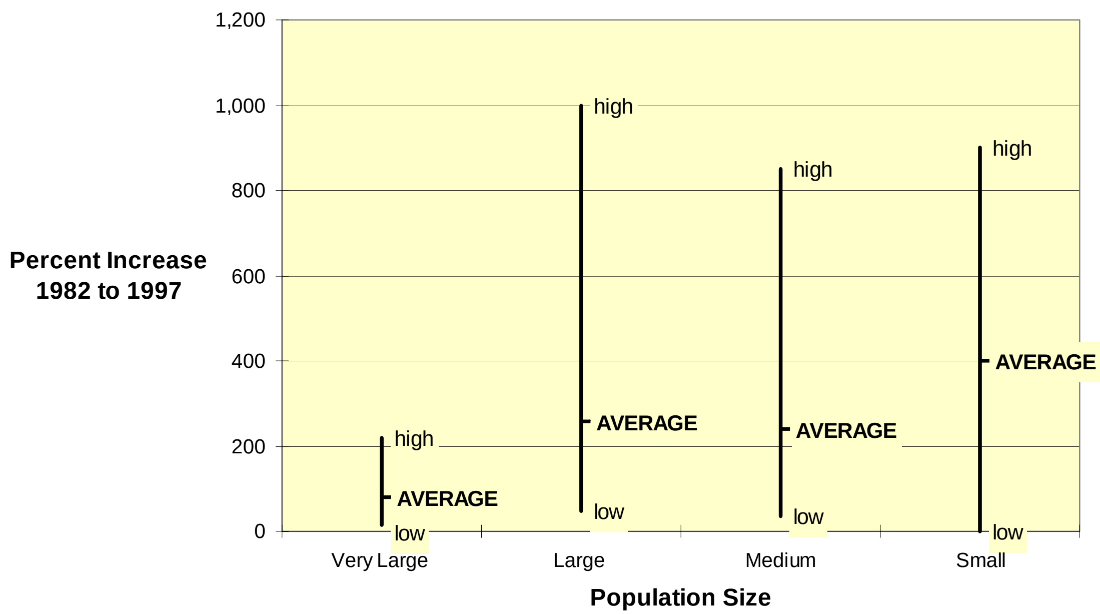
Notes: Only includes estimated freeway and principal arterial street travel conditions.
Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

- Corpus Christi was the only urban area to not have any long-term growth in the peak period time penalty between 1982 and 1997.
- Five urban areas had no short-term growth in the peak period time penalty between 1992 and 1997 (Albany, Corpus Christi, Hartford, Pittsburgh, and San Francisco-Oakland).
- Three urban areas had small declines in their peak period time penalty between 1992 and 1997 (New Orleans, San Jose and Tampa).
- The greatest long-term increase in the peak period time penalty between 1982 and 1997 by urban area size:
  - Very Large Boston 220 percent
  - Large Indianapolis 1,000 percent
  - Medium Albuquerque 850 percent
  - Small Colorado Springs 900 percent.
- The greatest short-term increase in the peak period time penalty between 1992 and 1997 by urban area size:
  - Very Large Houston 36 percent
  - Large Indianapolis 144 percent
  - Medium Albuquerque 90 percent
  - Small Laredo 150 percent.
- Corpus Christi is the only city with the same peak period time penalty change over both periods—indicating peak-travel penalties did not get worse between 1982 and 1992.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 5

Does city size affect the increase in travel times?
(change in peak period time penalty from 1982 to 1997)



- There is significant variation in TRI increase in all population groups.
- The range of percent increases in TRI was greatest for the Large population size, with about 952 percentage points separating the high and low.
- The range of percent increases in TRI was smallest for the Very Large population size, with only 205 percentage points separating the high and low.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 4. Annual Delay per Driver, 1982 to 1997

Population Group	Urban Area	Annual Delay per Eligible Driver							Long-Term Change 1982 to 1997		Short-Term Change 1992 to 1997	
		1982	1986	1990	1992	1995	1996	1997	Percent	Rank	Percent	Rank
Lrg	Indianapolis, IN	3	7	11	16	44	46	52	1,633	1	225	1
Sml	Laredo, TX	2	2	2	2	5	6	6	200	52	200	2
Lrg	Kansas City, MO-KS	3	6	11	11	20	24	28	833	9	155	3
Lrg	Atlanta, GA	16	33	27	30	53	61	68	325	39	127	4
Med	Nashville, TN	8	13	22	21	36	39	46	475	27	119	5
Med	Albuquerque, NM	4	9	15	18	31	34	39	875	8	117	6
Med	Tucson, AZ	5	5	13	13	18	20	28	460	28	115	7
Lrg	Cleveland, OH	2	4	9	10	16	19	20	900	5	100	8
Sml	Eugene-Springfield, OR	1	2	3	4	4	6	8	700	12	100	8
Med	Memphis, TN-AR-MS	4	5	10	15	26	28	29	625	17	93	10
Lrg	Minneapolis-St. Paul, MN	4	8	15	18	27	28	34	750	11	89	11
Sml	Salem, OR	1	3	6	8	11	12	15	1,400	2	88	12
Lrg	San Antonio, TX	7	19	12	14	21	24	26	271	44	86	13
Lrg	St. Louis, MO-IL	11	16	24	28	50	50	52	373	35	86	13
Sml	Spokane, WA	2	4	5	6	7	9	11	450	29	83	15
Med	Austin, TX	11	18	20	29	38	40	53	382	32	83	15
Lrg	Oklahoma City, OK	2	4	8	10	13	16	18	800	10	80	17
Lrg	Columbus, OH	3	6	16	17	26	26	30	900	5	76	18
Sml	Beaumont, TX	1	3	5	7	10	8	12	1,100	3	71	19
Med	Charlotte, NC	9	11	22	24	28	30	41	356	36	71	19
Med	Louisville, KY-IN	4	7	11	24	32	37	40	900	5	67	21
Med	Salt Lake City, UT	3	3	8	14	22	24	23	667	16	64	22
Vlg	Houston, TX	37	40	35	36	40	47	58	57	67	61	23
Lrg	Denver, CO	10	15	22	28	40	43	45	350	38	61	23
Sml	Colorado Springs, CO	2	4	6	10	14	14	16	700	12	60	25
Lrg	Fort Worth, TX	8	18	23	24	32	34	38	375	33	58	26
Med	Rochester, NY	1	2	6	7	10	11	11	1,000	4	57	27
Lrg	Norfolk, VA	9	17	22	22	26	32	34	278	43	55	28
Med	Jacksonville, FL	11	14	21	23	31	35	35	218	51	52	29
Lrg	Orlando, FL	9	15	14	27	30	35	41	356	36	52	29
Sml	Boulder, CO	1	2	3	4	5	5	6	500	22	50	31
Lrg	Dallas, TX	15	35	35	39	49	49	58	287	41	49	32
Lrg	Las Vegas, NV	7	11	28	23	35	37	34	386	31	48	33
Lrg	Cincinnati, OH-KY	5	8	18	21	26	28	31	520	19	48	33
Lrg	Baltimore, MD	13	20	36	33	44	45	47	262	45	42	35
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	5	9	11	22	26	27	31	520	19	41	36
Vlg	New York, NY-Northeastern, NJ	15	22	31	27	32	34	38	153	57	41	36
Lrg	Buffalo-Niagara Falls, NY	2	3	5	5	7	7	7	250	46	40	38
Vlg	Boston, MA	19	32	43	48	61	64	66	247	47	38	39
Lrg	Portland-Vancouver, OR-WA	9	18	27	38	50	55	52	478	26	37	40
Sml	Bakersfield, CA	1	3	5	6	7	8	8	700	12	33	41
Sml	Corpus Christi, TX	6	6	6	6	6	7	8	33	68	33	41
Med	Providence-Pawtucket, RI-MA	5	10	20	16	20	22	21	320	40	31	43
Vlg	Chicago, IL-Northwestern, IN	13	26	31	34	38	41	44	238	48	29	44
Med	Omaha, NE-IA	5	9	18	24	30	33	31	520	19	29	44

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 4. Annual Delay per Driver, 1982 to 1997, continued

Population Group	Urban Area	Annual Delay per Eligible Driver							Long-Term Change 1982 to 1997		Short-Term Change 1992 to 1997	
		1982	1986	1990	1992	1995	1996	1997	Percent	Rank	Percent	Rank
Vlg	Philadelphia, PA-NJ	16	20	21	21	23	26	27	69	65	29	49
Med	Fresno, CA	7	11	20	15	15	15	19	171	54	27	47
Lrg	Sacramento, CA	8	14	33	30	35	40	38	375	33	27	47
Vlg	Washington, DC-MD-VA	30	45	58	60	70	76	76	153	57	27	47
Lrg	Phoenix, AZ	16	25	29	28	28	33	35	119	60	25	50
Vlg	Detroit, MI	23	30	48	52	53	58	62	170	55	19	51
Lrg	Milwaukee, WI	5	8	15	21	28	26	25	400	30	19	51
Med	Tampa, FL	19	24	28	35	40	39	41	116	61	17	53
Lrg	Pittsburgh, PA	6	9	13	13	15	15	15	150	59	15	54
Sml	Albany-Schenectady-Troy, NY	1	3	7	7	8	9	8	700	12	14	55
Lrg	San Bernardino-Riverside, CA	7	21	38	43	47	50	47	571	18	9	56
Med	El Paso, TX-NM	2	4	7	11	12	10	12	500	22	9	56
Med	Tacoma, WA	5	13	29	27	26	26	29	480	25	7	58
Lrg	Miami-Hialeah, FL	22	29	48	54	54	50	57	159	56	6	59
Lrg	New Orleans, LA	12	20	24	24	28	26	25	108	62	4	60
Vlg	Los Angeles, CA	41	61	79	79	79	81	82	100	64	4	60
Lrg	San Diego, CA	6	18	34	35	35	36	36	500	22	3	62
Lrg	Seattle-Everett, WA	21	36	53	68	61	62	69	229	49	1	63
Sml	Brownsville, TX	1	1	3	3	4	4	3	200	52	0	64
Med	Hartford-Middletown, CT	6	14	25	23	18	20	23	283	42	0	64
Med	Honolulu, HI	14	20	25	29	30	29	29	107	63	0	64
Vlg	San Francisco-Oakland, CA	35	56	62	58	59	60	58	66	66	0	64
Lrg	San Jose, CA	14	28	49	48	47	47	45	221	50	-6	68
	68 area average	16	27	34	39	40	43	45	181		29	
	Very large area average	24	36	45	47	49	51	54	125		20	
	Large area average	10	17	25	33	35	37	40	300		43	
	Medium area average	7	10	18	24	26	28	31	343		55	
	Small area average	2	3	5	8	8	9	10	400		67	

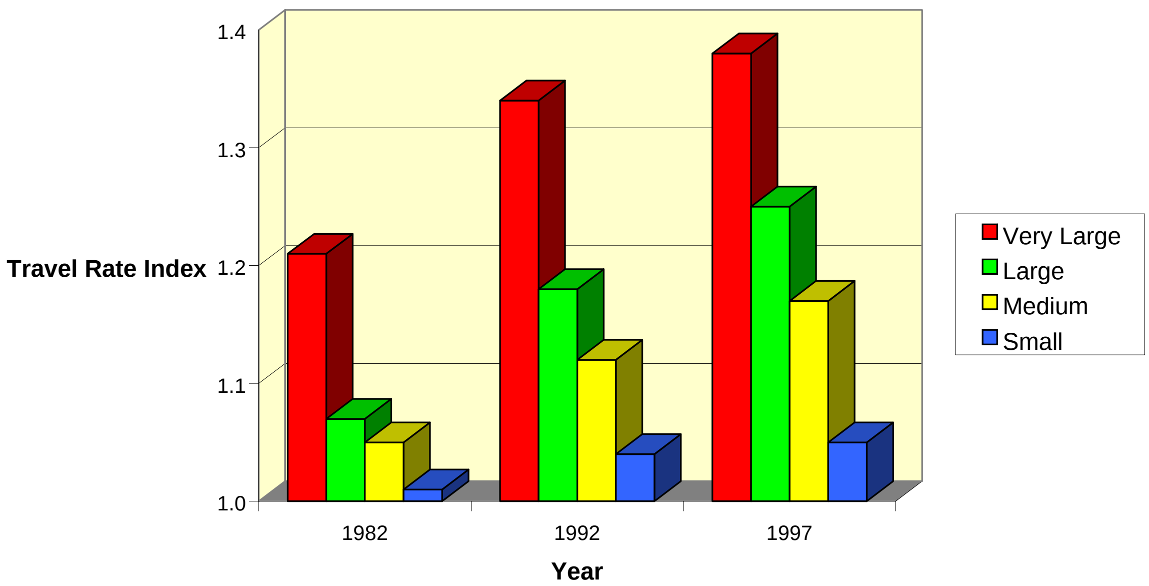
Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

- Only four areas—Houston, Corpus Christi, Philadelphia and San Francisco-Oakland—had long-term increases less than 100 percent.
- Four urban areas showed no short-term increase in delay per driver between 1992 and 1997 (Brownsville, Hartford, Honolulu, and San Francisco-Oakland).
- The greatest long-term increase in delay per driver between 1982 and 1997 by urban area size:
  - Very Large Boston 247 percent
  - Large Indianapolis 1,633 percent
  - Medium Rochester 1,000 percent
  - Small Salem 1,400 percent
- The greatest short-term increase in delay per driver between 1992 and 1997 by urban area size:
  - Very Large Houston 61 percent
  - Large Indianapolis 225 percent
  - Medium Nashville 119 percent
  - Small Laredo 200 percent

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 6

How did travel times change from 1982 to 1997?

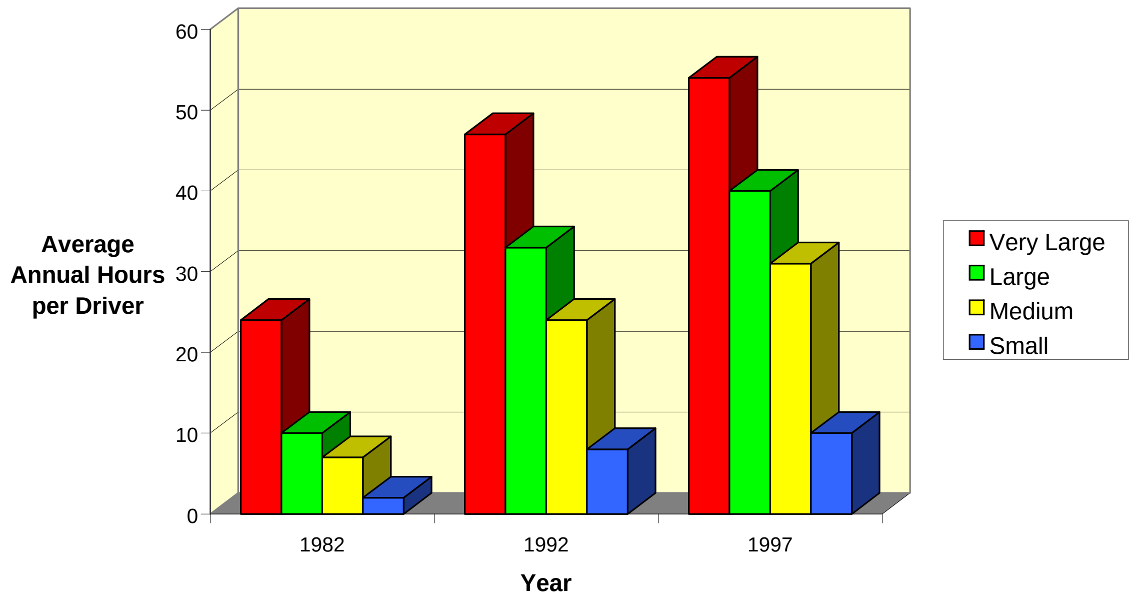


- ➢ The separation between Small and all other group average TRI values increased significantly from 1982 to 1997.
- ♦ The TRI values in 1982 range from 1.01 in the Small urban areas to 1.21 in the Very Large urban areas.
- ♦ The TRI values in 1997 range from 1.05 in the Small urban areas to 1.38 in the Very Large urban areas.
- ♦ The largest increase in TRI came in the Large urban areas, with about a 17 percent increase between 1982 and 1997.
- ♦ The Very Large urban areas experienced the second largest increase of about 14 percent between 1982 and 1997.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 7

How has driver delay grown?

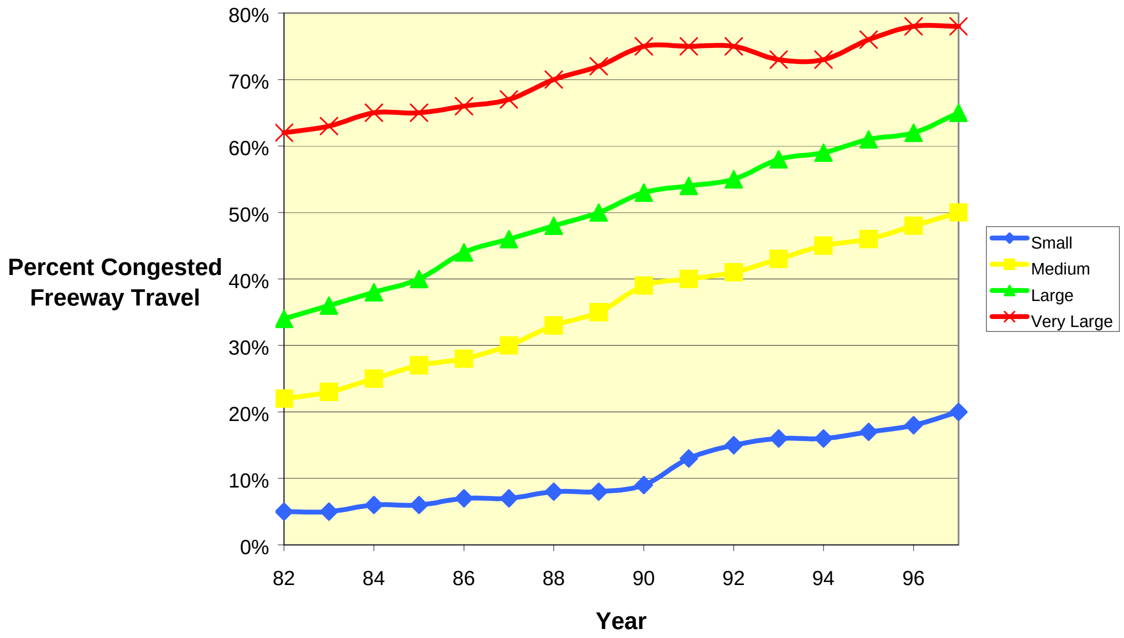


- The hours of delay per driver since 1982 has more than doubled in the Very Large urban areas, quadrupled in the Large and Medium urban areas, and has quintupled in the Small urban areas.
- The 1997 delay per driver in the Small urban areas is equal to the 1982 delay per driver in the Large urban areas.
- The 1997 delay per driver in the Medium urban areas is greater than the 1982 delay per driver in the Very Large urban areas.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 8

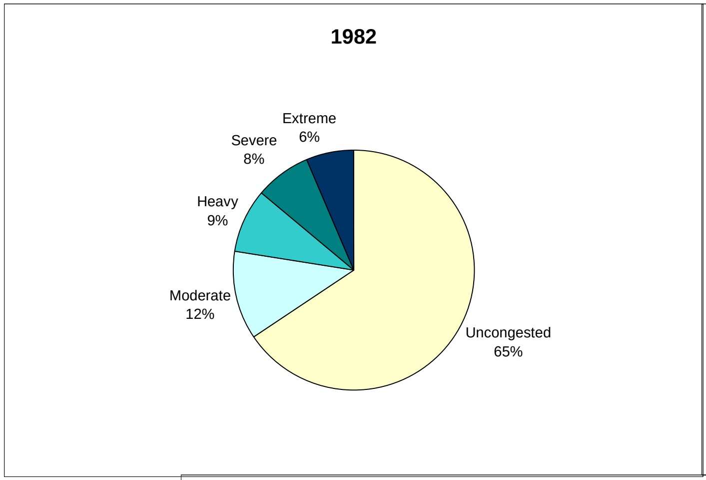
How much freeway travel is congested?

