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Building Roads to Reduce Traffic Congestion in America's Cities: How Much and at What Cost?

By David T. Hartgen, Ph.D., P.E. and M. Gregory Fields
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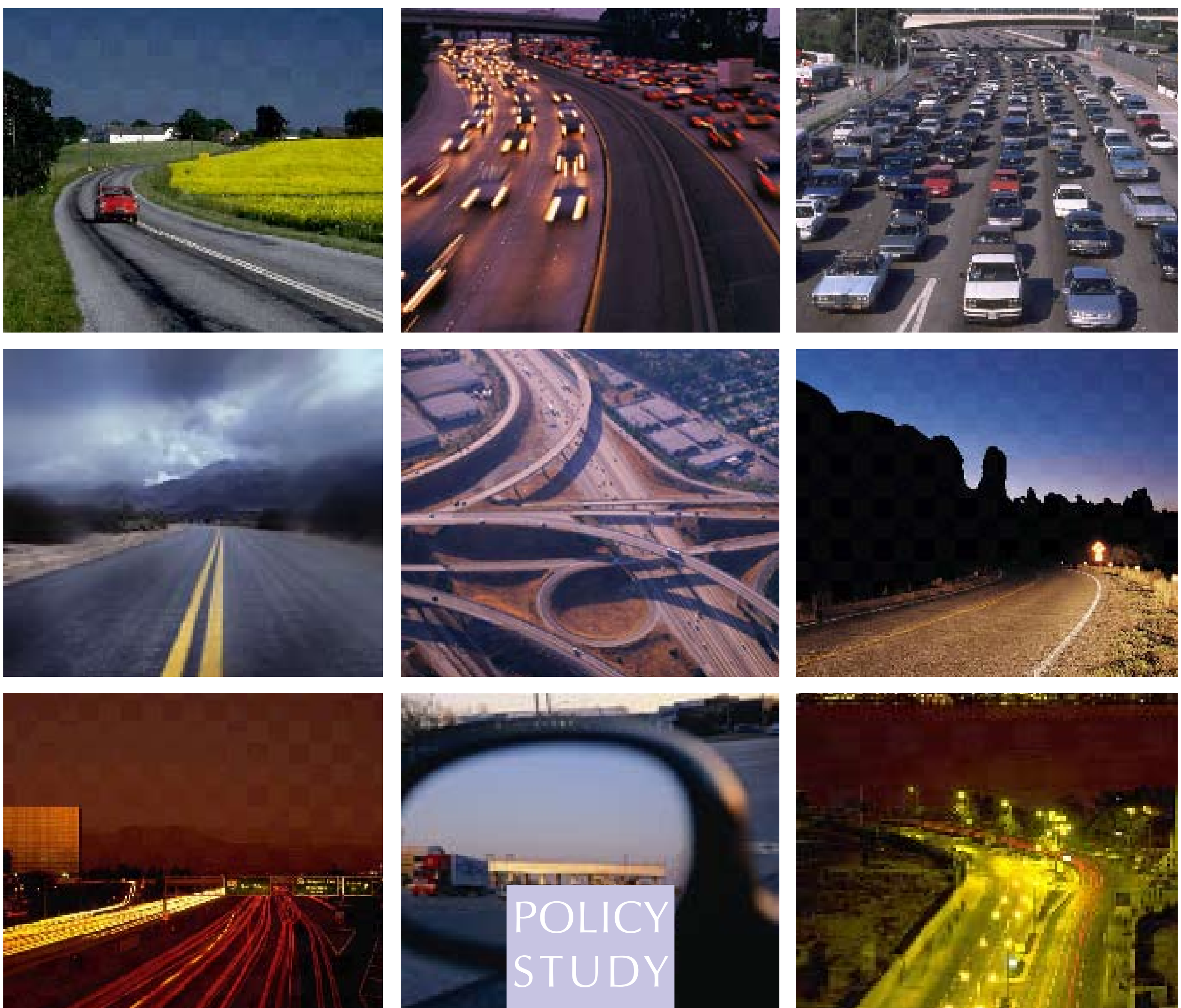

POLICY STUDY 346

The Galvin Mobility Project

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The Galvin Mobility Project

Traffic congestion is choking our cities, hurting our economy, and reducing our quality of life. Rush-hour delays rob us of time with our families, and commute times often dictate where we live and work. The impact our inadequate transportation network has on our economy is alarming. We waste an estimated $63 billion annually in time and fuel while sitting in traffic. Moreover, businesses and their customers bear enormous costs associated with traffic-related logistics problems, delivery delays, poor transportation reliability, and fewer potential employees within commuting distance.