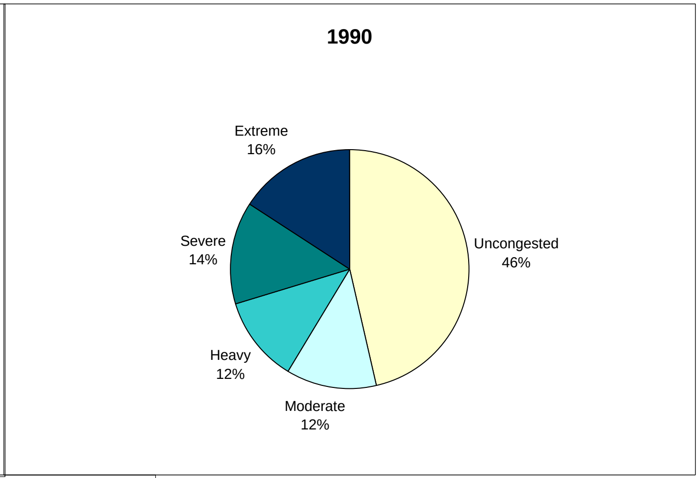


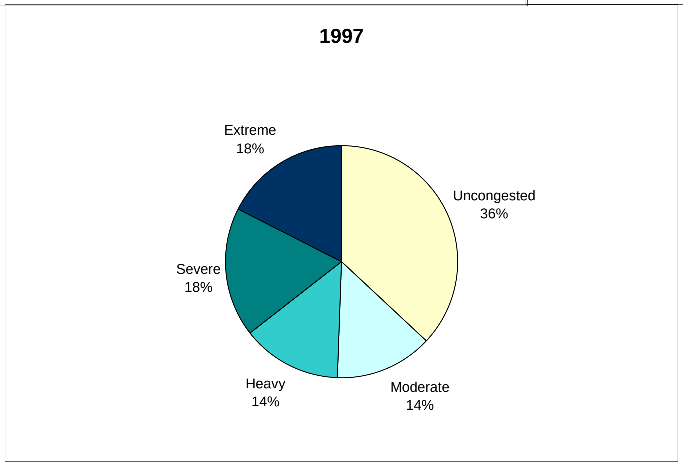
- ➢ Congested travel in the population groups increased by between 26 percent (Very Large) and 300 percent (Small) from 1982 to 1997.
- ♦ The percent of congested freeway travel in the Medium and Large urban areas is increasing faster than in the Small and Very Large urban areas.
- ♦ The percent of congested freeway travel in the Small and Very Large urban areas increased at about the same rate between 1982 and 1997.
- ♦ The percent of congested freeway travel in the Medium and Large urban areas increased at about the same rate between 1982 and 1997.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 9. Travel Conditions in All Study Areas
(percent of Travel in Each Congestion Condition Category)







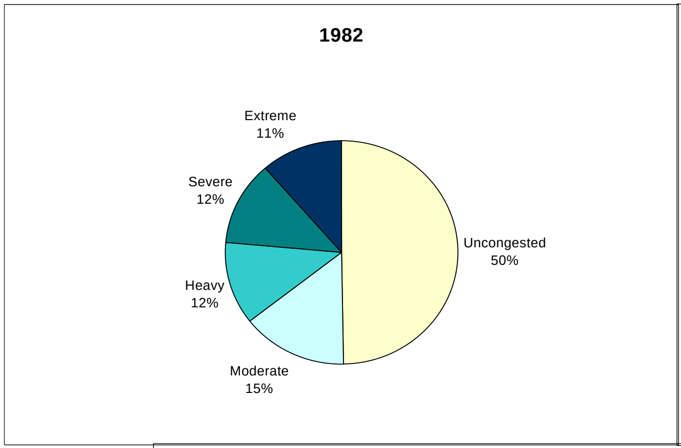
Traffic Volume Range and Congestion Level

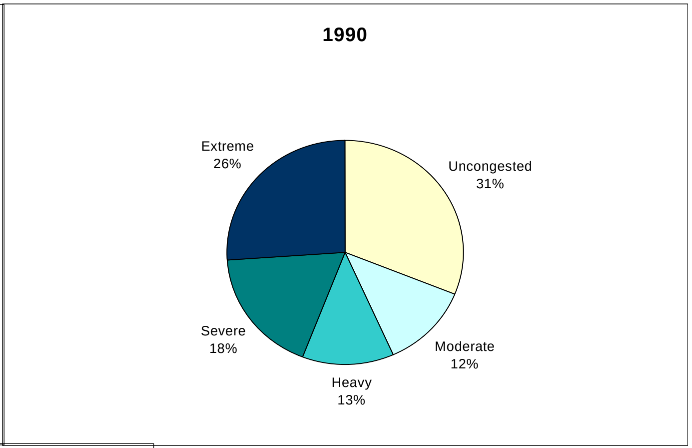
Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

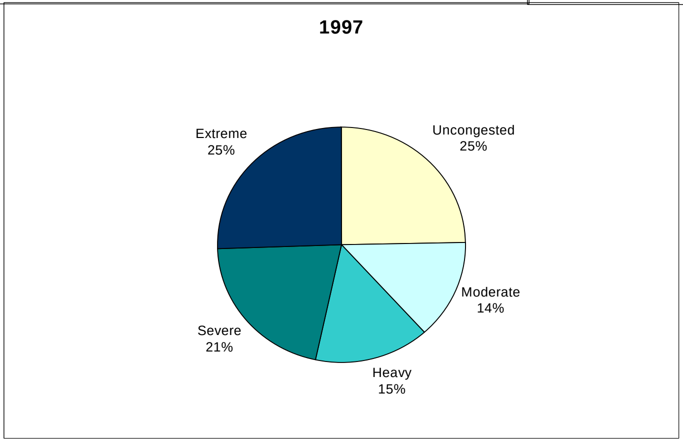
- Uncongested travel in all 68 urban areas fell from about two-thirds of the travel in 1982 (65 percent) to about one-third of the travel in 1997 (36 percent).
- Uncongested travel percentage gets larger as the urban area size gets smaller.
- The percentage of travel in the severe and extreme conditions gets smaller as the urban area gets smaller.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 10. Travel Conditions in Very Large Study Areas





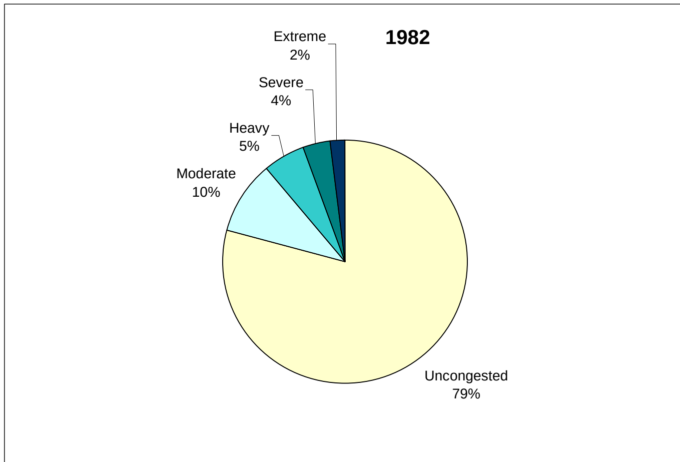


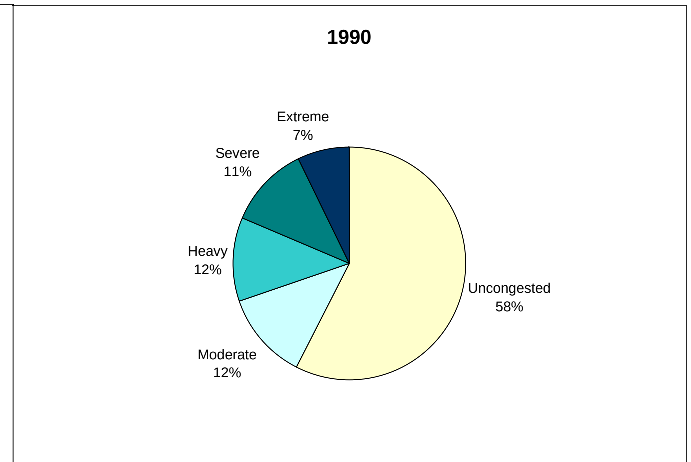
Traffic Volume Range and Congestion Level

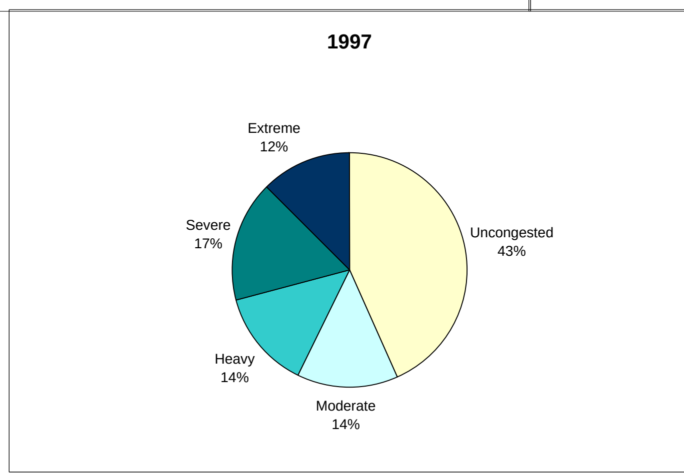
Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 11. Travel Conditions in Large Study Areas





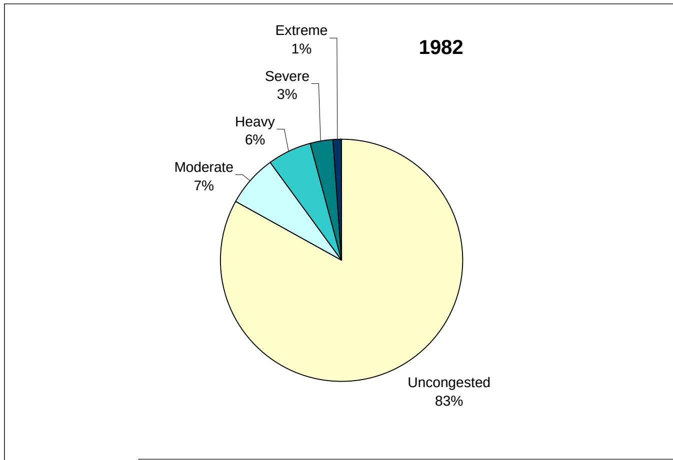


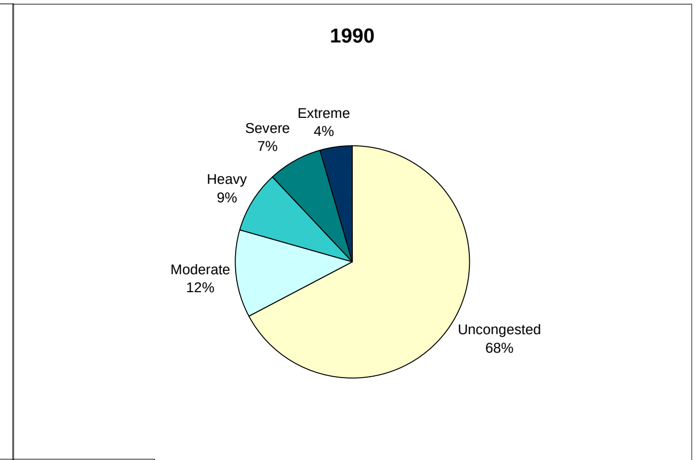
Traffic Volume Range and Congestion Level

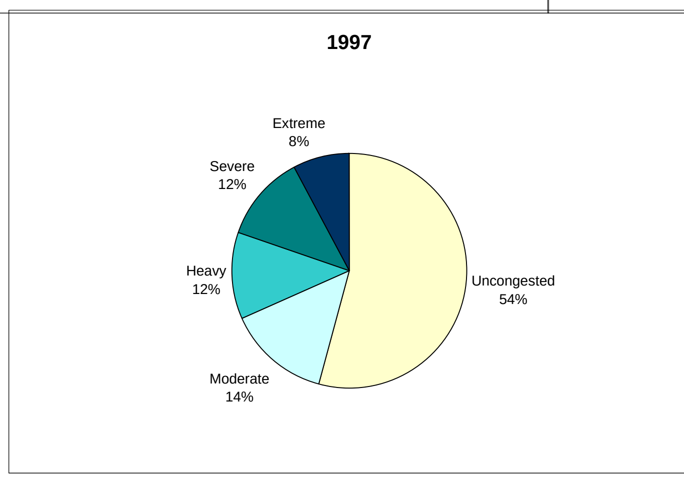
Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 12. Travel Conditions in Medium Study Areas





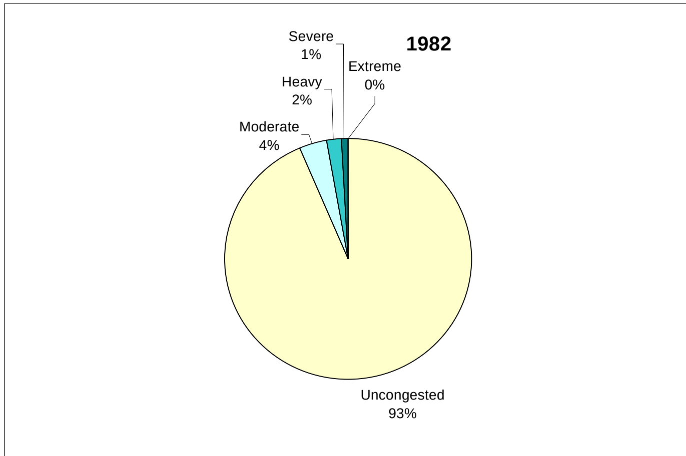


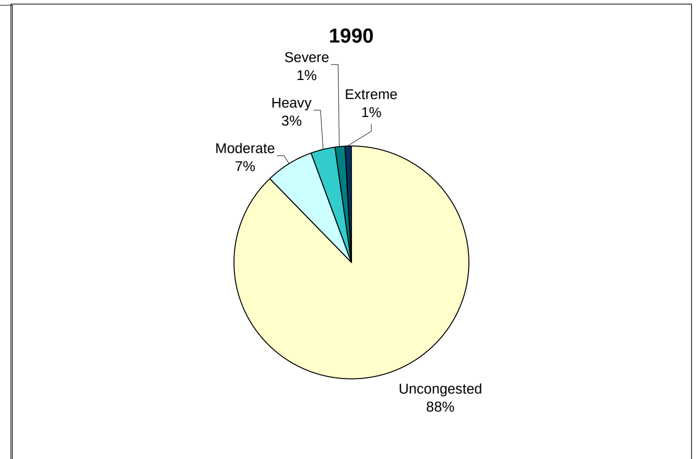
Traffic Volume Range and Congestion Level

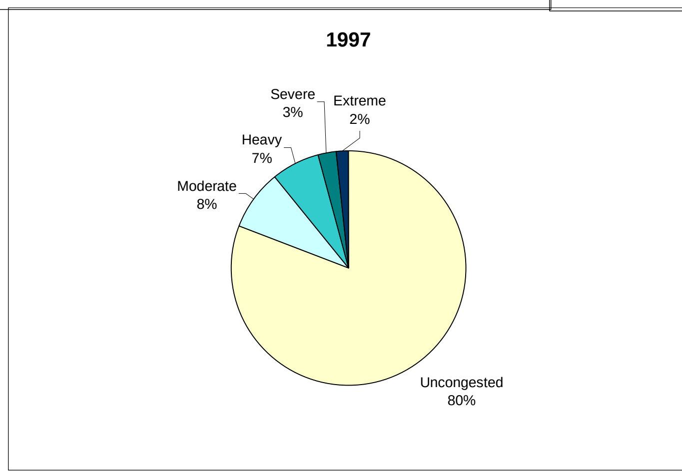
Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 13. Travel Conditions in Small Study Areas







Traffic Volume Range and Congestion Level

Congestion Level	Daily Traffic Volume per Lane	
	Freeway	Principal Arterial
Uncongested	Under 15,000	Under 5,500
Moderate	15,001-17,500	5,501-7,000
Heavy	17,501-20,000	7,001-8,500
Severe	20,001-25,000	8,501-10,000
Extreme	over 25,000	over 10,000

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

CHAPTER IV. WHAT CAN WE LEARN ABOUT MOBILITY TRENDS?

SUMMARY

This analysis tries to answer the question "is road construction a mobility benefit in urban areas?" Some argue that road construction hurts mobility because it induces additional travel that did not exist before the new construction. This additional travel adds to the congestion problem. Others argue that the number of trips in an area is governed by the land use and development patterns. New roadway redistributes trips to different times and road sections, improving the overall mobility provided to system users. One question that cannot be answered by the analysis presented here is "would the land use patterns be the same or would the development occur somewhere else—either in the same city or a different part of the country—if the new roadway were not added?"

The analysis in this chapter shows that overall mobility in urban areas is better if areas attempt to construct additional roadway at a pace similar to that of traffic demand growth. There is a correlation between the lane-mile addition "deficit" and mobility levels. If roadway is not added at a pace similar to the growth in traffic demand, travel time and delay per person increases. ***The bottom line from this analysis: Road construction does help slow the growth of traffic congestion, but roadway expansion opportunities are often limited because of environmental concerns, public opinion, and construction costs.***

BACKGROUND

The Urban Mobility Study provides a source of trend information to researchers, planners and operators in the 68 U.S. urban transportation systems. The annual report has traditionally provided a basic analysis of some trends and relationships. There are many other possible uses for the data set, and this section explores some of those. The general theme of this section relates to the relationship between urban area mobility and roadway system improvements. This analysis is performed at the urban area level—too broad to be used for planning or evaluating individual projects, but with enough information to explore some questions about urban transportation systems.

QUESTIONS

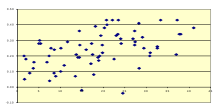
Question 1. How do the measures compare?

- Reviews the measures to be used in the analysis

Question 2. Do additional roads slow down the growth of delay?

- Roadway congestion and travel rates (Exhibit 14)

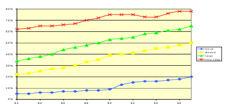
Roadway Congestion Index Increases



Travel Rate Index Increase

- The effect of roadway increases on travel time (Exhibit 15)

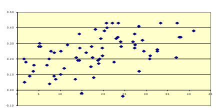
The Travel Time Growth Index



Year

- Change in congestion level and delay (Exhibit 16)

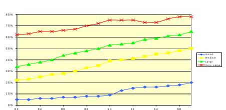
Roadway Congestion Index Increases



Delay per Driver Increase

- Change in delay per person for congestion growth groups (Exhibit 17)

Travel Delay Growth Increase

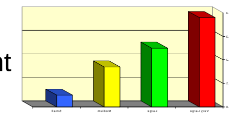


Year

Question 3. How much does the lack of roadway construction affect travel times.

- How much does the lack of road construction affect travel times. (Exhibit 18)

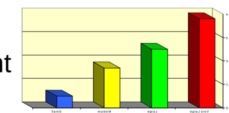
Percent



Lane-Mile Construction Deficit Group

- How much does the lack of road construction affect delay? (Exhibit 19)

Percent



Group

Question 1: How do the measures compare?

The indicators used in this analysis present three aspects of mobility. The Roadway Congestion Index (RCI), the Travel Rate Index (TRI) and delay per person (DPP) are created by different calculation procedures and provide three somewhat different views of the data. The RCI does not differentiate between mileage added because of roadway widening projects and mileage added due to urban boundary changes. The analyses will, therefore, discuss mileage "added" as opposed to "constructed."

Travel Rate Index—A comparison of travel time in the peak period to travel time in free-flow conditions. The TRI is calculated with the speed estimates for freeways and principal arterials. The estimates are based on the daily traffic volume per lane for the roadway segments in urban areas. The travel time estimates are for days when incidents do not seriously affect the transportation system. The index estimates the average travel conditions experienced by travelers on non-incident days.

Delay per Person—The Urban Mobility Study develops estimates of delay due to typical high volumes of traffic and delay caused by accidents and vehicle breakdowns. The total delay is divided by the number of urban area residents to create an estimate of the annual time penalties experienced by roadway users.

Roadway Congestion Index—A traffic density indicator (vehicles per road space) that indirectly measures traffic congestion. The RCI presents an areawide average estimate of traffic and tends to overstate the contribution to mobility improvement of lane-miles that typically have lower traffic densities, such as toll highways. The database includes toll highway mileage as equivalent to freeways, although the traffic volumes are usually lower. However, the freeway traveler will not necessarily notice a similar decrease in their travel time if the toll highway does not attract a significant number of trips.

Does it Measure:	RCI	TRI	DPP
Traffic density?	Yes	No	No
Travel delay?	No	Yes	Yes
Individual traveler experience?	Yes	Yes	Yes
Congestion due to daily traffic volumes?	Yes	Yes	Yes
Congestion due to incidents?	No	No	Yes
Average congestion level?	Yes	No	No
Effect of bottlenecks or isolated points of congestion?	No	No	No
Effect of congestion on a few sections of road?	No	Yes	Yes

Question 2: Do additional roads slow down the growth of delay?

The comparisons in this section (shown in Exhibits 14 through 17) address the issue of whether or not roadway additions made significant differences in the delay experienced by drivers in urban areas between 1982 and 1997. This period illustrates several instances of rapid population growth, usually accompanied by road congestion growth. The length of time needed to plan and construct major transportation improvements means that very few areas see a rapid increase in economic activity and population without a significant growth in congestion. Examining these factors over several years allowed the researchers to identify the responses to growth, which include:

- The RCI compares growth of traffic to new roadway. The measure should not be interpreted as indicating new roadway is the only method for alleviating congestion, but rather a measure that indicates the construction response to traffic growth.
- The TRI and DPP are good mobility measures for analyzing delay. The TRI accounts for only recurrent delay while DPP includes recurrent and incident delay.
- The analysis compares the growth in the RCI (how quickly travel is outpacing roadway expansion) with changes in mobility, as measured by the TRI and delay per person. If road growth is faster than the traffic growth, the RCI will decline. If additional roads slow down the growth in delay, areas where the RCI does not increase rapidly will also see relatively slow growth in the TRI and DPP.
- The RCI can be used as a control factor to identify the urban area roadway systems that are either not growing rapidly or those that are constructing new facilities at approximately the same rate as traffic is growing. These areas should show relatively slow growth in TRI and DPP if road construction has the intended effect. Areas where the RCI increases, indicating slow growth in roadway and rapid growth in vehicle travel, should show an increase in TRI and DPP.

Unfortunately, the analyses does not include the benefits or traveler impacts of operational improvements, incident management programs, transit improvements, and a variety of policy actions are not included in any of the measures. As improvements are made to the study methodology, many of these important programs will become part of the measured factors.

The units of change for each measure are the decimal points for RCI and TRI, and the number of hours of DPP. In the case of TRI and DPP, these units indicate the lengthening of trip times. This approach also eliminates some of the confusion caused by very low delay values in some smaller areas in 1982. Relatively small increases in travel time will be calculated as large percentage increases if the 1982 value was relatively low.

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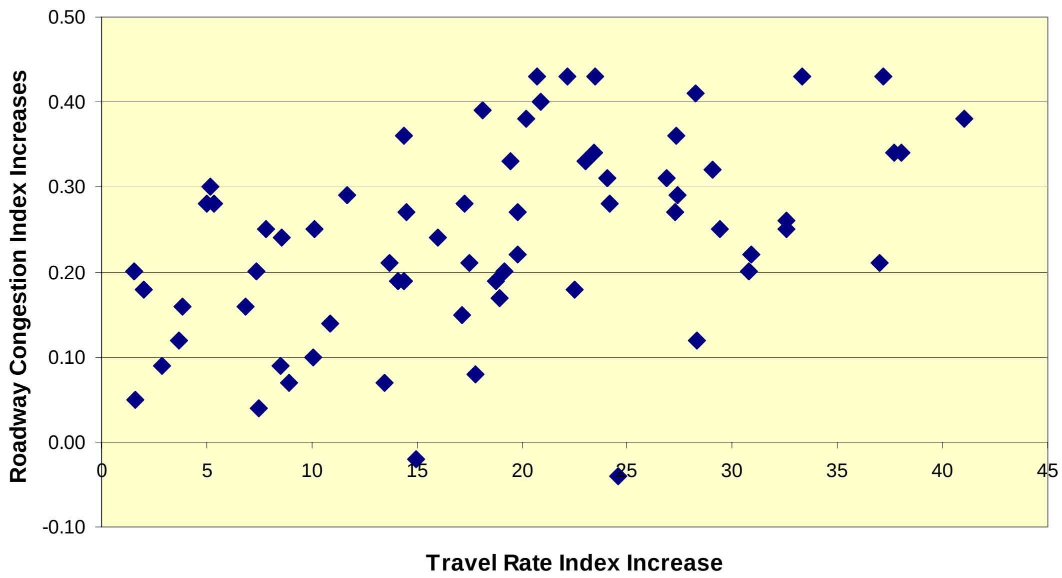
CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 14

Roadway Congestion and Travel Rates (1982 to 1997)

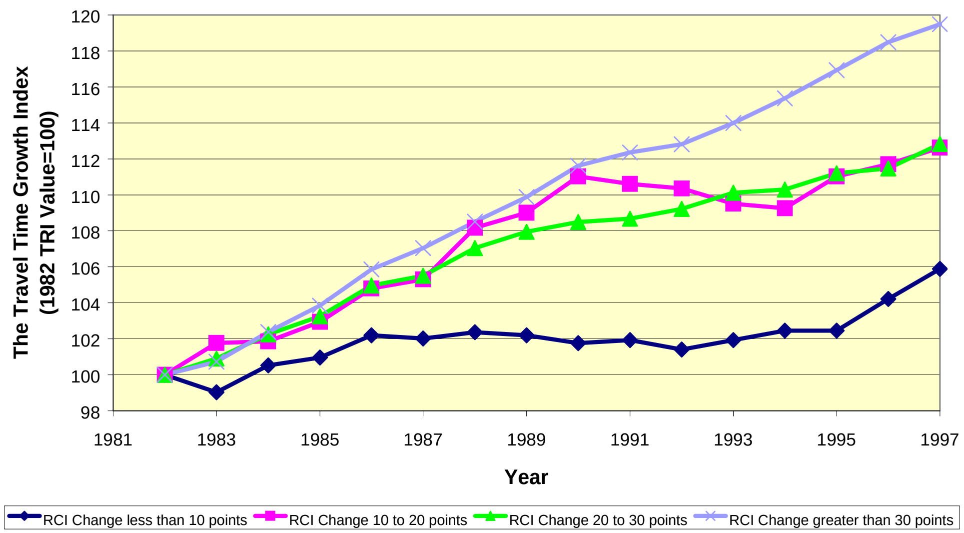


- The data is scattered but it does indicate a pattern. As the Roadway Congestion Index increases, meaning that vehicle travel increased faster than road space, the travel rate index also increased. The Spearman correlation coefficient (R^2) between the Travel Rate Index and the Roadway Congestion Index Increase is 0.67. This means that 67 percent of the variability in the Roadway Congestion Index Increase can be explained by the Travel Rate Index Increase. This correlation is significant at the 0.05 level. What does this mean? It means that statistically there is some relationship; however, it is not that strong, and other factors affect the relationship.
- The urban areas that experienced small amounts of decline in their Roadway Congestion Index had increases in their travel rate index between 1982 and 1997. For example, Houston had a small decline in its roadway congestion index between 1982 and 1997 but had more than a 6 point increase in Travel Rate Index during the same period (1.30 to 1.36). Charlotte also had a small decline in its Roadway Congestion Index between 1982 and 1997 but had a 21 point increase in its Travel Rate Index (1.08 to 1.29).
- This analysis does not reveal the contribution of transit or operational improvements to urban area travel conditions.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 15

The Effect of Roadway Increases on Travel Time
(1982 to 1997)



The 68 urban areas were grouped into four groups based on their change in RCI between 1982 and 1997. These four groups were:

1. Greater than a 30 point RCI increase between 1982 and 1997.
2. Between a 20 and 30 point RCI increase between 1982 and 1997.
3. Between a 10 and 20 point RCI increase between 1982 and 1997.
4. Less than a 10 point RCI increase between 1982 and 1997.

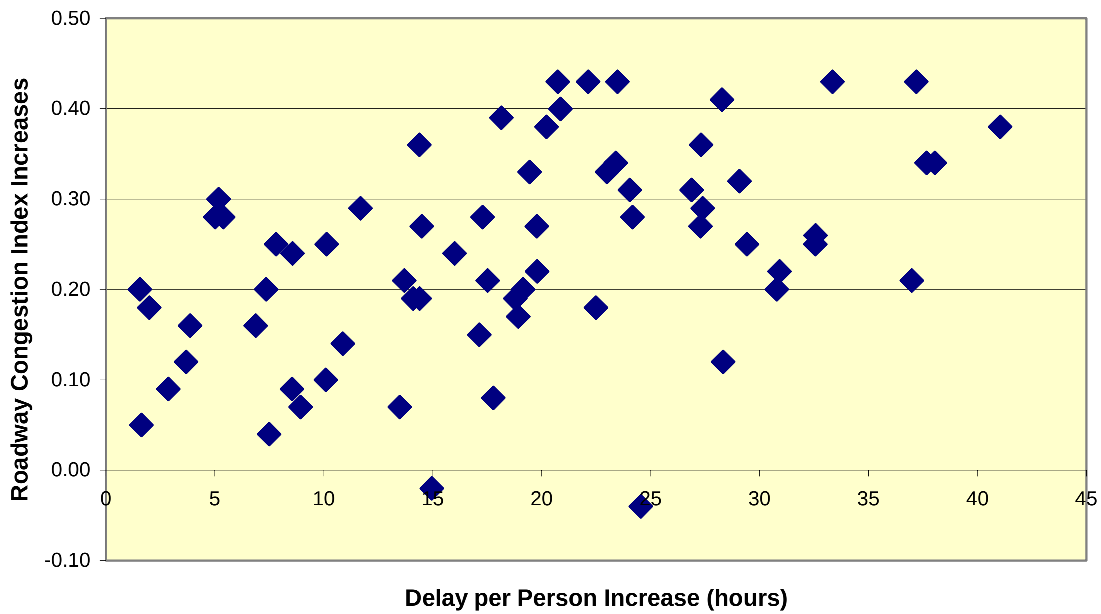
The Travel Time Growth Index uses an approach similar to the Consumer Price Index to show relative changes in mobility. The 1982 TRI values were assigned an index value of 100, and the change in this index reflects the annual percent change that occurred in the actual TRI values:

- A general trend appears to hold: The larger the increase in the Roadway Congestion Index, the larger the increase in the Travel Rate Index. The growth rates for the four RCI groups (except the 10 to 20 and 20 to 30 groups) are statistically different at the 95 percent confidence level. The Roadway Congestion Index change groups 10 to 20 and 20 to 30 are statistically similar for purposes of this analysis. What does this mean? It means that there are differences in how fast the Travel Rate Index grows, and these differences are closely related to how quickly traffic demand is outpacing capacity increases (as illustrated by Roadway Congestion Index increases). There is a significant difference in Travel Rate Index growth rates between the small Roadway Congestion Index change (less than 10 points), medium Roadway Congestion Index change (10 to 30 points), and the Large Roadway Congestion Index change (more than 30 points).

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 16

Change in Congestion Level and Delay (1982 to 1997)

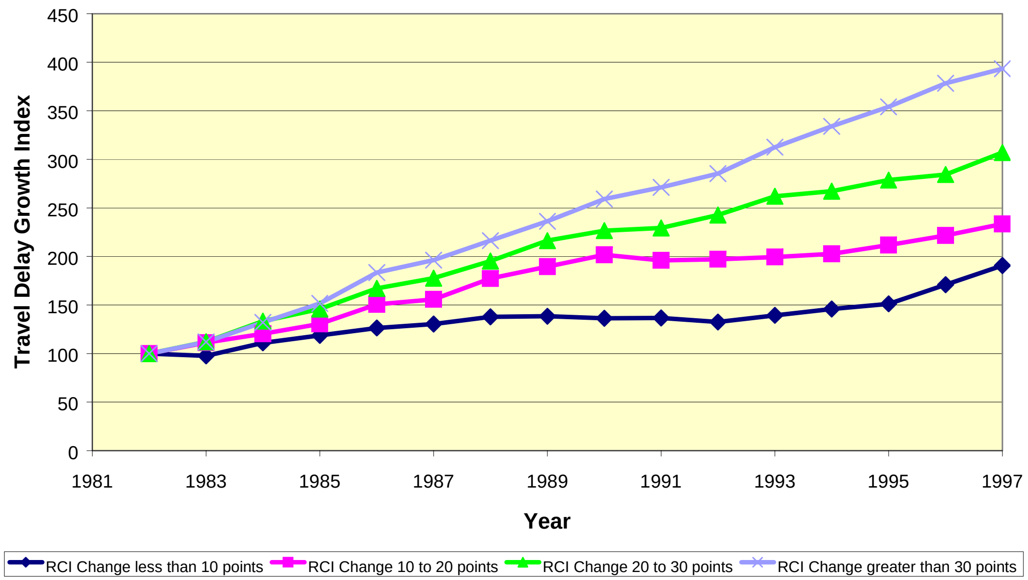


- The data are scattered but tend to show that as the roadway congestion index increases the delay per driver increases, as well. The Spearman correlation coefficient (R^2) between the Delay per Person Increase and the Roadway Congestion Index increase is 0.52. This means that 52 percent of the variability in the Roadway Congestion Index increase can be explained by the Delay per Person increase. This correlation is significant at the 0.05 level. What does this mean? It means that statistically there is some statistical relationship; however, it is not that strong, and other factors affect the relationship.
- Even the urban areas that experienced low increases in congestion levels between 1982 and 1997 (added significant roadway space or had very low traffic growth rates) experienced increases in Delay per Person during the study period.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 17

Change in Delay per Person for Congestion Growth Groups (1982 to 1997)



The 68 urban areas were grouped into four groups based on their change in RCI between 1982 and 1997. These four groups were:

1. Greater than a 30 point RCI increase between 1982 and 1997.
2. Between a 20 and 30 point RCI increase between 1982 and 1997.
3. Between a 10 and 20 point RCI increase between 1982 and 1997.
4. Less than a 10 point RCI increase between 1982 and 1997.

The Travel Delay Growth Index uses an approach similar to the Consumer Price Index to show relative changes in mobility. The 1982 Delay per Person values were assigned an index value of 100 and the change in the Travel Delay Growth Index reflects the annual percent change that occurred in the actual Delay per Person values.

- All growth rates for the four Roadway Congestion Index groups are statistically different at the 95 percent confidence level. Each Roadway Congestion Index group growth rate is different from all others unlike the Travel Time Growth Index (Exhibit 15). What does this mean? It means that there are differences in how the delay per person grows, and these are closely related to how quickly travel demand is outpacing capacity increases (as measured by Roadway Congestion Index increases).
  - Delay per Person in the greater than 30 group increased by 300 percent between 1982 and 1997.
  - Delay per Person in the 20 to 30 group increased by 200 percent between 1982 and 1997.
  - Delay per Person in the 10 to 20 group increased by 140 percent between 1982 and 1997.
  - Delay per Person in the less than 10 group increased by 100 percent between 1982 and 1997.

Conclusion

Additional roadway reduces the growth in travel delay experienced by motorists. The data indicate that adding roadway at rates close to the traffic growth rate results in slower growth in travel time statistics when compared to areas that do not add roadway. Additional roadway may not be the best long-term improvement for every area, but the data show a significant benefit over the 15-year period for 68 U.S. urban areas.

The 15-year period and the limited set of factors used in this study do not, however, allow a comprehensive assessment of the effect of additional roadway capacity. One problem that arises with this analysis is the additional mileage that is added to the urban transportation system through urban boundary changes. While these miles are not necessarily added as congestion reduction improvements, such as added auxiliary freeway lanes, they do have a beneficial effect on the areawide measures.

The same trend was true for the comparison of delay per person and the roadway congestion index. The delay per person calculation is comprised of estimates for recurring and incident delay (only recurring delay estimates are used in the calculation of the travel rate index). The variation in pattern between delay per person and the travel rate index is the result of including incident delay in the delay per person estimates.

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Question 3: How much does the lack of roadway construction affect travel times?

Another analysis was performed on the Urban Mobility Study database to determine if roadway construction has any effect on areawide travel times. This analysis compares the amount of needed but unconstructed roadway to the change in travel times in each of the 68 urban areas. The three variables used in the analysis are described below.

Lane-Mile Construction "Deficit" Percentage—A ratio indicating the amount of additional roadway needed to keep pace with travel growth. The amount of needed roadway is determined by calculating the annual growth rate of travel on area roadways. For this analysis, the period 1992 to 1997 was used to calculate the annual travel growth rate. Roadway capacity has to be added at the same rate as travel increases to achieve a "deficit" of zero.

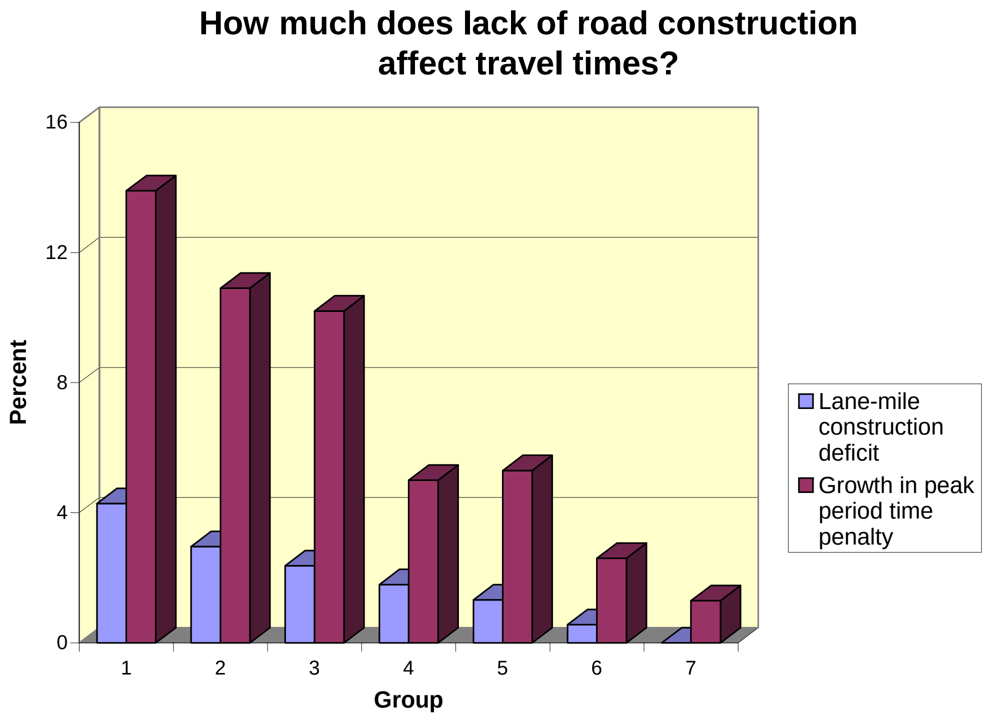
Travel Rate Index—A comparison of travel time in the peak period to travel time in free-flow conditions. The TRI is calculated with the speed estimates of the delay calculation, which are based on the traffic volume per lane. The estimates pertain to travel time on days when incidents do not seriously affect the transportation system. The index estimates travel conditions as a weighted average of the conditions experienced by travelers on freeways and principal arterial streets.

Delay per Person—The Urban Mobility Study develops estimates of delay due to typical high volumes of traffic and delay caused by accidents and vehicle breakdowns. The total delay is divided by the number of urban area residents to create an estimate of the annual time penalties experienced by the average roadway user.