Reason Foundation is developing practical, cost-effective solutions to traffic congestion with the Galvin Mobility Project, a policy initiative that will significantly increase our urban mobility through innovative engineering, value pricing, public-private partnerships, and innovations in performance and management. Under the leadership of Reason's Director of Transportation Studies Robert Poole, Reason's original research is building comprehensive policy recommendations that enhance mobility and help local officials move beyond business-as-usual transportation planning.

The old canard "we can't build our way out of congestion" is not true. Adding capacity and improving management of roads can eliminate chronic congestion. Public-private partnerships to build and operate toll facilities have sparked innovations in engineering and design, overcoming obstacles such as limited right-of-way and noise pollution. Capital markets also provide access to much-needed investment capital and ensure that new highway capacity is built where it is most needed.

In addition to adding road capacity, changing the way highways are managed can help to maximize the use of the capacity we have. The introduction of Intelligent Transportation System technologies can speed resolution to traffic delays, and electronic toll collection technologies can make extensive tolling practical. More importantly, variable pricing of lanes can keep traffic flowing all day by responding to changing demand.

We can solve our congestion woes. We can upgrade to an innovative, market-driven, world-class transportation infrastructure. We can change the institutions that guide our transportation decisions to create greater responsiveness, robustness, and efficiency. The Galvin Mobility Project provides the ideas and tools needed to make change happen.

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Executive Summary

This report quantifies the magnitude of traffic congestion and the cost of its removal through the provision of additional capacity. Other studies in the Galvin Mobility Project examine the role of other means of addressing congestion as well as financing, project management, and other issues that go along with adding road capacity in urban areas.

We define and quantify *severe congestion*, in which peak-hour traffic volumes exceed road capacity, and estimate future congestion if trends continue. With the help of 32 participating urbanized areas, the report uses sophisticated traffic modeling techniques to determine how much additional capacity will be needed to relieve severe congestion. These findings are then extended to all 403 urbanized areas. The report then estimates the cost of providing that additional capacity. These costs include construction in each state, major bridge widenings, adjustments for induced travel, and requirements for some elevated or tunnel sections. Detailed results are provided for each city and state. We also provide a simplified state-level assessment for rural areas and for moderate urban congestion.

This report finds that severe traffic congestion is pervasive in large regions and is worsening throughout the United States. In the future even small, urbanized areas are likely to experience congestion common in mid-sized areas today. The cause of this increase is not wastefulness but increasing population and preferences for private mobility, combined with limited additions to road capacity. Nationwide, the number of lane-miles of severely congested roads is expected to increase from about 39,500 in 2003 to 59,700 in 2030. To relieve severe congestion by providing additional

capacity, an additional 104,000 lane-miles of capacity (about 6.2 percent of current lane-miles) will be needed, costing about $533 billion over 25 years, in 2005 dollars. The amount needed—about $21 billion per year—is about 10-15 percent of the federal highway program over 25 years, about 28 percent of the cost of present urban transportation plans, and about 39 cents per day per commuter trip. However, the travel time savings are estimated at about 7.7 billion hours annually, so the cost per hour of delay saved is about $2.76. If moderate congestion and rural congestion are also to be addressed, an additional $304 billion will be needed.

We also find that congestion relief through provision of additional capacity is quite feasible, given current budgets. The benefits of an investment in additional capacity would be substantial. In addition to reduced travel time, other benefits include smoother traffic flow, reduced accidents, improved air quality through lower emissions, lower fuel use and operating costs, more reliable travel, lower logistical costs for manufacturing and delivery, more choices of jobs for workers and businesses and wider choices for consumers.

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Part 1

Introduction

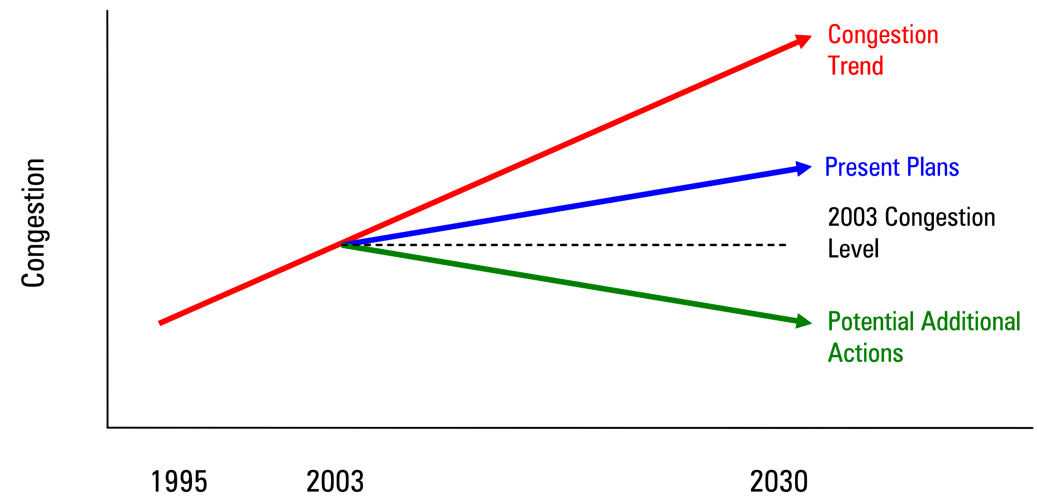
Urban congestion is a growing problem, as indicated in the annual congestion statistics reported for large urban regions. The Texas Transportation Institute annually calculates costs of traffic delay in the nation's largest cities and its 2005 report pegged the costs at $65 billion a year.[1] Numerous polls show growing frustration on the part of citizens and businesses with congestion and its deleterious impacts on personal lives and commerce. In a 2001 national travel survey fully 24 percent of respondents cited congestion as a severe or serious problem; in large cities 39 percent thought so, but even in smaller cities 21 percent thought so.[2] Federal policy documents cite congestion as "*…one of the biggest transportation challenges facing us…pervasive…affect[ing] more trips, more hours of the day and more of the transportation system.*"[3]

> *"Congestion is one of the single largest threats to our economic prosperity and way of life."*
> *—U.S. Department of Transportation report released May 16, 2006*

Figure 1 summarizes the status of planning for urbanized area congestion. The trend is steeply rising congestion compared to 2003 levels. Most current long-range transportation plans forecast worse congestion conditions *even after* the expenditure of billions of dollars. In most regions the competition is fierce for scarce dollars for transportation improvements. Many regions have very large maintenance and repair needs for the existing system. Planning requirements encourage expenditures for a variety of projects serving numerous objectives other than congestion. Pulled by competing priorities, many cities and states appear to be focusing largely on other objectives and are de-emphasizing the congestion problem. Some regions assert that congestion cannot be eliminated or reduced, or that the extra capacity will just be 'filled up' anyway, and addition of capacity is very expensive.

Nevertheless, the bottom line is clear: additional actions beyond current plans will be needed if congestion is to be reduced or maintained at current levels.

Figure 1: An Overview of the Congestion Problem



Several recent studies have reviewed the magnitude and cost of congestion. In addition to the Texas Transportation Institute's annual mobility study, the American Highway Users Alliance recently reviewed the delays associated with the worst highway bottlenecks.[4] They found that between 1999 and 2004 the number of major bottlenecks in the U.S. had increased from 167 to 233 locations, but that 7 of the worst 18 identified in 1999 had been alleviated. The federal government has estimated the cost of improving highway and bridge infrastructure in both condition and capacity at about $49.9 billion annually.[5] These important studies quantify portions of the problem but do not cover all urbanized areas. Nor do they include the 'spreading' effect of congestion as traffic spreads out in time and space, or possible 'induced' travel as roads are widened. More recently, several states and urbanized areas, notably Texas,[6] Washington,[7] and Atlanta,[8] have recognized the cost of congestion to their economic competitiveness and are taking steps to reduce or eliminate congestion. Most importantly, these initiatives have come primarily from pressure by the business community, which sees congestion as a serious threat to regional competitiveness. The Transportation Research Board, a national research organization, has recently listed congestion as its top concern.[9] However, little comprehensive assessment of the extent of the full congestion problem or the cost to deal with it has been made.

This report uses estimates from national congestion statistics and sophisticated traffic assignment methods to review recent trends in congestion and forecast how much there will be after present transportation plans are completed. It calculates the number and cost of additional lane-miles needed to eliminate severe congestion. It then compares these costs with the costs of planned transportation improvements. Detailed results are provided for each state and for each of 403 urbanized areas.