The 68 urban areas were placed in order ranging from the area with the greatest annual lane-mile deficit percentage down to the lowest. The 68 urban areas were divided into seven groups—six sets of 10 and one set of eight (group 7)—for graphical purposes in this analysis.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 18

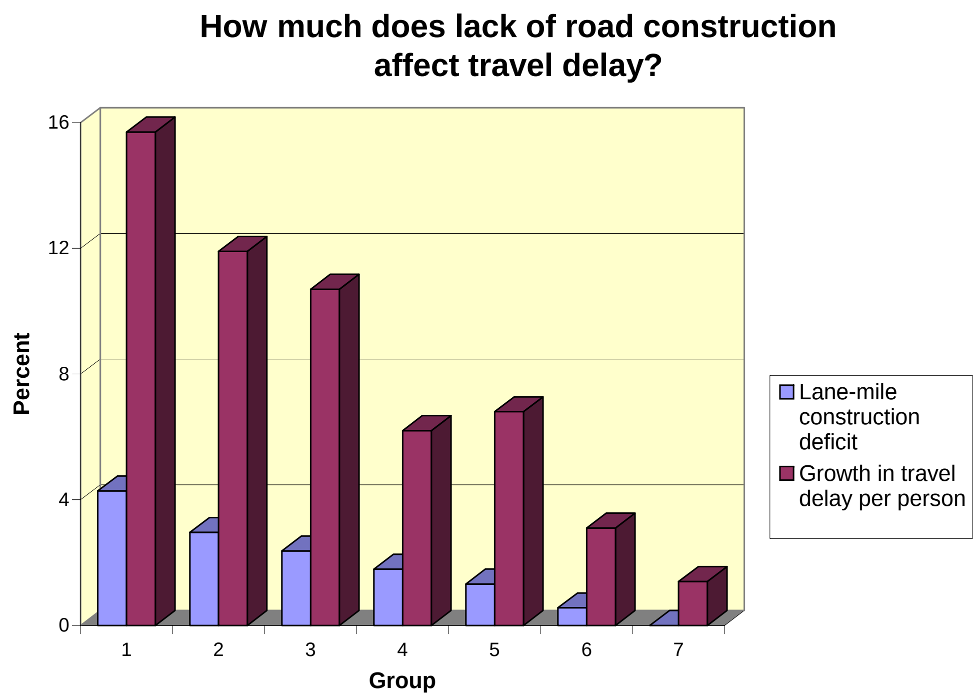


The average lane-mile deficit percentage ranged from about 4.3 percent in group 1 to about a 0.2 percent surplus in group 7. The annual growth in the Travel Rate Index ranged from 1.6 percent in group 1 to about 0.3 percent in group 7.

- The Spearman correlation coefficient (R^2) between the lane-mile construction deficit and the growth in peak period time penalty is 0.69. This means that 69 percent of the variability in one of the variables can be explained by the other variable. This correlation is significant at the 0.05 level. What does this mean? Statistically, there is a strong relationship between the deficit in roadway construction and increases in travel times.
- In general, as the lane-mile deficit decreases, the growth in the peak period time penalty decreases as well. In other words, as more roads are built, the amount of additional time required to make peak period trips increases at a slower rate than in areas where less roadway is constructed.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 19



The average lane-mile deficit percentage ranged from about 4.3 percent in group 1 to about a 0.2 percent surplus in group 7. The annual growth in travel Delay per Person ranged from 15.7 percent in group 1 to about 1.4 percent in group 7.

- The Pearson correlation coefficient (R^2) between the lane-mile construction deficit and the growth in travel delay is 0.71. This means that 71 percent of the variability in one variable can be explained by the other variable. This correlation is significant at the 0.05 level. What does this mean? There is a very strong relationship between the deficit in roadway construction and increases in travel times.
- In general, as the lane-mile deficit decreases, the growth in Delay per Person decreases as well. In other words, as more roads are built, the amount of additional Delay per Person increases at a slower rate than in areas where less roadway is constructed.

Conclusion

This analysis shows that changes in roadway supply have an effect on the amount of recurring delay in an area. Additional roadway reduces the rate of increase in the amount of time it takes travelers to make peak period trips. In general, as the lane-mile construction "deficit" gets smaller, meaning that urban areas keep pace with travel growth by adding capacity at about the same rate, the travel time increase is smaller. It appears that the growth in facilities has to be at a rate greater than travel growth in order to maintain constant travel times, if road construction is the only "solution" used to address mobility concerns. It is unclear from this analysis if urban areas can add enough capacity over longer periods of time so that this trend can be sustained.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

CHAPTER V. WHAT ARE THE ALTERNATIVES TO DECLINING MOBILITY?

SUMMARY

There are several alternative approaches to the mobility problem. None of them are easy to implement or completely benign in their effects. One alternative is to live with traffic congestion. Travelers in 68 urban areas spent over $72 billion in lost time and wasted fuel in 1997. This equates to about $755 per eligible driver per year in all of the 68 urban areas or about $3 per workday.

A second alternative is to fund road construction to keep pace with traffic growth. In the 68 urban areas, it would take an annual addition of 1,087 lane-miles of freeway and 1,432 lane-miles of principal arterial streets ***each year*** *to maintain current mobility levels. This equates to about 135 miles of an eight-lane freeway and 360 miles of a four-lane arterial* ***in addition to*** *the current rate of construction in the study areas. And this is only to "stay even" with the current level of mobility, which is relatively poor in many urban areas. The "downside" of this alternative includes the high cost associated with extensive road construction and the social and environmental impacts that are involved with roadway expansion. Some urban areas have chosen to accept higher travel times as a result of these factors.*

The other improvement options include such items as increased transit service, freeway incident management, high-occupancy vehicle lanes (HOV), ramp metering, etc. The HOV lanes on the 5 Houston freeways improved 1997 mobility levels ***by about 6 percent—the equivalent of several years growth****—because of the superior person-moving capabilities. The effect of the 72-mile HOV lane system was to improve the mobility level for the entire Houston urban area (with 2,400 freeway lane-miles) by about 1 percent in 1997.*

Another mobility improvement alternative would have all new person trips use an existing vehicle trip, thus raising the average vehicle occupancy level for the area. ***The average vehicle occupancy would have to increase by an average of 0.04 persons per vehicle in 1997 in the 68 urban areas to accommodate the growth in travel demand.*** *This averages to about 99,000 trips in each urban area. And this rate of new transit ridership and carpool formation would be needed in every following year if traffic demand keeps increasing.*

There are many other treatments that can be used to slow the growth of urban congestion. This study only examined the amount of effort that would be needed to accomplish a few of them. The treatments featured in each urban area will certainly be based on the characteristics of the area, available funding and public support.

BACKGROUND

This section looks at alternatives to congestion -- ranging from doing nothing to implementing some improvements that might slow or stop the growth of congestion. The four scenarios that are reviewed include:

- Sit in traffic—This item will focus on the size of the congestion problem in 1997. The gallons of fuel and hours of time wasted because of congestion are discussed. Also, a price tag is placed on the wasted fuel and hours to show the magnitude of the congestion problem in terms of dollars.
- Build roads—How much roadway do we need to build to stay even in the battle with traffic congestion? This item shows how many additional lane-miles of roadway would need to be constructed in each urban area in order to keep up with the growing traffic demand.
- Range of improvements—Many different improvements have been utilized in an effort to deal with traffic congestion. These improvements include such techniques as increased transit service, freeway incident management, HOV lanes, travel demand management and many others. The HOV lane system in Houston will be used as a case study to show the effect that these lanes have on mobility levels in Houston at both the corridor level and areawide.
- Changing occupancy—Similar to the discussion about how much new roadway would need to be added to avoid congestion growth, this item looks at the average vehicle occupancy rates to accommodate all of the new travel demand in an area.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Sit in Traffic

Table 5—Annual Hours of Delay, 1997

- Includes hours of delay due to heavy traffic demand and amount due to incidents
- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1997 Data
  - ✶ Recurring Hours of Delay
  - ✶ Incident Hours of Delay
  - ✶ Total Hours of Delay
  - ✶ Rank of Total Hours of Delay

How much time is wasted in urban areas (1982 to 1997)? (Exhibit 20)

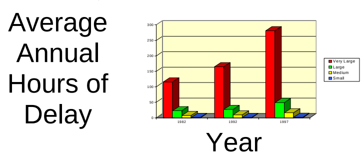


Table 6—Wasted Fuel in 1997

- A measure of how much fuel is wasted due to congestion
- Contains these statistics:
  - ✶ Urban Area
  - ✶ Fuel Wasted due to Recurring Congestion
  - ✶ Fuel Wasted due to Incident Congestion
  - ✶ Total Fuel Wasted
  - ✶ Rank of Total Fuel Wasted
  - ✶ Wasted Fuel per Capita
  - ✶ Rank of Wasted Fuel per Capita
  - ✶ Wasted Fuel per Driver
  - ✶ Rank of Wasted Fuel per Driver

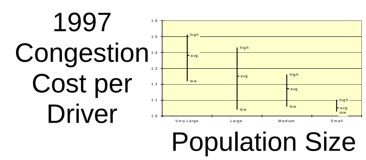
Table 7—1997 Annual Congestion Cost

- A measure of the cost of congestion based on wasted time and fuel
- Contains these statistics:
  - ✶ Urban Area
  - ✶ Congestion Cost due to Delay
  - ✶ Congestion Cost due to Fuel
  - ✶ Total Congestion Cost
  - ✶ Rank of Total Congestion Cost

Table 8—1997 Annual Individual Congestion Cost

- A measure of the cost of congestion to the individual
- Contains these statistics:
  - ✶ Cost per Eligible Driver
  - ✶ Rank of Cost per Eligible Driver
  - ✶ Cost per Capita
  - ✶ Rank of Cost per Capita

How much does congestion cost per driver vary? (Exhibit 21)



CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Build Roads

Table 9—Illustration of Annual Capacity Increase Required to Prevent Congestion Growth

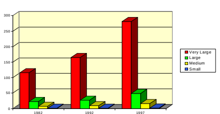
- Shows the lane miles required to prevent congestion levels from increasing
- Contains these statistics:
  - ✶ Urban Area
  - ✶ Existing Lane-Miles of Roadway
  - ✶ Average Annual Growth in Travel
  - ✶ Annual Lane-Miles Needed
  - ✶ Annual Lane-Miles Added
  - ✶ Lane-Mile Deficiency

Table 10—If Road Expansion Were the Only Congestion Reduction Technique

- Shows the comparison of lane-miles that have been added and the level required to meet congestion needs with additional roads
- Contains these statistics:
  - ✶ Population Group
  - ✶ Growth in Travel
  - ✶ Percent of Lane-Miles Added

How did road expansion match needs? (Exhibit 22)

Percent of Roadway Added



Years

Change Vehicle Occupancy

Table 11—Illustration of Occupancy Increase Needed to Prevent Mobility Decline

- Shows the occupancy level that is required to offset congestion growth
- Contains these statistics
  - ✶ Urban Area
  - ✶ Growth in Travel
  - ✶ Additional Person Travel
  - ✶ Additional Trips
  - ✶ Occupancy Level

Incorporating Mobility Improvements

- Shows the effect high-occupancy vehicle lanes on peak period travel times in Houston

Tables 12, 13, 14, and 15 present the methodology and estimates of the contribution of HOV lanes to improving mobility in Houston.

Sit in Traffic

The first alternative to traffic congestion is the 'do nothing' strategy—no new construction to the transportation system in use today. This means that motorists will be lucky to only suffer through the same congested conditions that they do presently. If traffic demand continues to grow, the amount of delay will increase rapidly. As traffic delay increases, the amount of wasted fuel increases as well. The magnitude of the congestion problem is shown for each urban area with the hours of delay and the gallons of fuel that are wasted annually.

Another method of assessing the impact of congestion is to look at the dollar value of the delay and wasted fuel. Many different variables are used to estimate the cost of congestion in this study. Some of these cost variables fluctuate with price trends. The variables—fuel cost, commercial vehicle operating cost, and the average cost of time—are updated annually to reflect the change in these costs. The annual cost of congestion is shown for each urban area as well as the impact of these costs on individuals in those areas.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 5. Annual Hours of Delay, 1997

Population Group	Urban Area	Annual Person-Hours of Delay (000)			
		Recurring	Incident	Total	Rank[1]
Vlg	Los Angeles, CA	341,495	397,750	739,245	1
Vlg	New York, NY-Northeastern, NJ	194,615	337,575	532,190	2
Vlg	Chicago, IL-Northwestern, IN	123,990	142,905	266,895	3
Vlg	Washington, DC-MD-VA	78,670	137,440	216,110	4
Vlg	Detroit, MI	73,840	118,070	191,910	5
Vlg	San Francisco-Oakland, CA	78,940	98,950	177,890	6
Vlg	Boston, MA	49,215	109,815	159,030	7
Lrg	Atlanta, GA	65,040	71,550	136,590	8
Vlg	Houston, TX	57,325	75,145	132,470	9
Vlg	Philadelphia, PA-NJ	45,370	65,805	111,175	10
Lrg	Seattle-Everett, WA	45,975	60,585	106,560	11
Lrg	Dallas, TX	40,230	61,925	102,155	12
Lrg	Miami-Hialeah, FL	41,005	52,265	93,270	13
Lrg	St. Louis, MO-IL	37,405	42,850	80,255	14
Lrg	Baltimore, MD	27,740	51,510	79,250	15
Lrg	San Diego, CA	42,230	30,305	72,535	16
Lrg	Phoenix, AZ	35,985	27,200	63,185	17
Lrg	Denver, CO	30,665	32,080	62,745	18
Lrg	Minneapolis-St. Paul, MN	31,025	29,395	60,420	19
Lrg	San Jose, CA	27,435	28,385	55,820	20
Lrg	Portland-Vancouver, OR-WA	20,210	34,065	54,275	21
Lrg	San Bernardino-Riverside, CA	26,250	19,635	45,885	22
Med	Indianapolis, IN	17,490	22,535	40,025	23
Lrg	Fort Worth, TX	14,605	22,625	37,230	24
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	18,000	18,740	36,740	25
Lrg	Sacramento, CA	18,675	16,280	34,955	26
Lrg	Orlando, FL	14,975	18,665	33,640	27
Lrg	Cincinnati, OH-KY	16,220	14,225	30,445	28
Lrg	Cleveland, OH	16,375	13,550	29,925	29
Lrg	Las Vegas, NV	11,520	18,310	29,830	30
Lrg	Kansas City, MO-KS	8,970	19,845	28,815	31
Lrg	Norfolk, VA	10,005	17,145	27,150	32
Med	Louisville, KY-IN	11,085	15,955	27,040	33
Med	Tampa, FL	12,140	14,610	26,750	34
Med	Austin, TX	11,550	14,625	26,175	35
Lrg	Milwaukee, WI	12,095	12,500	24,595	36
Lrg	Columbus, OH	12,910	10,870	23,780	37
Lrg	San Antonio, TX	11,315	12,450	23,765	38
Lrg	Pittsburgh, PA	8,915	13,780	22,695	39
Med	Nashville, TN	8,900	13,450	22,350	40
Lrg	New Orleans, LA	8,995	12,705	21,700	41
Med	Jacksonville, FL	9,865	11,735	21,600	42
Med	Memphis, TN-AR-MS	9,475	11,990	21,465	43
Med	Charlotte, NC	9,275	8,735	18,010	44
Med	Albuquerque, NM	7,455	9,565	17,020	45

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 5. Annual Hours of Delay, 1997, continued

Population Group	Urban Area	Annual Person-Hours of Delay (000)			
		Recurring	Incident	Total	Rank[1]
Med	Honolulu, HI	6,880	9,190	16,070	46
Med	Providence-Pawtucket, RI-MA	6,770	8,485	15,255	47
Med	Salt Lake City, UT	8,300	6,575	14,875	48
Med	Tucson, AZ	6,635	7,300	13,935	49
Med	Oklahoma City, OK	5,245	8,460	13,705	50
Med	Omaha, NE-IA	5,540	7,540	13,080	51
Med	Tacoma, WA	7,265	5,800	13,065	52
Med	Hartford-Middletown, CT	3,690	7,705	11,395	53
Med	Fresno, CA	3,060	4,210	7,270	54
Lrg	Buffalo-Niagara Falls, NY	2,070	3,570	5,640	55
Med	El Paso, TX-NM	2,430	2,960	5,390	56
Med	Rochester, NY	1,665	3,660	5,325	57
Sml	Colorado Springs, CO	2,040	2,945	4,985	58
Sml	Albany-Schenectady-Troy, NY	1,465	1,800	3,265	59
Sml	Spokane, WA	1,275	1,495	2,770	60
Sml	Bakersfield, CA	930	1,275	2,205	61
Sml	Salem, OR	950	1,080	2,030	62
Sml	Corpus Christi, TX	620	1,155	1,775	63
Sml	Beaumont, TX	505	845	1,350	64
Sml	Eugene-Springfield, OR	550	765	1,315	65
Sml	Laredo, TX	300	345	645	66
Sml	Boulder, CO	245	290	535	67
Sml	Brownsville, TX	155	190	345	68
	68 area total	1,864,080	2,457,720	4,321,800	
	68 area average	27,413	36,143	63,556	
	Very large area average	115,940	164,828	280,768	
	Large area average	22,653	26,600	49,253	
	Medium area average	7,332	9,116	16,448	
	Small area average	821	1,108	1,929	

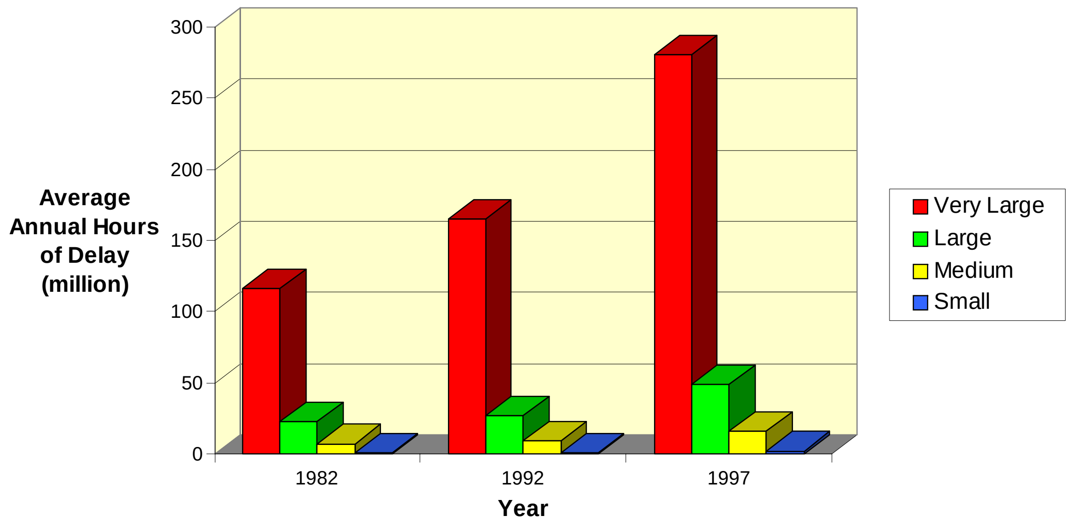
Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

- On average, delay from incidents (accidents, breakdowns, etc.) account for about 57 percent of delay.
- The Very Large urban areas had, on average, about 140 times more delay (281 million hours) than the Small urban areas (2 million hours).
- The Very Large urban areas had, on average, about six times more delay (281 million hours) than the Large urban areas (49 million hours).
- The urban areas with the greatest amount of delay in 1997 by urban area size:
  - Very Large   Los Angeles   739 million hours
  - Large   Atlanta   137 million hours
  - Medium   Louisville   27 million hours
  - Small   Colorado Springs   5 million hours

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 20

How much time is wasted in urban areas?
(1982 to 1997)



- Total hours of delay in the 68 urban areas were about 1.9 billion hours in 1982, 2.5 billion hours in 1992, and 4.3 billion hours in 1997.
- Between 1982 and 1997, annual hours of delay increased by
  - 142 percent in the Very Large urban areas
  - 113 percent in the Large urban areas
  - 129 percent in the Medium urban areas
  - 100 percent in the Small urban areas