Studies are necessarily limited in scope, based on assumptions, and it is important to know what this report does not cover. It does not look in detail at ALL congestion, focusing instead on the most severe congestion in urbanized areas. (In a short section we look briefly at moderate congestion, but only at the state level.) It is not intended as a full assessment of various approaches to dealing with congestion problems, many of which are appropriate along with capacity expansions. These include a wide range of pricing options (HOT lanes, tolls, and mileage-based fees), transit services, demand management, activity scheduling, ITS (Intelligent Transportation System) technologies, operational improvements, and many others. Many of these options are reviewed in other reports of the Galvin Mobility Project. We do not minimize the difficulties of locating these improvements, given environmental and location constraints. Nor does the report deal with rehabilitation or maintenance needs, which may overlap with capacity expansion needs for specific road sections, or may compete for funds, thus increasing costs. All these issues warrant attention, but do not obviate the need for a comprehensive assessment of capacity expansion opportunities.

Instead, the report focuses on the capacity side of congestion relief, looking at what a concerted nationwide effort to address severe congestion through capacity relief might cost. It is therefore intended as input to the policy debate, not a conclusion.

Part 2

Methodology

We focus initially on severe congestion in 403 urbanized areas in the United States with populations greater than 50,000 persons in 2003.[10] Supplemental analysis is also added for rural congestion outside of urbanized areas, and moderate congestion in urbanized areas. A more detailed description of the steps is provided in Appendix B. The basic steps followed in the study are:

1. **Current Congestion.** Estimates of current (2003) *severe congestion,*[11] sometimes called 'gridlock',[12] are prepared by consolidating statistics on urbanized area congestion indices for 86 larger regions,[13] supplemented by estimates of congestion indices for 317 additional smaller regions. Special tabulations from the national Highway Performance Monitoring System are also used to estimate, for each urbanized area, the amount of mileage and lane-miles with severe congestion, by functional class.[14] Along with current travel time index (TTI) values, this data is used as estimates of current congestion.

2. **Future Congestion.** Future congestion is estimated by relating current congestion indices to urbanized area population and traffic density (daily vehicle-miles-of-travel[15] per mile of road). Forecasts of population and traffic density to 2030 are then made for each urbanized area, and future TTIs are also estimated by trend. A separate forecast of lane-miles with severe congestion (volume exceeds capacity) is then made using forecasts of population and traffic congestion indices. These projections incorporate planned capacity additions under long range transportation plans. This is the primary estimate of future congestion used for analytical purposes.

3. **Needed Capacity Increases**. Capacity increases needed to relieve severe congestion are then estimated from the future congestion estimates (lane-miles over: traffic exceeds capacity) for each urbanized area, such that peak-hour capacity is sufficient to carry peak-hour traffic volumes. These estimates are adjusted to account for diverted traffic (traffic moving to faster roads as they are widened) using network-based traffic assignments or similar information for 32 urbanized areas participating in the study. The numbers from these contributing areas are highlighted in Appendix C. Results from these 32 urbanized areas assignments are then used to scale up the preliminary estimates for the other urbanized areas.

4. **Cost of Capacity Increases.** To estimate costs of capacity increases, federal estimates of construction costs per-lane-mile (engineering, construction, right-of-way, and mobilization) for roads of various types are multiplied by estimates of needed lane-miles from Step 3. These costs are then adjusted for price increases between 1997 and 2005, different construction costs by state, the need for large-bridge widenings, induced travel,[16] and the need for elevated-or-tunnel construction. Risk analysis software (Crystal Ball®) is used to analyze the uncertainty in these assessments. This software considers a range of inputs rather than an average for particular entries in the database. Ranges are used for the cost factors in the model, and the resulting uncertainty in the overall estimate is then determined and shows that our estimate falls in the middle of the most likely range for the likely costs.

5. **Comparisons with Long-Range Plans.** Cost estimates for relieving severe congestion are then compared with the financial transportation plans of 43 urbanized areas to determine what portion of current plans might be implied by a significant congestion-relief effort.

6. **Rural Congestion and Moderate Urban Congestion.** In a short follow-up analysis, the additional cost of reducing congestion further in rural areas and moderate congestion in urban areas is also estimated using state-level data.

7. **User Benefits of Congestion Reduction**. Finally, savings in delay are estimated for each region, and for the United States as a whole. These are compared with the cost of capacity expansion. This estimate is conservative since it does not consider fuel savings, reduced operating costs, or other benefits. Two more detailed examples (Atlanta and Detroit) are also developed to show how travelers benefit from congestion removal, through higher speeds and savings in travel time, operating costs, and lower accident rates.

Part 3

Eliminating Severe Congestion by Increasing Capacity

A. Overall Findings

1. Urban Population Trends

The 403 largest urbanized areas of the United States, those over 50,000 in population in 2003, together contain about 189 million people, or about 66 percent of the U.S. population.[17] Assuming recent economic and population trends continue, the population of these urbanized areas is expected to grow to about 245 million by 2030, an increase of about 30 percent.

2. Trends in Congestion

The Texas Transportation Institute generates an annual survey on congestion. The Institute uses a "**Travel Time Index" (TTI)**, defined as the ratio of travel time in peak hours to the travel time in off-peak hours.[18] For instance, an index of 1.5 means that travel time in the peak hour is 50 percent longer than in the off-peak. The 'delay' in the travel time is the portion over 1.0. This data was used to chart trends in congestion in the nation's largest 86 cities, then extended to other smaller urbanized areas, and then forecast to 2030 based on trends and on forecasts of population and traffic density.

Table 1 shows recent trends and forecasts of travel time indices for urbanized areas. For large areas over 3 million in population, congestion is predicted to increase from an average of 1.46 to 1.76 over the next 25 years; for smaller cities, the forecast is for less severe but faster growing congestion.

However, if trends continue, by 2030 even small cities will be experiencing significant and noticeable congestion. In very large regions, 'delay' over the next 25 years will increase 65 percent, from 46 percent over free-flow travel time to 76 percent over free-flow travel time. In smaller regions, the 'delay' portion of peak-hour travel time will more than double. These results suggest that traffic congestion is likely to widen geographically and deepen in intensity, affecting more mid-size and smaller urbanized areas and worsening throughout the nation. Residents of smaller areas may notice the effect more than residents of larger areas.

Table 1: Trends and Forecasts of Travel Time Indices

City Size	1982	1993	1995	2003	2030 Est.	Relative Increase in 'Delay' 2003 to 2030
Ave 3+ M	1.15	1.35	1.36	1.46	1.76	65%
Ave 1-3 M	1.08	1.18	1.21	1.28	1.53	89%
Ave 500K-1M	1.05	1.11	1.13	1.18	1.36	100%
Ave 250-500 K			1.04	1.06	1.15	150%
Ave 50-250 K			1.03	1.04	1.09	125%

To put these in perspective, consider today's congestion levels. Present-day (2003) Los Angeles is the most congested city in the United States, with a travel time index of 1.75. But by 2030, urbanized areas with over three million people will be *averaging* about the same travel time delay (1.76) as today's Los Angeles. Cities with travel time delays equal to today's Los Angeles will include Atlanta, Denver, and Minneapolis/St. Paul.

By 2030, regions in the 1-3 million range will be seeing congestion about as severe as present-day Chicago (1.56). These cities include Baltimore, Portland, Sacramento, and Tucson. By 2030, small regions will be seeing congestion about the same as areas with over one million in population saw in the early 1980s.

Table 2: Cities with 2030 Travel Time Delays Worse Than Today's Los Angeles

City	Population in 2030 (000s)	Congestion Index in 2030
Los Angeles-Long Beach	15,652	1.94
Chicago	9,522	1.88
Washington	5,973	1.87
San Francisco-Oakland	4,968	1.86
Atlanta	5,009	1.85
Miami	7,551	1.84
Denver-Aurora	3,210	1.80
Seattle-Tacoma, WA	3,963	1.79
Las Vegas	1,029	1.79
Minneapolis-St. Paul	3,370	1.76
Baltimore	2,437	1.75
Portland	2,513	1.75

Table 3: Additional Cities with Travel Time Delays Worse Than Today's Chicago		
City	**Population in 2030 (000s)**	**Congestion Index in 2030**
New York-Newark	21,295	1.74
Sacramento	2,488	1.73
Dallas-Fort Worth	7,014	1.73
San Diego	3,720	1.70
San Jose	2,036	1.65
Phoenix-Mesa	5,313	1.64
Riverside-San Bernardino	2,629	1.64
Charlotte	1,185	1.62
Bridgeport-Stamford	1,018	1.62
Boston	4,636	1.62
Houston	3,987	1.61
Philadelphia	5,879	1.61
Tucson	1,094	1.60
Salt Lake City	1,251	1.59
Orlando	2,112	1.59

An alternate way of viewing traffic congestion is to look at *overall traffic density*, the amount of traffic per mile of road space. Table 4 shows recent trends and forecasts of traffic density for cities by size.