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 6. Wasted Fuel in 1997

Population Group	Urban Area	Annual Gallons of Fuel Wasted (million)				Annual Excess Fuel Consumed per Capita (gallons)	Rank	Annual Excess Fuel Consumed per Eligible Driver (gallons)	Rank
		Recurring	Incident	Total	Rank				
Vlg	Los Angeles, CA	512	596	1,108	1	90	2	120	1
Vlg	New York NY-Northeastern, NJ	293	509	802	2	47	22	58	27
Vlg	Chicago, IL-Northwestern, IN	185	210	398	3	50	20	65	20
Vlg	Washington, DC-MD-VA	119	208	327	4	94	1	116	2
Vlg	Detroit, MI	111	177	288	5	72	6	92	6
Vlg	San Francisco-Oakland, CA	124	156	280	6	72	6	91	8
Vlg	Boston, MA	73	163	236	7	78	5	98	5
Lrg	Atlanta, GA	102	112	214	8	83	4	106	3
Vlg	Houston, TX	89	117	206	9	66	9	90	9
Vlg	Philadelphia, PA-NJ	68	98	166	10	31	43	40	44
Lrg	Seattle-Everett, WA	71	94	165	11	84	3	106	3
Lrg	Dallas, TX	64	98	162	12	70	8	92	6
Lrg	Miami-Hialeah, FL	60	76	136	13	66	9	83	10
Lrg	Baltimore, MD	43	80	123	14	57	15	72	16
Lrg	St. Louis, MO-IL	57	65	122	15	60	13	79	13
Lrg	San Diego, CA	68	49	117	16	45	26	59	25
Lrg	Denver, CO	47	49	96	17	53	17	70	18
Lrg	Minneapolis-St. Paul, MN	49	47	96	17	42	30	53	30
Lrg	Phoenix, AZ	53	40	93	19	39	33	51	33
Lrg	San Jose, CA	42	44	86	20	53	17	69	19
Lrg	Portland-Vancouver, OR-WA	31	53	84	21	63	11	80	12
Lrg	San Bernardino-Riverside, CA	41	31	72	22	53	17	74	15
Med	Indianapolis, IN	27	34	61	23	60	13	79	13
Lrg	Fort Worth, TX	23	36	59	24	45	26	60	23
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	27	28	55	25	37	36	47	36
Lrg	Sacramento, CA	29	25	54	26	44	28	59	25
Lrg	Orlando, FL	22	28	50	27	47	22	60	23
Lrg	Cincinnati, OH-KY	26	23	49	28	39	33	50	34
Lrg	Cleveland, OH	26	22	48	29	26	49	33	50
Lrg	Kansas City, MO-KS	14	31	45	30	33	41	44	41
Lrg	Las Vegas, NV	17	27	44	31	38	35	50	34
Med	Louisville, KY-IN	17	25	42	32	50	20	63	21
Lrg	Norfolk, VA	15	26	41	33	40	31	52	32
Med	Austin, TX	18	22	40	34	63	11	82	11
Lrg	Milwaukee, WI	19	19	38	35	30	45	39	45
Med	Tampa FL	17	21	38	35	46	25	58	27
Lrg	San Antonio TX	18	20	38	35	31	43	42	43
Lrg	Columbus OH	20	17	37	38	36	37	47	36
Med	Nashville TN	14	21	35	39	56	16	71	17
Med	Jacksonville FL	15	18	33	40	40	31	53	30
Lrg	Pittsburgh PA	13	20	33	40	18	54	22	55
Lrg	New Orleans LA	13	19	32	42	29	47	37	48
Med	Memphis TN-AR-MS	14	18	32	42	33	41	44	41
Med	Charlotte NC	14	13	27	44	47	22	61	22
Med	Honolulu, HI	11	14	25	45	35	39	45	39

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 6. Wasted Fuel in 1997, continued

Population Group	Urban Area	Annual Gallons of Fuel Wasted (million)				Annual Excess Fuel Consumed per Capita (gallons)	Rank	Annual Excess Fuel Consumed per Eligible Driver (gallons)	Rank
		Recurring	Incident	Total	Rank				
Med	Albuquerque, NM	11	14	25	45	44	28	57	29
Med	Salt Lake City, UT	13	10	23	47	26	49	36	49
Med	Providence-Pawtucket, RI-MA	10	13	23	47	26	49	32	51
Med	Oklahoma City, OK	8	14	22	49	22	52	29	52
Med	Tacoma, WA	12	9	21	50	36	37	47	36
Med	Tucson, AZ	9	10	19	51	29	47	38	46
Med	Omaha, NE-IA	8	11	19	51	34	40	45	39
Med	Hartford-Middletown, CT	6	13	19	51	30	45	38	46
Med	Fresno, CA	4	6	10	54	19	53	26	53
Med	El Paso, TX-NM	4	5	9	55	15	57	20	57
Med	Rochester, NY	3	6	9	55	15	57	19	58
Lrg	Buffalo-Niagara Falls, NY	3	6	9	55	8	64	11	65
Sml	Colorado Springs, CO	3	4	7	58	17	55	23	54
Sml	Albany-Schenectady-Troy, NY	2	3	5	59	10	61	13	61
Sml	Spokane, WA	2	2	4	60	12	60	16	60
Sml	Salem, OR	1	2	3	61	16	56	21	56
Sml	Bakersfield, CA	1	2	3	61	8	64	12	63
Sml	Corpus Christi, TX	1	2	3	61	10	61	13	61
Sml	Eugene-Springfield, OR	1	1	2	64	9	63	12	63
Sml	Beaumont, TX	1	1	2	64	14	59	18	59
Sml	Laredo, TX	0	0	0	66	0	66	0	66
Sml	Boulder, CO	0	0	0	66	0	66	0	66
Sml	Brownsville, TX	0	0	0	66	0	66	0	66
	68 area total	2,855	3,740	6,595					
	68 area average	42	55	97		53		69	
	Very large area average	175	248	423		63		81	
	Large area average	36	42	78		48		62	
	Medium area average	12	15	27		36		48	
	Small area average	1	2	3		10		13	

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

- Total fuel "wasted" due to congestion was 2.8 billion gallons in 1982, 3.7 billion gallons in 1992 and 6.7 billion gallons in 1997.
- On average, the 68 urban areas wasted about 97 million gallons of fuel due to congestion in 1997.
- On average, wasted fuel due to incidents (accidents, breakdowns, etc.) account for about 57 percent of wasted fuel due to congestion.
- The urban areas with the greatest amount of wasted fuel in 1997 by urban area size:

♦ Very Large	Los Angeles	1.1 billion gallons
♦ Large	Atlanta	214 million gallons
♦ Medium	Louisville	2 million gallons
♦ Small	Colorado Springs	7 million gallons

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 7. 1997 Annual Congestion Cost

Population Group	Urban Area	Annual Cost Due to Congestion ($ millions)			Rank
		Delay	Fuel	Total	
Vlg	Los Angeles, CA	10,855	1,550	12,405	1
Vlg	New York, NY-Northeastern, NJ	7,835	1,050	8,885	2
Vlg	Chicago IL-Northwestern, IN	3,915	485	4,400	3
Vlg	Washington, DC-MD-VA	3,190	370	3,560	4
Vlg	Detroit, MI	2,820	325	3,145	5
Vlg	San Francisco-Oakland, CA	2,670	395	3,065	6
Vlg	Boston, MA	2,330	305	2,635	7
Lrg	Atlanta, GA	2,050	220	2,270	8
Vlg	Houston, TX	1,980	230	2,210	9
Vlg	Philadelphia, PA-NJ	1,630	195	1,825	10
Lrg	Seattle-Everett, WA	1,585	220	1,805	11
Lrg	Dallas, TX	1,535	180	1,715	12
Lrg	Miami-Hialeah, FL	1,355	160	1,515	13
Lrg	Baltimore, MD	1,185	145	1,330	14
Lrg	St. Louis, MO-IL	1,180	130	1,310	15
Lrg	San Diego, CA	1,100	165	1,265	16
Lrg	Denver, CO	930	120	1,050	17
Lrg	Phoenix, AZ	925	125	1,050	17
Lrg	Minneapolis-St. Paul, MN	915	115	1,030	19
Lrg	San Jose, CA	835	120	955	20
Lrg	Portland-Vancouver, OR-WA	810	120	930	21
Lrg	San Bernardino-Riverside, CA	690	100	790	22
Lrg	Indianapolis, IN	595	70	665	23
Lrg	Fort Worth, TX	560	65	625	24
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	540	65	605	25
Lrg	Sacramento, CA	520	75	595	26
Lrg	Orlando, FL	495	60	555	27
Lrg	Cincinnati, OH-KY	460	55	515	28
Lrg	Cleveland, OH	450	55	505	29
Lrg	Las Vegas, NV	440	65	505	29
Lrg	Kansas City, MO-KS	435	50	485	31
Med	Louisville, KY-IN	405	50	455	32
Lrg	Norfolk, VA	405	45	450	33
Med	Austin, TX	385	45	430	34
Med	Tampa, FL	385	45	430	34
Lrg	Milwaukee, WI	365	45	410	36
Lrg	Columbus, OH	360	45	405	37
Lrg	San Antonio, TX	355	40	395	38
Med	Nashville, TN	335	40	375	39
Lrg	Pittsburgh, PA	330	40	370	40
Med	Jacksonville, FL	320	40	360	41
Lrg	New Orleans, LA	315	35	350	42
Med	Memphis, TN-AR-MS	315	35	350	42
Med	Charlotte, NC	270	30	300	44
Med	Albuquerque, NM	250	35	285	45

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 7. 1997 Annual Congestion Cost, continued

Population Group	Urban Area	Annual Cost Due to Congestion ($ millions)			Rank
		Delay	Fuel	Total	
Med	Honolulu, HI	235	45	280	46
Med	Salt Lake City, UT	225	30	255	47
Med	Providence-Pawtucket, RI-MA	225	30	255	47
Lrg	Oklahoma City, OK	210	25	235	49
Med	Tacoma, WA	200	25	225	50
Med	Tucson, AZ	200	25	225	50
Med	Omaha, NE-IA	190	25	215	52
Med	Hartford-Middletown, CT	170	25	195	53
Med	Fresno, CA	105	15	120	54
Med	Rochester, NY	80	15	95	55
Lrg	Buffalo-Niagara Falls, NY	85	10	95	55
Med	El Paso, TX-NM	80	10	90	57
Sml	Colorado Springs, CO	75	10	85	58
Sml	Albany-Schenectady-Troy, NY	45	10	55	59
Sml	Spokane, WA	40	10	50	60
Sml	Bakersfield, CA	35	5	40	61
Sml	Salem, OR	30	0	30	62
Sml	Corpus Christi, TX	25	0	25	63
Sml	Beaumont, TX	25	0	25	63
Sml	Eugene-Springfield, OR	20	0	20	65
Sml	Laredo, TX	10	0	10	66
Sml	Boulder, CO	10	0	10	66
Sml	Brownsville, TX	5	0	5	68
	68 area total	63,920	8,280	72,200	
	68 area average	940	122	1,062	
	Very large area average	4,136	545	4,681	
	Large area average	734	92	826	
	Medium area average	243	31	274	
	Small area average	29	3	32	

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 8. 1997 Annual Individual Congestion Cost

Population Group	Urban Area	Annual Congestion Cost			
		Per Eligible Driver (dollars)	Rank	Per Capita (dollars)	Rank
Vlg	Los Angeles, CA	1,370	1	1,010	2
Vlg	Washington, DC-MD-VA	1,260	2	1,025	1
Lrg	Seattle-Everett, WA	1,165	3	920	3
Lrg	Atlanta, GA	1,125	4	880	4
Vlg	Boston, MA	1,095	5	875	5
Vlg	Detroit, MI	1,010	6	785	6
Vlg	San Francisco-Oakland, CA	995	7	785	6
Lrg	Dallas, TX	975	8	740	8
Vlg	Houston, TX	960	9	715	10
Lrg	Miami-Hialeah, FL	930	10	730	9
Lrg	Portland-Vancouver, OR-WA	885	11	695	11
Med	Austin, TX	880	12	685	12
Lrg	Indianapolis, IN	865	13	660	13
Lrg	St. Louis, MO-IL	845	14	645	14
Lrg	San Bernardino-Riverside, CA	815	15	580	19
Lrg	Baltimore, MD	780	16	620	15
Lrg	San Jose, CA	765	17	590	17
Med	Nashville, TN	765	17	595	16
Lrg	Denver, CO	760	19	585	18
Vlg	Chicago IL-Northwestern, IN	720	20	550	20
Med	Louisville, KY-IN	680	21	540	21
Med	Charlotte, NC	680	21	520	22
Lrg	Orlando, FL	670	23	520	22
Med	Tampa, FL	650	24	520	22
Med	Albuquerque, NM	650	24	505	26
Lrg	Sacramento, CA	645	26	480	28
Vlg	New York NY-Northeastern, NJ	640	27	520	22
Lrg	Fort Worth, TX	640	27	480	28
Lrg	San Diego, CA	635	29	485	27
Lrg	Phoenix, AZ	580	30	440	31
Med	Jacksonville, FL	580	30	435	34
Lrg	Las Vegas, NV	575	32	440	31
Lrg	Minneapolis-St. Paul, MN	570	33	450	30
Lrg	Norfolk, VA	570	33	440	31
Lrg	Cincinnati, OH-KY	525	35	405	35
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	515	36	405	35
Lrg	Columbus, OH	515	36	400	37
Med	Honolulu, HI	510	38	395	38
Med	Omaha, NE-IA	510	38	385	39
Med	Tacoma, WA	500	40	380	40
Med	Memphis, TN-AR-MS	480	41	360	41
Lrg	Kansas City, MO-KS	475	42	360	41
Med	Tucson, AZ	450	43	345	43
Vlg	Philadelphia, PA-NJ	445	44	345	43
Lrg	San Antonio, TX	435	45	320	46

Table 8. 1997 Annual Individual Congestion Cost, continued

Population Group	Urban Area	Annual Congestion Cost			
		Per Eligible Driver (dollars)	Rank	Per Capita (dollars)	Rank
Lrg	Milwaukee, WI	425	46	325	45
Lrg	New Orleans, LA	400	47	315	47
Med	Salt Lake City, UT	400	47	285	49
Med	Hartford-Middletown, CT	390	49	305	48
Med	Providence-Pawtucket, RI-MA	360	50	285	49
Lrg	Cleveland, OH	345	51	270	51
Med	Fresno, CA	315	52	220	53
Lrg	Oklahoma City, OK	305	53	235	52
Sml	Colorado Springs, CO	275	54	205	54
Lrg	Pittsburgh, PA	245	55	195	55
Sml	Beaumont, TX	225	56	180	56
Sml	Salem, OR	215	57	160	57
Med	El Paso, TX-NM	205	58	150	59
Med	Rochester, NY	200	59	155	58
Sml	Spokane, WA	200	59	150	59
Sml	Bakersfield, CA	155	61	105	62
Sml	Albany-Schenectady-Troy, NY	140	62	110	61
Sml	Eugene-Springfield, OR	120	63	95	63
Lrg	Buffalo-Niagara Falls, NY	115	64	90	64
Sml	Corpus Christi, TX	110	65	80	66
Sml	Boulder, CO	110	65	90	64
Sml	Laredo, TX	90	67	60	67
Sml	Brownsville, TX	50	68	35	68
	68 area average	755		584	
	Very large area average	898		700	
	Large area average	671		517	
	Medium area average	515		392	
	Small area average	164		123	

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

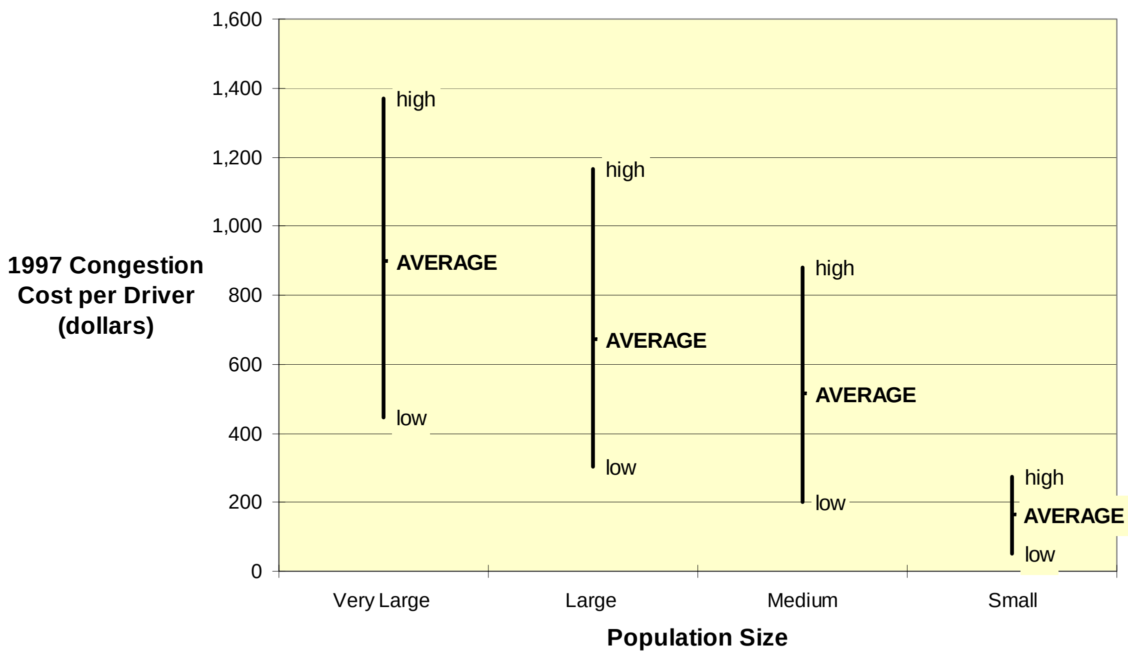
CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

- The congestion cost in the top three urban areas (Los Angeles, New York, and Chicago), when combined, is greater than the congestion cost in all of the Large urban areas combined.
- The annual congestion cost in Los Angeles and New York is larger than the annual congestion cost in the Small and Medium urban areas combined.
- The urban areas with the highest annual congestion cost by population size are:
  - Very Large Los Angeles $12,405 million
  - Large Atlanta $ 2,270 million
  - Medium Louisville $ 455 million
  - Small Colorado Springs $ 85 million
- The urban areas with the lowest annual congestion cost by population size are:
  - Very Large Philadelphia $1,825 million
  - Large Buffalo $ 95 million
  - Medium El Paso $ 90 million
  - Small Brownsville $ 5 million

- Six urban areas have congestion costs per driver of more than $1,000 per year which equates to about $4 per work day.
- The urban areas with the highest annual congestion cost per driver and their overall rank by population size are:
  - Very Large Los Angeles $1,370 (1st)
  - Large Seattle $1,165 (3rd)
  - Medium Austin $880 (12th)
  - Small Colorado Springs $275 (54th)
- The urban areas with the lowest annual congestion cost per driver and their overall rank by population size are:
  - Very Large Philadelphia $445 (44th)
  - Large Buffalo $115 (64th)
  - Medium Rochester $200 (tied 59th)
  - Small Brownsville $50 (68th)

Exhibit 21

How much does congestion cost per driver vary?



- The average annual congestion cost per driver ranges from $164 in the Small urban areas to $898 in the Very Large urban areas.
- The annual congestion cost per driver in the Very Large urban areas equate to about $3.50 per workday.
- The annual congestion cost per driver in the Small urban areas equate to about $0.70 per workday.

Build Roads

Another way to deal with traffic congestion is to construct new lane-miles of roadway. This section presents a relatively simple analysis based on the concept that if an area wants to keep congestion levels constant, system supply has to increase by the same percentage as the system demand.

Very few urban areas, however, have been able to sustain the level of roadway construction necessary to slow the growth of congestion on their major roadway system. Applying the traffic growth rate to the amount of freeway and principal arterial streets develops the annual roadway construction needed to address increasing traffic levels.

The statistics in Table 9 show the amount of additional capacity needed and the capacity supplied; it is apparent that the **construction of additional roadway capacity cannot be the sole alternative used to deal with urban mobility in most areas**. And the travel rate index (TRI) values indicate that even if the roadway construction rates could be achieved, they would only keep a bad situation from getting worse in many areas.

Table 9 shows the existing lane-miles of freeway and principal arterial streets in 1997 and the recent traffic growth rate. The annual freeway and principal arterial street lane-miles that are needed to offset the travel growth are also shown. The "deficiency" in lane-mile construction is the difference between the "needed" lane-miles and the roadway added to the urban area. The study database does not differentiate between **newly constructed** lane-miles and those that **were added due to a growing urban boundary –** this understates the "deficiency". The amount of extra lane-miles of both freeway and arterial streets is usually greater in the Very Large and Large urban areas. But the impact of rapid growth or an economic slowdown is also evident. Areas with the lowest "deficiency" are typically either small cities or areas where traffic growth is relatively low.

Table 10 compares the "added" and "needed" roadway estimates for the population groups. The table shows the growth in vehicle-miles of travel and the percent of the needed lane-miles that were added (lane-miles added divided by the lane-miles needed) for three time periods: 1982 to 1985, 1988 to 1991, and 1994 to 1997.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 9. Illustration of Annual Capacity Increase Required to Prevent Congestion Growth

Population Group	Urban Area	Existing (1997) Lane-miles		Average Annual VMT Growth (%)[1]	Annual Lane-miles Needed		Lane-mile Deficiency		1997 Travel Rate Index
		Freeway	Principal Arterial		Freeway	Principal Arterial Street	Freeway	Principal Arterial	
Vlg	New York, NY-Northeastern, NJ	6,550	7,535	3.1	203	233	150	51	1.30
Lrg	Atlanta, GA	2,220	2,330	6.2	138	145	103	95	1.34
Lrg	Kansas City, MO-KS	1,685	1,105	5.3	89	58	45	71	1.09
Lrg	Orlando, FL	680	1,370	9.3	63	127	22	71	1.20
Lrg	Denver, CO	1,030	1,970	4.3	44	84	30	62	1.28
Lrg	San Antonio, TX	1,065	975	3.3	36	33	23	68	1.15
Vlg	Washington, DC-MD-VA	1,835	2,390	3.9	72	93	31	55	1.41
Vlg	Houston, TX	2,415	2,455	5.0	121	123	70	14	1.30
Lrg	Minneapolis-St. Paul, MN	1,530	1,295	3.9	60	51	60	22	1.26
Vlg	Chicago, IL-Northwestern, IN	2,625	5,725	3.3	86	187	49	32	1.37
Lrg	Indianapolis, IN	750	1,215	6.4	48	77	44	34	1.22
Vlg	Boston, MA	1,310	2,055	2.6	34	54	32	45	1.32
Lrg	Phoenix, AZ	870	2,940	3.2	28	94	-11	84	1.28
Vlg	Philadelphia, PA-NJ	1,730	3,105	2.1	37	66	23	38	1.22
Med	Jacksonville, FL	660	1,400	5.5	36	77	4	53	1.14
Lrg	Cincinnati, OH-KY	975	820	4.1	40	34	33	22	1.22
Lrg	Columbus, OH	815	580	3.6	30	21	23	32	1.21
Lrg	Baltimore, MD	1,440	1,430	2.3	33	32	20	30	1.23
Lrg	Oklahoma City, OK	730	1,020	3.8	28	39	25	25	1.09
Lrg	Cleveland, OH	1,195	1,035	2.4	29	25	24	22	1.18
Med	Charlotte, NC	450	465	8.7	39	40	10	31	1.23
Med	Nashville, TN	725	1,035	4.2	30	43	13	28	1.13
Med	Memphis, TN-AR-MS	460	1,040	3.5	16	37	11	29	1.17
Lrg	Las Vegas, NV	375	545	7.4	28	41	4	34	1.31
Med	Louisville, KY-IN	665	630	5.2	34	33	21	17	1.19
Med	Albuquerque, NM	250	910	4.6	12	42	9	26	1.19
Med	Austin, TX	545	705	5.5	30	39	16	18	1.23
Med	Tucson, AZ	175	740	8.1	14	60	1	33	1.19
Lrg	Portland-Vancouver, OR-WA	690	905	3.8	26	34	20	13	1.30
Lrg	Fort Worth, TX	1,145	1,560	5.6	64	88	28	4	1.16
Lrg	Buffalo-Niagara Falls, NY	625	1,030	0.9	6	9	8	23	1.04
Lrg	Dallas, TX	1,950	2,540	3.8	74	97	18	13	1.24
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	725	1,350	3.9	28	53	17	13	1.24
Lrg	Sacramento, CA	680	1,205	1.0	7	12	11	19	1.24
Vlg	Los Angeles, CA	5,240	12,730	0.8	41	100	-27	54	1.51
Lrg	Pittsburgh, PA	1,190	1,590	1.1	14	18	0	25	1.08
Lrg	Norfolk, VA	620	655	3.0	19	20	11	12	1.18
Med	Salt Lake City, UT	475	425	2.8	13	12	13	8	1.22
Sml	Bakersfield, CA	160	545	1.3	2	7	1	18	1.05
Lrg	San Bernardino-Riverside, CA	885	2,150	1.5	13	33	-5	23	1.28
Lrg	St. Louis, MO-IL	1,675	2,200	2.0	34	45	23	-5	1.24
Sml	Albany-Schenectady-Troy, NY	525	555	2.0	10	11	9	8	1.03
Sml	Colorado Springs, CO	240	420	4.7	11	20	7	10	1.10
Lrg	Seattle-Everett, WA	1,265	1,500	1.5	19	23	16	1	1.43
Sml	Corpus Christi, TX	280	335	4.0	11	13	8	8	1.03

Table 9. Illustration of Annual Capacity Increase Required to Prevent Congestion Growth, continued

Population Group	Urban Area	Existing (1997) Lane-miles		Average Annual VMT Growth (%)[1]	Annual Lane-miles Needed		Lane-mile Deficiency		1997 Travel Rate Index
		Freeway	Principal Arterial		Freeway	Principal Arterial Street	Freeway	Principal Arterial	
Sml	Laredo, TX	60	190	14.2	8	27	4	11	1.05
Med	Omaha, NE-IA	290	500	3.5	10	18	1	12	1.16
Med	Providence-Pawtucket, RI-MA	630	800	2.2	14	17	2	10	1.13
Med	El Paso, TX-NM	280	750	2.7	8	20	3	8	1.08
Med	Hartford-Middletown, CT	610	380	1.1	7	4	3	8	1.09
Med	Tampa, FL	435	990	6.4	28	64	4	6	1.19
Vlg	Detroit, MI	1,790	4,310	0.9	15	37	12	-3	1.31
Med	Rochester, NY	500	185	2.2	11	4	5	4	1.06
Med	Tacoma, WA	300	580	1.8	5	10	1	8	1.26
Sml	Beaumont, TX	125	150	3.7	5	6	2	6	1.05
Med	Fresno, CA	170	490	2.0	3	10	1	7	1.13
Sml	Eugene-Springfield, OR	110	125	2.9	3	4	3	4	1.06
Lrg	Miami-Hialeah, FL	710	2,440	2.0	15	50	-1	8	1.34
Sml	Spokane, WA	125	530	1.7	2	9	2	5	1.06
Sml	Salem, OR	95	285	1.0	1	3	1	4	1.08
Sml	Boulder, CO	50	90	3.1	2	3	1	3	1.05
Sml	Brownsville, TX	30	125	4.0	1	5	1	2	1.04
Med	Honolulu, HI	400	260	0.9	4	2	0	-2	1.22
Lrg	Milwaukee, WI	610	1,260	1.4	9	18	-5	2	1.21
Lrg	New Orleans, LA	410	880	3.1	13	28	6	-10	1.19
Vlg	San Francisco-Oakland, CA	2,280	2,000	0.6	14	13	2	-9	1.42
Lrg	San Diego, CA	1,790	1,875	1.0	17	18	-4	-10	1.31
Lrg	San Jose, CA	1,160	1,210	0.9	10	11	0	-31	1.29
	68 area total	67,085	100,920		2,055	2,964	1,087	1,432	
	68 area average	987	1,484	2.8	30	44	16	37	
	Very large area average	2,864	4,701	2.2	69	101	38	69	
	Large area average	1,050	1,433	3.2	35	47	20	46	
	Medium area average	446	683	4.0	17	30	7	24	
	Small area average	164	305	2.9	5	10	4	11	

[1]Average annual growth rate of freeway and principal arterial street travel between 1992 and 1997.

Vlg — Very Large urban areas - over 3 million population
Lrg — Large urban areas - over 1 million and less than 3 million population
Med — Medium urban areas - over 500,000 and less than 1 million population
Sml — Small urban areas - less than 500,000 population

- The "deficit" of freeway lane-miles in all 68 urban areas for 1997 was 1,087, which is equivalent to 136 miles of an eight-lane freeway.
- The "deficit" of principal arterial lane-miles in all 68 urban areas for 1997 was 1,432, which is equal to about 358 miles of a 4-lane street.
- Six urban areas had a lane-mile surplus between 1992 and 1997 (Honolulu, Milwaukee, New Orleans, San Francisco-Oakland, San Diego, and San Jose).

Table 10. If Road Expansion Were the Only Congestion Reduction Technique

Population Group	1982 to 1985		1988 to 1991		1994 to 1997	
	Percent Growth in VMT	Percent Added[1]	Percent Growth in VMT	Percent Added[1]	Percent Growth in VMT	Percent Added[1]
68 Area Average	4.3	48	3.0	74	2.5	45
Very Large	3.2	49	2.4	87	2.0	47
Large	4.8	45	3.2	74	2.8	42
Medium	5.2	45	4.1	59	3.5	49
Small	6.0	54	3.7	35	3.5	32

[1] Lane-miles added divided by lane-miles needed.

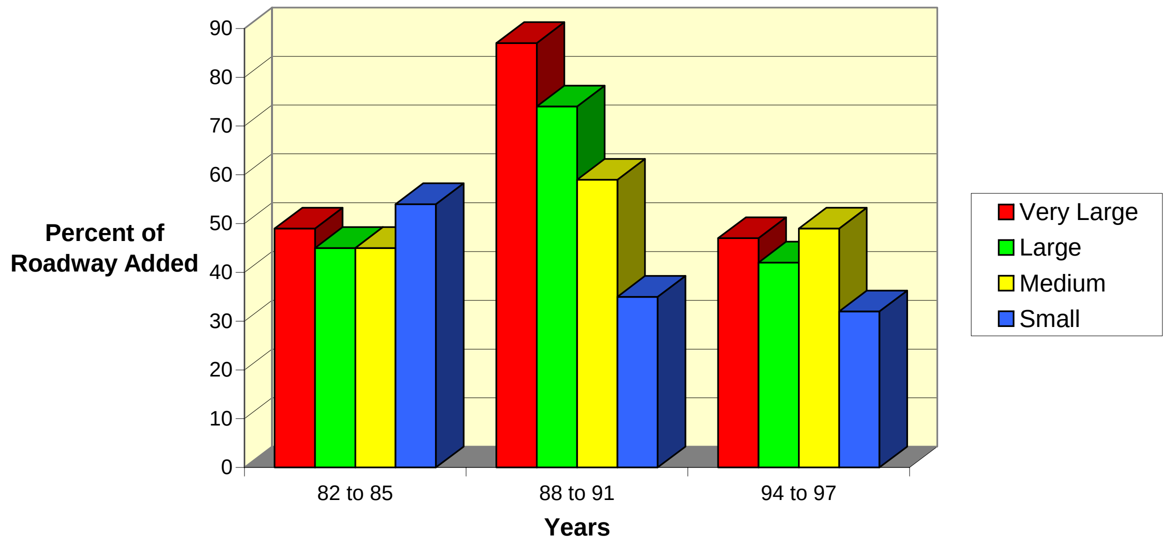
Note: Assumes that all added lane-miles are roadway expansion. The database does not include data concerning the addition of lane-miles through changing urban boundaries.

Note: Population groups determined by population in the final year of each range.

- The amount of roadway added in 1988 to 1991 is generally higher than the amount added in the other two periods. This may be partially due to the fact that urban area boundaries were significantly changed near the 1990 census.
- The Small urban areas experienced the lowest percent added values despite having the lowest amount of roadway required to address congestion growth.

Exhibit 22

How did road expansion match needs?



- The percentage of roadway added, when compared to the amount "needed" to accommodate travel growth, varies significantly across time and among urban area population groups.
- The Very Large urban areas experienced a peak in percent added in 1988 to 1991 of 87 percent.
- The Medium and Large urban areas experienced peaks in percent added in 1988/91, up to 59 percent and 74 percent, respectively.
- The Small urban areas experienced a peak in percent added between 1982 and 1985.

Change Vehicle Occupancy

As a counterpoint to the alternative of adding capacity (supply) to offset traffic growth, this alternative looks at changing the occupancy level in the traffic volume (demand) to accommodate travel growth. The result of this analysis shows what the average vehicle occupancy would have to be in order to maintain the existing congestion levels. The "next year" vehicle travel volume is calculated by applying the annual growth rate to the previous year's estimate of vehicle-miles of travel. Passenger-miles of travel are estimated using the standard 1.25 persons per vehicle value used elsewhere in the study. The "next year" passenger travel estimate divided by the "previous year" vehicle travel volume gives the vehicle occupancy ratio needed to accommodate one year of growth. Dividing an average trip length into the added passenger-miles of travel gives some idea of the number of additional trips that would have to be made by carpool or transit.

Table 11 shows the new average occupancy levels that would be required to maintain the existing mobility level for each urban area. The average growth rate of passenger-miles of travel, additional passenger-miles of travel, and the number of additional trips that must take some higher occupancy travel mode is also shown. This increase in vehicle occupancy must occur every year to keep pace with increasing demand. The formation of carpoolers and transit riders also must occur against the prevailing trend in urban transportation. Commuter vehicle occupancy has declined from 1.18 in 1970 to 1.09 in 1990 (1).

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Table 11. Illustration of Annual Occupancy Increase Needed to Prevent Mobility Decline

Population Group	Urban Area	Growth in Person Travel			Occupancy Level to Maintain 1997 Mobility Level[3]
		Percent[1]	Additional Miles	Estimated Trips[2]	
Sml	Laredo, TX	13.9	211,000	23,445	1.42
Lrg	Orlando, FL	9.2	1,905,000	211,665	1.37
Med	Charlotte, NC	8.6	1,019,000	113,220	1.36
Med	Tucson, AZ	8.0	687,000	76,335	1.35
Lrg	Las Vegas, NV	7.4	839,000	93,220	1.34
Med	Tampa, FL	6.4	1,028,000	114,220	1.33
Lrg	Indianapolis, IN	6.3	1,455,000	161,665	1.33
Lrg	Atlanta, GA	6.2	4,121,000	457,890	1.33
Lrg	Fort Worth, TX	5.6	1,535,000	170,555	1.32
Med	Austin, TX	5.5	831,000	92,335	1.32
Med	Jacksonville, FL	5.5	1,068,000	118,665	1.32
Lrg	Kansas City, MO-KS	5.2	1,495,000	166,110	1.31
Med	Louisville, KY-IN	5.1	865,000	96,110	1.31
Vlg	Houston, TX	5.0	3,172,000	352,445	1.31
Sml	Colorado Springs, CO	4.7	262,000	29,110	1.31
Med	Albuquerque, NM	4.6	507,000	56,335	1.31
Lrg	Denver, CO	4.2	1,425,000	158,335	1.30
Med	Nashville, TN	4.2	820,000	91,110	1.30
Lrg	Cincinnati, OH-KY	4.1	979,000	108,780	1.30
Sml	Brownsville, TX	3.9	41,000	4,555	1.30
Sml	Corpus Christi, TX	3.9	209,000	23,220	1.30
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	3.9	891,000	99,000	1.30
Lrg	Minneapolis-St. Paul, MN	3.9	1,568,000	174,220	1.30
Vlg	Washington, DC-MD-VA	3.9	2,536,000	281,780	1.30
Lrg	Dallas, TX	3.8	2,016,000	224,000	1.30
Lrg	Oklahoma City, OK	3.7	634,000	70,445	1.30
Lrg	Portland-Vancouver, OR-WA	3.7	819,000	91,000	1.30
Sml	Beaumont, TX	3.6	103,000	11,445	1.29
Lrg	Columbus, OH	3.6	703,000	78,110	1.30
Med	Memphis, TN-AR-MS	3.5	528,000	58,665	1.29
Med	Omaha, NE-IA	3.5	312,000	34,665	1.29
Vlg	Chicago, IL-Northwestern, IN	3.3	3,547,000	394,110	1.29
Lrg	San Antonio, TX	3.3	764,000	84,890	1.29
Lrg	Phoenix, AZ	3.2	1,263,000	140,335	1.29
Vlg	New York NY-Northeastern, NJ	3.1	5,914,000	657,110	1.29
Sml	Boulder, CO	3.0	38,000	4,220	1.29
Lrg	New Orleans, LA	3.0	400,000	44,445	1.29
Lrg	Norfolk, VA	3.0	466,000	51,780	1.29
Sml	Eugene-Springfield, OR	2.9	71,000	7,890	1.29
Med	El Paso, TX-NM	2.7	226,000	25,110	1.28
Med	Salt Lake City, UT	2.7	323,000	35,890	1.28
Vlg	Boston, MA	2.6	1,242,000	138,000	1.28
Lrg	Cleveland, OH	2.4	692,000	76,890	1.28
Lrg	Baltimore, MD	2.3	839,000	93,220	1.28
Vlg	Philadelphia, PA-NJ	2.1	1,193,000	132,555	1.28

Table 11. Illustration of Annual Occupancy Increase Needed to Prevent Mobility Decline, continued

Population Group	Urban Area	Growth in Person Travel			Occupancy Level to Maintain 1997 Mobility Level[3]
		Percent[1]	Additional Miles	Estimated Trips[2]	
Med	Providence-Pawtucket, RI-MA	2.1	316,000	35,110	1.28
Med	Rochester, NY	2.1	170,000	18,890	1.28
Sml	Albany-Schenectady-Troy, NY	2.0	203,000	22,555	1.27
Lrg	Miami-Hialeah, FL	2.0	754,000	83,780	1.28
Lrg	St. Louis, MO-IL	2.0	922,000	102,445	1.28
Med	Fresno, CA	1.8	110,000	12,220	1.27
Med	Tacoma, WA	1.8	177,000	19,665	1.27
Sml	Spokane, WA	1.7	80,000	8,890	1.27
Lrg	San Bernardino-Riverside, CA	1.5	496,000	55,110	1.27
Lrg	Seattle-Everett, WA	1.5	601,000	66,780	1.27
Lrg	Milwaukee, WI	1.4	273,000	30,335	1.27
Sml	Bakersfield, CA	1.3	62,000	6,890	1.27
Med	Hartford-Middletown, CT	1.1	134,000	14,890	1.26
Lrg	Pittsburgh, PA	1.1	288,000	32,000	1.26
Sml	Salem, OR	1.0	30,000	3,335	1.26
Lrg	San Diego, CA	1.0	470,000	52,220	1.26
Lrg	Buffalo-Niagara Falls, NY	0.9	117,000	13,000	1.26
Med	Honolulu, HI	0.9	90,000	10,000	1.26
Lrg	Sacramento, CA	0.9	218,000	24,220	1.26
Lrg	San Jose, CA	0.9	279,000	31,000	1.26
Vlg	Detroit, MI	0.8	597,000	66,335	1.26
Vlg	Los Angeles, CA	0.8	1,987,000	220,780	1.26
Vlg	San Francisco-Oakland, CA	0.6	442,000	49,110	1.26
	68 area total	2.8	60,378,000	6,708,660	
	68 area average	2.8	887,912	98,657	1.29
	Very large area average	2.2	2,292,222	254,692	1.28
	Large area average	3.2	974,233	108,248	1.29
	Medium area average	4.0	511,22	56,858	1.30
	Small area average	2.9	119,091	13,232	1.29

[1]Annual growth in person-miles of travel between 1992 and 1997.
[2]Assumes an average trip length of 9 miles (7).
[3]From a base level of 1.25 persons per vehicle in every urban area.

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

- Based on recent growth in travel, there will be an additional 60 million passenger-miles of travel in the 68 urban areas in 1997. This additional travel equates to about 6.7 million trips.
- The average vehicle occupancy in the 68 urban areas would have to increase to 1.29 from 1.25 to accommodate the additional passenger-miles of travel, with no decline in mobility levels.
- The highest average occupancy levels needed by population group are:
  - Very Large Houston 1.31 persons per vehicle
  - Large Orlando 1.37 persons per vehicle
  - Medium Charlotte 1.36 persons per vehicle
  - Small Laredo 1.42 persons per vehicle

Incorporating Mobility Improvements

The revised mobility measurement procedures use travel speed and person travel volume as the key data elements. This general approach means that many of the effects of operational treatments will be illustrated in the data collected as part of the evaluation.