Table 4: Changes in Traffic Density Forecast, 403 Urbanized Areas					
City Size	**1995**	**2003**	**2020**	**2030**	**Percent Increase 2003-30**
Ave 3+ M	7,050	7,500	8,400	9,000	19.8
Ave 1-3 M	6,000	6,300	7,000	7,500	18.3
Ave 500K-1M	5,800	6,000	6,400	6,600	10.5
Ave 250-501K	4,700	4,900	5,500	5,800	17.6
Ave 50-251K	3,800	4,100	4,800	5,300	28.2

Traffic Density = Average annual daily traffic, per mile of road, rounded to 100s.

Traffic densities are rising, but not as fast as travel time factors, because as urban regions spread they add more road mileage, and because congestion goes up faster than just the increase in driving. Nevertheless, street-level traffic is likely to rise about 20 percent in large regions, but even higher, almost 30 percent, in smaller regions over the next several decades.

A third way of looking at congestion is the number of *lane-miles of severely congested facilities.* "Severe congestion" is defined as peak-hour traffic volume which exceeds the peak-hour capacity of the facility to carry it. Recent data from the federal Highway Performance Monitoring System (Table 5) show that the Urban Interstate system has the highest proportion of severely congested miles, 16.4 percent, followed by other freeways, 11.5 percent. About 39,500 lane-miles of road in the 403 largest urbanized areas currently carry more traffic than their rated capacities. This number is expected to grow about 50 percent to about 59,700 severely congested lane-miles by 2030, assuming trends in traffic density and population continue.

Table 5: Severely Congested Roadways, 403 Urbanized Areas

Roadway Type	2003 Miles	2003 Miles Severely Congested*	Percent Severely Congested	2003 Lane-Miles Severely Congested*	2030 Lane-Miles Severely Congested*	Percent Change
Urban Interstate	12,766	2,100	16.4	17,800	27,400	54.3
Urban Other Freeway	8,677	1,000	11.5			
Urban Other Principal Arterial	44,351	2,200	4.9	9,000	12,400	37.5
Urban Minor Arterial	75,124	3,700	4.9	12,700	19,900	56.1
Urban Collector	75,894	2,700	3.6			
Urban Local	553,822	-	-			
Total	**770,634**	**11,700****	**-**	**39,500**	**59,700**	**51.1**

Severely congested= facilities for which peak-hour traffic volumes exceed capacity

* Rounded to nearest 100 for convenience.

** Excluded local mileage.

The spreading of urbanized areas may obviate congestion trends somewhat, and in some regions congestion trends may be flattening a bit. On the other hand, rising auto use at either end of the age spectrum, longer and healthier living, and greater economic wealth suggest that travel will continue to increase and that congestion is likely to spread unless capacity is increased. Trends may change, but these look likely to continue for some time, one reason we have expanded the assessment below to include rural and moderate congestion.

3. Costs to Relieve Severe Congestion

The amount of additional capacity needed to relieve predicted severe congestion is greater than the lane-miles severely congested, because the additional capacity will be partially filled by cars shifting from other roads or other travel times. Using the results of specialized studies by 32 participating cities (described in Appendix B), and expanding these findings to all 403 cities, we estimate that about 104,000 lane-miles, or about 6.2 percent of the current urbanized area lane-miles, would be needed to provide enough capacity to relieve severe congestion in urbanized areas. The cost of this mileage in 2005 dollars is about $391 billion, or $3.8 million per lane-mile.

But since these capacity additions constitute major system expansions in many urban regions, their likely impact in creating some additional travel due to the convenience of uncongested roadways should also be considered. This effect, sometimes called ‘induced travel’ is estimated at about 10,900 lane-miles, and is estimated to add about $41 billion.[19]

Additions for major bridge widenings and for elevated or tunnel-design sections might also significantly increase costs, because of high-cost construction in constrained space.[20] We estimate that about $31 billion would be needed for major bridge widenings to accommodate increased capacity requirements, and about $70 billion would be needed for elevated structures or tunnel sections.