- Demand management effects will be illustrated in shorter travel times and shorter peak periods.
- Traffic signal coordination improvements will be found in quicker travel speeds on arterial streets.
- Incident management technique effects will be somewhat harder to fully measure since they decrease the variation in travel time, something that is easy to measure only if facilities are instrumented to continuously collect speed data. The effect, however, is to reduce average travel times by reducing the effect of crashes and breakdowns.
- High-occupancy vehicle lanes improve travel time and person movement.

HOV lanes are the only treatment studied in the first two years of the Urban Mobility Study that requires any special treatment in the preparation of mobility measures and which can be addressed in the current study procedures. The person movement volume on the HOV lanes have not previously been included in the travel estimates for freeways or arterial streets. This section describes the procedures needed to accommodate the attributes and performance of HOV lanes into the mobility measures.

High-Occupancy Vehicle Lane Performance

Successful HOV lanes move greater numbers of people at faster speeds during peak travel times than general-purpose lanes. Incorporating the information from HOV systems will give a more accurate picture of the mobility experience of urban travelers. The HOV lane data can be added to the mobility statistics because the HOV lane travelers are not currently counted in the study database. The HOV person volume can be used to weight the contribution of the lanes to the average travel rate for an analysis area as measured by the travel rate index. This contribution will be relatively small on an areawide basis, but it can be important in corridor analyses.

Table 12 illustrates the performance characteristics of the five Houston HOV lanes (71.6 miles) in 1997. The person volume data are collected at one or two locations where there is a significant difference in volume. The average travel speeds for the morning and evening peak periods use person volume as the weighting factor. HOV lane length is used to calculate person-miles of travel.

Table 12. 1997 Houston HOV Lane Performance Summary

Freeway and Section	Total Length (miles)	Morning Peak Period		Evening Peak Period	
		Person Volume	Speed (mph)	Person Volume	Speed (mph)
Houston					
Katy	13.1	8,380	60	8,515	58
North	16.9	9,460	52	9,320	55
Gulf	15.5	5,370	52	5,120	52
Northwest	13.5	6,700	60	6,680	60
Southwest	12.6	7,375	46	7,205	48
Summary	71.6	37,285	54	36,840	55

Table 13 illustrates the base areawide statistics for 1997 in Houston. These data are only for freeways and principal arterial streets from the Urban Mobility database. One change of note to the typical Urban Mobility Study data is the inclusion of some collected travel speeds on the five freeways with HOV lanes. The Automated Vehicle Identification (AVI) System records travel time between checkpoints for all vehicles with electronic toll transponders. For this analysis, the average freeway speed includes the actual speeds for the five freeways with HOV lanes and AVI, and estimated speeds for the remainder of the Houston freeways. The resulting data is noted as the "enhanced" TRI.

Table 13. Base Areawide Mobility Statistics

Urban Area	Freeway		Principal Arterial Street		"Enhanced" Travel Rate Index
	Person-Miles of Travel (1000)	Speed (mph)[1]	Person-Miles of Travel (1000)	Speed (mph)	
Houston	22,438	45.7	9,473	28.3	1.29

[1]Includes speeds collected by the Automated Vehicle Identification System on Houston freeways.

The effect of HOV lane operations is more apparent if the statistics are analyzed for individual freeways. This shows the effect of the HOV lane on the mobility levels in the area where the HOV lane operates. Table 14 illustrates the travel rate index for each freeway without HOV, the HOV lane, and the combination of the two. The HOV lanes on the five freeways experience almost a free flow trip, and reduce the combined travel rate index by an average of about 6 percent compared to the freeway main lanes. This means that on these five corridors, the average traveler experiences a reduction in travel time of 6 percent relative to the mainlanes because of the superior person-moving capabilities of the HOV lanes.

Table 14. Freeway Corridor "Enhanced" Travel Rate Index Values

Freeway	Peak-Period "Enhanced" Travel Rate Index			% Reduction in TRI with HOV
	Base Freeway	HOV	Combined Freeway And HOV	
Houston				
Katy	1.76	1.02	1.52	14
North	1.36	1.12	1.28	6
Gulf	1.20	1.15	1.19	1
Northwest	1.50	1.00	1.38	8
Southwest	1.36	1.28	1.35	1
Average	1.44	1.11	1.33	6

Table 15 incorporates HOV lane data into the base areawide data for Houston from Table 2. The difference in the TRI is 0.01 which is equal to about one year of growth in travel congestion.

Table 15. Areawide Mobility Statistics Including HOV Lane Data

Urban Area	Freeway and HOV		Principal Arterial Street		"Enhanced" Travel Rate Index
	Person-Miles of Travel (1000)	Speed (mph)[1]	Person-Miles of Travel (1000)	Speed (mph)[1]	
Houston without HOV	22,438	45.7	9,473	28.3	1.29
Houston with HOV	23,504	46.2	9,473	28.3	1.29

[1]Includes speeds collected by the Automated Vehicle Identification System on Houston freeways.

This analysis shows that the high-speed, high person movement attributes make a significant impact on mobility levels experienced by travelers in HOV corridors. The smaller areawide impact is because HOV travel is only a small fraction of the total travel on the urban transportation system each day. This analysis re-emphasizes the point that significantly increasing the areawide mobility level generally takes a combination of several treatments to make a sizable impact.

CHAPTER VI. CONCLUSIONS

The problem with describing urban mobility is that there is not a single measure that everyone agrees with, and the experiences of the travelers and residents vary by what routes are used and what time of day/week/year the travel occurs. This study indicates that for travelers in most of the 68 U.S. cities studied mobility is getting worse no matter how it is measured. It is taking longer to make the trip they made last week, last year, or for the past several years. Each traveler also has different expectations about their desired speed, cost and comfort of the trip, and they use these expectations to "grade" their trip. These disagreements are overshadowed in many areas by the discussion of what to do about the problem.

USING MOBILITY MEASURE INFORMATION

Against this backdrop, the annual urban mobility statistics can be a part of the discussion. The report provides a source of data that can be used and interpreted for many purposes. It provides a method of gauging mobility from a system element perspective—looking at road segments, roadway corridors, and the freeway and major street system as a whole. It also develops information to estimate the conditions that a road traveler would experience—at the individual level.

The information can be used in conjunction with other analyses as a component in a future condition forecast. These have been used in cities when long-term planning and financing decisions are being made.

The lack of a single, agreed-upon measure means that there are several techniques and measures presented in the study. No single measure is "more correct" than any other. The application depends on the type of concern, the type of analysis and the problem or solution being tested.

Some address the intensity or severity issue—"How bad is my mobility level?" The study offers a number of measures that relate to individual concerns. The report shows that roadway mobility levels are frequently related to size—larger urban areas have more congestion. Rapid mobility decline, however, is more often related to a growing economy rather than the size of the area—significant increases in residents and jobs almost always occur before the transportation system is expanded. So the trend information may be more relevant in some cities.

Some measures address the magnitude issue—"How much travel delay is in our area?" This measure is related to population size; larger areas have greater delay and more fuel consumed in congestion and higher costs as a result. These are useful in a benefit/cost sense and to identify the possible transportation needs.

The magnitude statistics are also useful in describing where in the United States the mobility problem is most significant—from a population size perspective. Certainly every major urban area has locations that cause travelers to believe there is a significant problem. This local perception may be more related to the impacts of recent traffic growth rather than to any research study measure.

HOW DO WE SOLVE THE MOBILITY PROBLEM?

The measurement of urban mobility does not automatically mean that all the solutions should be in the form of road construction. One inescapable conclusion of this report is that it is very difficult to maintain the financial and public support to add roads and lanes as fast as travel volume grows. At the same time road construction has been shown to play a key role in holding the line against urban mobility decline. So what is the magical answer to the mobility question?

The solutions to mobility problems are costly. Building roads or using high-tech solutions are not inexpensive. However, the public is already paying a price for the declining mobility levels in urban America. This report has quantified the annual cost of congestion. Perhaps the answer lies in transferring the current costs that the public is paying in lost time and fuel into mobility improvements.

Almost all the urban areas in this study are pursuing more than one technique to improve mobility. At a relatively basic level, congestion levels can be improved by one or more of the following approaches. **The combination of techniques that are implemented in an urban area is a product of financial, environmental, public support and other concerns; the program may be different in every urban area and may include:**

Add road space—This might be new roads or widened existing roads.

Lower the number of vehicles—Techniques attempt to reduce the number of vehicles or increase the number of people in each vehicle including new or enhanced transit, travel demand management options, bicycle and pedestrian treatments and land use pattern changes.

Change the time that vehicles use the road—This reduces the load on the system at peak travel times.

Get more vehicles past a spot on the road—More efficient operation of the roadway has the effect of adding capacity, although not usually of the same magnitude as adding a full lane.

Add Road Space

The expenditures and/or public support to build more capacity have not maintained pace with the growth in demand, but there have been significant additions. Most of these have been traditional (e.g., non-toll) street or freeway lanes. There are, however, several toll highway projects under development and several tests of variable pricing ideas. These projects attempt to provide more capacity to a targeted market that is willing to pay for better service from the transport system than they get from a congested road.

Lower the number of vehicles

Reducing vehicle travel is the goal of many transport and land use strategies. These strategies attempt to design transportation options and land use patterns that make other modes more attractive either by performance enhancements or by design treatments.

High-occupancy vehicle lanes use time savings and improved travel time reliability to get travelers to choose carpools and transit. Successful HOV lanes provide greater person movement and lower travel times, on average, in the corridor.

Traffic congestion in the peak hour may not decrease, because traffic from other roads or other times of the day replace the carpoolers and transit riders who have moved from the general purpose lanes. The net effect is to decrease the peak period length and to improve operations on parallel roads. As the case study of the Houston HOV lanes shows, the effects of the HOV lanes are felt much more at the corridor level than at the areawide level, but they make a difference by improving mobility levels.

Changing the land use pattern is not a quick solution, and not everyone wishes to live near his or her office in a townhouse/apartment type of development. There are many reasons why city residents choose a place to live, many of which have nothing to do with transportation. However, there are a variety of ways to mix jobs, shops and homes that may result in lower vehicle trip-making. These developments can also be more conducive to transit use. The challenge is to make these economically viable for developers and desirable for consumers. With the shift of the "baby boom" families to more homes without children, there may be a more diversified home ownership market in the future that may include less vehicle use as one aspect.

Another factor affecting the number of vehicles is the local economy. It is difficult to lower the number of vehicles on the road during times of economic expansion. As the numbers of jobs increase and as incomes rise, travel demand grows and most of that is reflected in vehicular travel increases. If a major industry has a slow period or a decline, congestion levels do not increase as sharply, or may decrease. The effect of the California economic slowdown of the early 1990s is evident in the trend data in this report. Needless to say, congestion reduction was not the intended result of this slowdown, and recession is not a goal in most cities.

Change the time that vehicles use the road

Flexible work hours, telecommunication technology and variable pricing for transportation services can provide incentives for travelers to change the time they use the road system. Telecommunication technology can eliminate the need for physical travel altogether. The daily system travel amount may not change, but if trips are moved away from the peak period, vehicle congestion can be reduced. Pricing can move demand away from congested areas in much the same way that congestion now encourages travelers to select different routes or times to travel.

Get more vehicles past a spot on the road

A more efficiently operating transport system can improve the vehicle moving capability of the roadway and the person moving capability of the transit system. The intelligent transportation system (ITS) is a group of technologies and processes that, among several goals, attempt to make better use of the road space that already exists and utilize computer applications that improve communications. Included in this range of road improvements are ideas such as ramp metering to smooth freeway traffic flow, traffic signal coordination, and systems for detecting and removing incidents quickly. Transit systems can also benefit from better methods for communicating between buses, control centers, the traffic signal system and customers.

DEVELOPING MOBILITY INFORMATION

The focus of this report is on measuring congestion and mobility at the urban area level. While the effect of many of the solutions is not illustrated by the measures in this report, most urban areas rely on the basic freeway and principal arterial street network to provide at least 95 percent of their mobility needs. The existing measures work reasonably well for describing this type of system.

As operational improvements and demand management activities are implemented, however, the measures will do a less effective job of describing travel conditions. The research team is pursuing a number of new measures and improvements to existing measures that will illustrate improvements in urban mobility well into the next century. These changes should be apparent over the next four years as new information is produced. This report includes the beginning of this evolution with the extensive use of the Travel Rate Index and the corridor-based analysis of the HOV system in Houston.

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CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

APPENDIX A

TABLES AND EXHIBITS

Table A-1—Percentage of Congested Lane-miles, 1990 to 1997

- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1990, 1994, 1997 Data
  - ✶ Percentage of Congested Lane-miles
  - ✶ Freeway and Principal Arterial Street

Table A-2—Percentage of Congested Travel, 1982 to 1997

- ✶ Urban Area
- ✶ 1982, 1990, 1997 Data
- ✶ Percentage of Congested Travel
- ✶ Freeway and Principal Arterial Street

Table A-3—Roadway Congestion Index

- A measure of the areawide congestion level
- Contains these statistics:
  - ✶ Urban Area
  - ✶ Freeway and Principal Arterial Travel
  - ✶ Freeway and Principal Arterial Travel per Lane-mile
  - ✶ Roadway Congestion Index, 1997

Table A-4—Roadway Congestion Index, 1982 to 1997

- A measure of areawide congestion level
- Contains these statistics:
  - ✶ Urban Area
  - ✶ 1982 to 1997 Data
  - ✶ Roadway Congestion Index Values
  - ✶ Percent Change, Long-term and Short-term

Appendix A-1. Congested Lane-Miles of Roadway

Population Group	Urban Area	Peak Period Congested Lane Miles (%)					
		Freeway			Principal Arterial Street		
		1990	1994	1997	1990	1994	1997
Lrg	Atlanta, GA	30	50	65	60	55	65
Lrg	Baltimore, MD	35	40	45	55	60	60
Lrg	Buffalo-Niagara Falls, NY	10	15	15	25	30	25
Lrg	Cincinnati, OH-KY	40	45	45	40	35	35
Lrg	Cleveland, OH	20	30	40	40	35	50
Lrg	Columbus, OH	25	35	35	45	45	65
Lrg	Dallas, TX	40	35	45	25	30	35
Lrg	Denver, CO	35	40	50	45	60	70
Lrg	Fort Worth, TX	30	30	35	20	30	30
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	25	40	40	45	50	55
Lrg	Kansas City, MO-KS	10	15	25	45	45	50
Lrg	Las Vegas, NV	45	50	45	60	65	75
Lrg	Miami-Hialeah, FL	55	60	60	55	60	65
Lrg	Milwaukee, WI	40	50	50	30	45	45
Lrg	Minneapolis-St. Paul, MN	25	40	50	50	50	55
Lrg	New Orleans, LA	50	35	35	50	50	50
Lrg	Norfolk, VA	30	30	40	35	40	50
Lrg	Orlando, FL	45	40	40	45	50	50
Lrg	Phoenix, AZ	40	50	55	50	55	60
Lrg	Pittsburgh, PA	10	10	10	50	55	55
Lrg	Portland-Vancouver, OR-WA	35	40	45	25	50	55
Lrg	Sacramento, CA	40	55	55	70	60	65
Lrg	San Antonio, TX	20	25	35	25	30	40
Lrg	San Bernardino-Riverside, CA	55	55	60	40	40	50
Lrg	San Diego, CA	70	70	70	35	45	50
Lrg	San Jose, CA	50	50	55	70	65	65
Lrg	Seattle-Everett, WA	75	65	70	45	60	60
Lrg	St. Louis, MO-IL	20	40	45	45	60	65
Med	Albuquerque, NM	25	30	40	45	45	50
Med	Austin, TX	25	30	45	40	45	60
Med	Charlotte, NC	45	40	45	45	65	65
Med	El Paso, TX-NM	15	25	25	20	20	25
Med	Fresno, CA	15	15	15	55	50	55
Med	Hartford-Middletown, CT	15	15	25	45	50	50
Med	Honolulu, HI	35	35	35	75	80	80
Med	Indianapolis, IN	15	30	35	35	60	70
Med	Jacksonville, FL	30	35	30	40	45	45
Med	Louisville, KY-IN	20	30	35	45	60	65
Med	Memphis, TN-AR-MS	15	25	35	45	50	55
Med	Nashville, TN	20	25	30	40	45	50
Med	Oklahoma City, OK	15	15	30	20	25	30
Med	Omaha, NE-IA	20	20	20	45	50	50
Med	Providence-Pawtucket, RI-MA	25	25	30	35	45	55

Appendix A-1. Congested Lane-Miles of Roadway, continued

Population Group	Urban Area	Peak Period Congested Lane Miles (%)					
		Freeway			Principal Arterial Street		
		1990	1994	1997	1990	1994	1997
Med	Rochester, NY	10	15	20	40	35	35
Med	Salt Lake City, UT	20	35	50	60	70	75
Med	Tacoma, WA	55	60	70	30	35	35
Med	Tampa, FL	35	30	30	50	60	65
Med	Tucson, AZ	35	35	35	65	65	75
Sml	Albany-Schenectady-Troy, NY	5	5	5	40	40	45
Sml	Bakersfield, CA	5	10	15	25	20	25
Sml	Beaumont, TX	5	5	15	20	20	25
Sml	Boulder, CO	5	5	5	30	50	60
Sml	Brownsville, TX	5	5	10	25	30	35
Sml	Colorado Springs, CO	10	20	20	30	40	45
Sml	Corpus Christi, TX	5	10	10	25	20	20
Sml	Eugene-Springfield, OR	0	5	10	50	50	55
Sml	Laredo, TX	5	5	5	25	25	45
Sml	Salem, OR	5	25	25	25	40	35
Sml	Spokane, WA	5	15	25	20	35	30
Vlg	Boston, MA	45	55	55	70	70	75
Vlg	Chicago, IL-Northwestern, IN	55	55	65	60	70	70
Vlg	Detroit, MI	45	50	55	55	55	60
Vlg	Houston, TX	45	40	50	35	40	50
Vlg	Los Angeles, CA	85	85	85	55	60	70
Vlg	New York, NY-Northeastern, NJ	40	35	45	40	50	65
Vlg	Philadelphia, PA-NJ	25	25	30	55	60	65
Vlg	San Francisco-Oakland, CA	70	70	75	65	60	65
Vlg	Washington, DC-MD-VA	60	60	65	75	75	75
	68 area average	40	43	49	48	53	59
	Very large area average	55	54	60	54	59	67
	Large area average	35	41	46	44	49	54
	Medium area average	22	27	34	41	48	54
	Small area average	5	10	12	28	33	36

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Appendix A-2. Congested Person-Miles of Travel

Population Group	Urban Area	Peak Period Congested Percent of Person-Miles of Travel (%)					
		Freeway			Principal Arterial Street		
		1982	1990	1997	1982	1990	1997
Lrg	Atlanta, GA	40	45	75	60	70	80
Lrg	Baltimore, MD	40	55	60	50	75	75
Lrg	Buffalo-Niagara Falls, NY	10	15	25	30	45	40
Lrg	Cincinnati, OH-KY	35	55	60	30	65	60
Lrg	Cleveland, OH	20	30	55	30	55	65
Lrg	Columbus, OH	25	45	55	30	60	80
Lrg	Dallas, TX	45	55	70	25	40	65
Lrg	Denver, CO	45	60	70	50	65	85
Lrg	Fort Worth, TX	30	45	60	25	35	50
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	40	55	60	45	60	65
Lrg	Kansas City, MO-KS	5	20	40	50	60	70
Lrg	Las Vegas, NV	40	70	70	50	75	85
Lrg	Miami-Hialeah, FL	45	70	80	60	70	75
Lrg	Milwaukee, WI	30	60	70	35	45	60
Lrg	Minneapolis-St. Paul, MN	20	40	65	40	60	65
Lrg	New Orleans, LA	60	70	55	60	70	70
Lrg	Norfolk, VA	45	50	60	35	50	65
Lrg	Orlando, FL	45	70	65	55	60	65
Lrg	Phoenix, AZ	50	65	75	65	70	75
Lrg	Pittsburgh, PA	15	20	25	50	70	75
Lrg	Portland-Vancouver, OR-WA	45	65	70	40	45	70
Lrg	Sacramento, CA	30	55	65	55	65	70
Lrg	San Antonio, TX	35	40	50	40	45	60
Lrg	San Bernardino-Riverside, CA	60	75	80	40	45	60
Lrg	San Diego, CA	45	80	80	35	45	60
Lrg	San Jose, CA	45	65	70	70	80	75
Lrg	Seattle-Everett, WA	40	85	85	60	65	80
Lrg	St. Louis, MO-IL	20	35	55	65	65	85
Med	Albuquerque, NM	5	35	60	35	55	65
Med	Austin, TX	45	45	60	40	60	75
Med	Charlotte, NC	35	55	60	25	50	80
Med	El Paso, TX-NM	25	40	45	10	30	40
Med	Fresno, CA	10	25	30	45	65	75
Med	Hartford-Middletown, CT	15	30	35	45	65	65
Med	Honolulu, HI	40	50	50	75	85	90
Med	Indianapolis, IN	20	40	60	25	45	60
Med	Jacksonville, FL	25	45	50	35	50	60
Med	Louisville, KY-IN	10	35	50	50	60	80
Med	Memphis, TN-AR-MS	10	25	55	45	60	70
Med	Nashville, TN	20	30	45	35	55	60
Med	Oklahoma City, OK	5	25	45	30	35	50
Med	Omaha, NE-IA	15	35	35	40	65	75
Med	Providence-Pawtucket, RI-MA	20	35	45	40	65	70

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Appendix A-2. Congested Person-Miles of Travel, continued

Population Group	Urban Area	Peak Period Congested Percent of Person-Miles of Travel (%)					
		Freeway			Principal Arterial Street		
		1982	1990	1967	1982	1990	1997
Med	Rochester, NY	10	20	35	45	60	50
Med	Salt Lake City, UT	10	35	65	60	75	85
Med	Tacoma, WA	30	65	75	35	50	50
Med	Tamps	50	50	40	60	65	75
Med	Tucson	25	50	45	65	75	85
Sml	Albany-Schenectady-Troy, NY	5	5	5	30	50	60
Sml	Bakersfield, CA	5	10	25	25	40	45
Sml	Beaumont, TX	5	10	20	15	30	35
Sml	Boulder, CO	5	5	5	20	40	65
Sml	Brownsville, TX	5	10	15	15	45	50
Sml	Colorado Springs, CO	10	20	40	10	50	70
Sml	Corpus Christi, TX	5	15	20	45	40	35
Sml	Eugene-Springfield, OR	0	0	15	45	65	70
Sml	Laredo, TX	5	5	10	35	40	70
Sml	Salem, OR	0	10	35	20	35	55
Sml	Spokane, WA	0	5	35	25	35	45
Vlg	Boston, MA	30	60	65	50	80	85
Vlg	Chicago, IL-Northwestern, IN	55	75	80	60	75	80
Vlg	Detroit, MI	45	65	75	65	75	80
Vlg	Houston, TX	65	70	75	50	55	70
Vlg	Los Angeles, CA	80	95	95	45	65	80
Vlg	New York, NY-Northeastern, NJ	55	60	65	75	85	85
Vlg	Philadelphia, PA-NJ	25	45	55	70	75	80
Vlg	San Francisco-Oakland, CA	80	85	85	70	75	75
Vlg	Washington, DC-MD-VA	60	75	80	80	85	85
	68 area average	46	61	68	53	66	74
	Very large area average	62	75	78	61	74	81
	Large area average	35	54	65	48	61	70
	Medium area average	20	38	50	40	57	68
	Small area average	5	9	20	27	43	54

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Appendix A-3. 1997 Roadway Congestion Index

Population Group	Urban Area	Freeway/Expressway Daily VMT (000)	Freeway/Expressway Daily VMT Lane-Mile	Principal Arterial Street Daily VMT (000)	Principal Arterial Street Daily VMT Lane-Mile	Roadway Congestion Index	Rank
Vlg	Los Angeles, CA	116,920	22,315	85,300	6,700	1.51	1
Vlg	Washington, DC-MD-VA	33,340	18,170	19,290	8,070	1.33	2
Vlg	San Francisco-Oakland, CA	42,565	18,670	14,045	7,025	1.33	2
Vlg	Chicago, IL-Northwestern, IN	46,800	17,830	40,300	7,040	1.28	4
Lrg	Seattle-Everett, WA	22,795	18,020	8,900	5,935	1.26	5
Lrg	Miami-Hialeah, FL	12,250	17,255	17,550	7,195	1.26	5
Vlg	Boston, MA	21,800	16,640	16,110	7,840	1.24	7
Lrg	Atlanta, GA	38,650	17,410	14,575	6,255	1.23	8
Lrg	Portland-Vancouver, OR-WA	11,900	17,245	5,800	6,410	1.22	9
Vlg	Detroit, MI	29,355	16,400	28,365	6,580	1.18	10
Lrg	San Bernardino-Riverside, CA	14,940	16,880	11,210	5,215	1.15	11
Med	Tacoma, WA	5,100	17,000	2,760	4,760	1.15	11
Lrg	Sacramento, CA	10,470	15,395	8,335	6,915	1.14	13
Lrg	Minneapolis-St. Paul, MN	24,485	16,005	7,400	5,715	1.13	14
Lrg	Phoenix, AZ	13,925	16,005	17,680	6,015	1.13	14
Lrg	San Diego, CA	28,515	15,930	10,520	5,610	1.12	16
Vlg	New York, NY-Northeastern, NJ	94,755	14,465	58,610	7,780	1.11	17
Lrg	Denver, CO	15,700	15,245	11,130	5,650	1.08	18
Lrg	San Jose, CA	17,170	14,800	7,890	6,520	1.08	18
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	11,350	15,655	7,000	5,185	1.08	18
Lrg	Cincinnati, OH-KY	14,900	15,280	4,290	5,230	1.08	18
Vlg	Houston, TX	35,900	14,865	15,155	6,175	1.07	22
Lrg	Las Vegas, NV	5,400	14,400	3,725	6,835	1.07	22
Med	Tampa, FL	5,675	13,045	7,250	7,325	1.07	22
Med	Honolulu, HI	5,730	14,325	1,920	7,385	1.06	25
Vlg	Philadelphia, PA-NJ	23,540	13,605	21,590	6,955	1.05	26
Lrg	Baltimore, MD	20,775	14,425	8,915	6,235	1.05	26
Lrg	Indianapolis, IN	10,640	14,185	7,730	6,360	1.05	26
Med	Albuquerque, NM	3,730	14,920	5,090	5,595	1.05	26
Lrg	Dallas, TX	28,550	14,640	13,930	5,485	1.04	30
Med	Louisville, KY-IN	9,475	14,250	3,995	6,340	1.04	30
Lrg	Columbus, OH	11,515	14,130	3,975	6,855	1.04	30
Med	Charlotte, NC	6,200	13,780	3,305	7,110	1.04	30
Med	Salt Lake City, UT	6,650	14,000	2,905	6,835	1.04	30
Lrg	St. Louis, MO-IL	24,195	14,445	12,260	5,575	1.03	35
Med	Austin, TX	7,540	13,835	4,600	6,525	1.03	35
Lrg	Cleveland, OH	16,660	13,940	6,380	6,165	1.01	37
Lrg	Milwaukee, WI	8,750	14,345	6,570	5,215	1.01	37
Med	Omaha, NE-IA	2,955	10,190	4,135	8,270	1.00	39
Med	Tucson, AZ	1,775	10,145	5,090	6,880	1.00	39
Lrg	New Orleans, LA	5,470	13,340	5,250	5,965	0.99	41
Lrg	Norfolk, VA	6,850	11,050	5,500	8,395	0.97	42
Med	Nashville, TN	9,450	13,035	6,220	6,010	0.96	43
Med	Memphis, TN-AR-MS	5,920	12,870	6,065	5,830	0.96	43
Lrg	Orlando, FL	8,305	12,215	8,240	6,015	0.93	45

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Appendix A-3. 1997 Roadway Congestion Index, continued

Population Group	Urban Area	Freeway/Expressway		Principal Arterial Street		Roadway Congestion Index	Rank
		Daily VMT (000)	Daily VMT Lane-Mile	Daily VMT (000)	Daily VMT Lane-Mile		
Med	Jacksonville, FL	8,650	13,105	6,900	4,930	0.93	45
Lrg	San Antonio, TX	13,730	12,890	4,845	4,970	0.92	47
Lrg	Fort Worth, TX	14,615	12,765	7,500	4,810	0.91	48
Med	Hartford-Middletown, CT	7,570	12,410	2,220	5,840	0.90	49
Med	Fresno, CA	1,905	11,205	2,850	5,815	0.90	49
Sml	Beaumont, TX	1,600	12,800	700	4,665	0.90	49
Med	Providence-Pawtucket, RI-MA	7,300	11,585	4,500	5,625	0.87	52
Med	El Paso, TX-NM	3,460	12,355	3,295	4,395	0.86	53
Lrg	Oklahoma City, OK	8,665	11,870	4,945	4,850	0.85	54
Sml	Eugene-Springfield, OR	1,185	10,775	755	6,040	0.84	55
Sml	Salem, OR	1,060	11,160	1,345	4,720	0.82	56
Sml	Spokane, WA	1,335	10,680	2,525	4,765	0.81	57
Sml	Boulder, CO	475	9,500	530	5,890	0.80	58
Med	Rochester, NY	5,235	10,470	1,140	6,160	0.78	59
Sml	Colorado Springs, CO	2,470	10,290	1,990	4,740	0.77	60
Lrg	Kansas City, MO-KS	17,310	10,275	5,730	5,185	0.76	61
Lrg	Pittsburgh, PA	10,540	8,855	9,720	6,115	0.76	61
Sml	Albany-Schenectady-Troy, NY	4,975	9,475	3,235	5,830	0.75	63
Sml	Bakersfield, CA	1,630	10,190	2,340	4,295	0.75	63
Lrg	Buffalo-Niagara Falls, NY	5,790	9,265	5,100	4,950	0.72	65
Sml	Corpus Christi, TX	2,740	9,785	1,505	4,495	0.72	65
Sml	Brownsville, TX	260	8,665	565	4,520	0.71	67
Sml	Laredo, TX	360	6,000	850	4,475	0.61	68
	68 area average	15,032	15,237	9,440	6,361	1.10	
	Very large area average	49,442	17,264	33,196	7,062	1.24	
	Large area average	15,160	14,443	8,420	5,877	1.04	
	Medium area average	5,796	13,007	4,124	6,043	0.97	
	Small area average	1,645	10,050	1,485	4,878	0.76	

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Appendix A-4. Roadway Congestion Index, 1982 to 1997

Population Group	Urban Area	Short-Term Change 1992 to 1997		Long-Term Change 1982 to 1997		Roadway Congestion Index						
		Percent	Rank	Percent	Rank	1982	1986	1990	1992	1995	1996	1997
Lrg	San Jose, CA	-3	1	42	47	0.76	0.87	1.07	1.11	1.08	1.08	1.08
Lrg	San Diego, CA	-3	1	40	45	0.80	1.02	1.15	1.15	1.13	1.14	1.12
Vlg	Los Angeles, CA	-2	3	9	6	1.39	1.46	1.56	1.54	1.50	1.54	1.51
Med	Tampa, FL	-2	3	18	12	0.91	0.91	1.02	1.09	1.11	1.09	1.07
Lrg	Milwaukee, WI	-1	5	33	33	0.76	0.82	0.93	1.02	1.02	1.01	1.01
Med	Honolulu, HI	-1	5	23	18	0.86	0.99	1.04	1.07	1.07	1.07	1.06
Lrg	San Bernardino-Riverside, CA	0	7	58	62	0.73	0.83	1.06	1.15	1.16	1.17	1.15
Vlg	San Francisco-Oakland, CA	1	8	28	27	1.04	1.26	1.36	1.32	1.34	1.36	1.33
Lrg	New Orleans, LA	1	8	11	8	0.89	0.93	1.01	0.98	1.02	0.99	0.99
Lrg	Fort Worth TX	1	8	25	20	0.73	0.86	0.92	0.90	0.87	0.90	0.91
Lrg	Miami-Hialeah, FL	2	11	30	29	0.97	1.05	1.23	1.24	1.28	1.22	1.26
Vlg	Detroit, MI	2	11	20	14	0.98	1.02	1.08	1.16	1.15	1.15	1.18
Med	Tacoma, WA	3	13	49	53	0.77	0.91	1.06	1.12	1.10	1.11	1.15
Lrg	Pittsburgh, PA	3	13	6	3	0.72	0.73	0.75	0.74	0.76	0.76	0.76
Lrg	Dallas, TX	3	13	35	38	0.77	0.97	0.99	1.01	0.98	1.00	1.04
Med	Omaha, NE-IA	4	16	49	53	0.67	0.74	0.87	0.96	0.99	1.02	1.00
Med	Hartford-Middletown, CT	5	17	30	29	0.69	0.79	0.87	0.86	0.87	0.88	0.90
Med	Providence-Pawtucket, RI-MA	5	17	10	7	0.79	0.87	0.91	0.83	0.84	0.87	0.87
Med	El Paso, TX-NM	5	17	30	29	0.66	0.75	0.77	0.82	0.84	0.83	0.86
Med	Rochester, NY	5	17	47	52	0.53	0.58	0.72	0.74	0.79	0.79	0.78
Med	Fresno, CA	6	21	11	8	0.81	0.89	0.93	0.85	0.87	0.84	0.90
Lrg	Phoenix, AZ	7	22	20	14	0.94	1.04	1.04	1.06	1.06	1.11	1.13
Vlg	Philadelphia, PA-NJ	7	22	7	4	0.98	1.01	0.99	0.98	1.00	1.03	1.05
Vlg	Washington, DC-MD-VA	7	22	34	35	0.99	1.16	1.21	1.24	1.32	1.32	1.33
Lrg	Buffalo-Niagara Falls, NY	7	22	20	14	0.60	0.57	0.64	0.67	0.72	0.73	0.72
Med	Tucson, AZ	8	26	27	24	0.79	0.73	0.89	0.93	0.94	0.95	1.00
Lrg	Sacramento, CA	8	26	61	65	0.71	0.86	1.06	1.06	1.12	1.15	1.14
Lrg	Seattle-Everett, WA	8	26	20	14	1.05	1.22	1.21	1.17	1.20	1.22	1.26
Sml	Salem, OR	8	26	44	49	0.57	0.67	0.72	0.76	0.77	0.80	0.82
Sml	Spokane, WA	8	26	27	24	0.64	0.72	0.76	0.75	0.76	0.77	0.81
Vlg	Houston, TX	8	26	-2	2	1.09	1.12	1.00	0.99	0.98	1.02	1.07
Lrg	Orlando, FL	8	26	43	48	0.65	0.80	0.76	0.86	0.84	0.87	0.93
Lrg	St. Louis, MO-IL	8	26	27	24	0.81	0.84	0.93	0.95	1.00	1.01	1.03
Vlg	Chicago, IL-Northwestern, IN	8	26	36	42	0.94	1.06	1.15	1.18	1.24	1.26	1.28
Sml	Albany-Schenectady-Troy, NY	9	35	56	60	0.48	0.56	0.68	0.69	0.72	0.74	0.75
Sml	Bakersfield, CA	9	35	60	63	0.47	0.57	0.66	0.69	0.72	0.74	0.75
Lrg	Norfolk, VA	9	35	29	28	0.75	0.86	0.92	0.89	0.93	0.97	0.97
Lrg	Las Vegas, NV	9	35	60	63	0.67	0.79	0.95	0.98	1.09	1.10	1.07
Sml	Boulder, CO	10	39	25	20	0.64	0.71	0.71	0.73	0.74	0.75	0.80
Vlg	New York, NY-Northeastern, NJ	10	39	18	12	0.94	0.98	1.05	1.01	1.04	1.06	1.11
Lrg	Baltimore, MD	11	41	35	38	0.78	0.81	0.94	0.95	1.03	1.04	1.05
Vlg	Boston, MA	11	41	36	42	0.91	1.01	1.08	1.12	1.19	1.22	1.24
Med	Jacksonville, FL	11	41	11	8	0.84	0.87	0.87	0.84	0.88	0.92	0.93
Sml	Brownsville, TX	11	41	34	35	0.53	0.54	0.62	0.64	0.70	0.69	0.71
Sml	Beaumont, TX	11	41	34	35	0.67	0.74	0.75	0.81	0.82	0.84	0.90

Appendix A-4. Roadway Congestion Index, 1982 to 1997, continued

Population Group	Urban Area	Short-Term Change 1992 to 1997		Long-Term Change 1982 to 1997		Roadway Congestion Index						
		Percent	Rank	Percent	Rank	1982	1986	1990	1992	1995	1996	1997
Med	Nashville, TN	12	46	35	38	0.71	0.82	0.85	0.86	0.93	0.92	0.96
Med	Austin, TX	12	46	32	32	0.78	0.86	0.89	0.92	0.94	0.96	1.03
Lrg	Cleveland, OH	12	46	35	38	0.75	0.77	0.89	0.90	0.98	0.99	1.01
Med	Memphis, TN-AR-MS	13	49	26	22	0.76	0.73	0.84	0.85	0.93	0.95	0.96
Lrg	Ft. Lauderdale-Hollywood-Pompano Bch, FL	14	50	54	58	0.70	0.76	0.79	0.95	1.02	1.04	1.08
Lrg	Portland-Vancouver, OR-WA	14	50	54	58	0.79	0.98	1.02	1.07	1.15	1.20	1.22
Med	Charlotte, NC	14	50	-4	1	1.08	1.00	0.97	0.91	0.96	0.97	1.04
Med	Salt Lake City, UT	14	50	53	57	0.68	0.66	0.78	0.91	1.04	1.05	1.04
Lrg	Oklahoma City, OK	15	54	49	53	0.57	0.62	0.73	0.74	0.82	0.84	0.85
Sml	Colorado Springs, CO	15	54	24	19	0.62	0.63	0.66	0.67	0.75	0.74	0.77
Sml	Corpus Christi, TX	16	56	7	4	0.67	0.70	0.69	0.62	0.62	0.67	0.72
Sml	Eugene-Springfield, OR	17	57	56	60	0.54	0.54	0.63	0.72	0.78	0.82	0.84
Med	Louisville, KY-IN	17	57	44	49	0.72	0.74	0.80	0.89	0.99	1.02	1.04
Lrg	Kansas City, MO-KS	17	57	36	42	0.56	0.62	0.66	0.65	0.72	0.75	0.76
Lrg	Denver, CO	17	57	40	45	0.77	0.84	0.91	0.92	1.03	1.07	1.08
Lrg	Columbus, OH	18	61	70	68	0.61	0.72	0.87	0.88	0.99	1.00	1.04
Lrg	Cincinnati, OH-KY	19	62	33	33	0.81	0.78	0.89	0.91	1.00	1.02	1.08
Sml	Laredo, TX	20	63	17	11	0.52	0.56	0.61	0.51	0.54	0.56	0.61
Med	Albuquerque, NM	21	64	52	56	0.69	0.84	0.85	0.87	0.98	1.01	1.05
Lrg	San Antonio, TX	21	64	26	22	0.73	0.85	0.75	0.76	0.88	0.89	0.92
Lrg	Minneapolis-St. Paul, MN	22	66	61	65	0.70	0.83	0.89	0.93	1.06	1.08	1.13
Lrg	Indianapolis, IN	25	67	69	67	0.62	0.76	0.81	0.84	1.01	1.00	1.05
Lrg	Atlanta, GA	27	68	45	51	0.85	1.01	0.95	0.97	1.12	1.17	1.23
	68 area average	7		27		0.86	0.95	1.02	1.03	1.07	1.08	1.10
	Very large area average	4		20		1.03	1.13	1.19	1.19	1.24	1.23	1.24
	Large area average	9		39		0.75	0.85	0.93	0.95	1.00	1.02	1.04
	Medium area average	8		31		0.74	0.80	0.87	0.90	0.94	0.95	0.97
	Small area average	10		38		0.55	0.61	0.68	0.69	0.71	0.74	0.76

Notes: Vlg—Very large urban areas – over 3 million population
Lrg—Large urban areas – over 1 million and less than 3 million population
Med—Medium urban areas – over 500,000 and less than 1 million population
Sml—Small urban areas – less than 500,000 population