Thus, the total cost to provide the needed capacity to significantly relieve severe congestion is about $533 billion, in 2005 dollars. Over 25 years, this is about $21 billion per year.[21]

Table 6: Summary of Findings: Cost to Relieve Severe Congestion

	Lane-Miles Needed	Increment, $Billion	Cost, $Billion
Base Estimate	104,000 (6.2%)	391	391
Add-on for Induced Travel		41	
Add-on for Large Bridge Widening		31	
Add-on for Elevated or Tunnel Structures		70	533

These estimates compare reasonably well with other recent partial assessments. The USDOT estimate of $49.9 billion annually includes costs of improving the physical condition of roads and bridges as well as increased capacity, and so should be somewhat higher than our estimates.[22] A recent study for work needed to reduce Atlanta's future travel time index to 1.18 (about the same as removing severe congestion), estimates the cost at $22.1 billion; when adjusted for a key different assumption concerning arterial lane-miles, the number is about $13.4 billion, very close to our estimate of $13.1 billion for Atlanta.[23] And a recent assessment of the needs for a group of major Texas urbanized areas estimates that $54 billion would be needed to reduce the "Texas Congestion Index" to 1.18, close to our Texas state total estimate, $49.1 billion.[24] Though some factors could raise costs above our estimates, we are confident that the above national estimate is reasonable at this time.[25]

These cost estimates should be put in perspective. The present U.S. highway program, including capital and maintenance, costs about $140 billion per year (the new federal transportation bill increases that by about 40 percent); over 25 years, it might be expected to total at least $3.5 trillion, in current dollars.[26] Thus $533 billion, if fully added to the current program, would be an increase of about 15 percent of highway capital and maintenance expenditures. But since the current program includes some capital actions that will relieve some severe congestion, and the program itself has been increasing, the percent increase over the current program is probably closer to 10 percent.

Another way to look at these costs is to compare them with other common expenses.

- In 2005, Americans spent about $41 billion at Lowes Home Improvement, $81.5 billion at Home Depot, and about $13.6 billion on pet food;
- There are about $21 billion in student loans in default nationwide;

- In 2003, the federal government spent nearly $25 billion on things it could not identify—"unreconciled expenditures."

So, the $21 billion/year cost of removing severe congestion would be about one-fifth of what we spent at two major chains to fix up our homes, and about one and a half times what we spent for pet food. It is an amount our government has been willing to essentially write off in the past. The cost of relieving severe congestion may not be as high as many say.

4. Unit Costs per Capita and per Commuter Trip

From a per-commuter perspective, the projected cost of $533 billion over 25 years is in the range of $368 per commuter per year for large regions, declining to less than $50 per commuter per year in smaller regions.

Table 7: Individual Costs of Relieving Severe Congestion

City Size	Cost per Commuter per Year ($)	Cost per Resident per Year ($)	Cost per Commuter per Day ($)	Cost per Commuter Trip ($)
Ave 3+ M	368.47	184.23	1.47	0.75
Ave 1-3 M	118.97	59.49	0.48	0.24
Ave 500K-1M	147.04	73.52	0.59	0.30
Ave 250-500K	151.73	75.87	0.61	0.31
Ave 50-250K	44.96	22.48	0.18	0.09
Average for All	$196.21	$98.11	$0.78	$0.39

Put another way, the costs average about 39 cents per trip by each commuter—from 75 cents per commuter trip in large regions down to 9 cents per trip for commuters in small regions.

It would not seem unreasonable that commuters in large cities might be willing to pay, in various ways, 75 cents per trip for relief from severe congestion. It seems highly likely that commuters in smaller regions would be willing to pay 9 cents per trip, in various ways, for relief from severe congestion. And these costs would be even smaller if spread out over all trips—commuter trips are only about 20-25 percent of all trips.

B. Costs by Road Type (Functional Class)

As might be expected, the additional capacity necessary to significantly reduce severe congestion is largely concentrated in the higher-level roads.[27] Table 8 shows that the Urban Interstate (UI) and Other Freeway/Expressway (OFE) system would need to be expanded in capacity by about one-third nationwide; urban Other Principal Arterials would need to be expanded 11.7 percent. For the lower systems about a 6.3 overall percent increase is implied. The unit cost per lane-mile averages about $9.4 million for Interstates, $3.6 million for principal arterials, and $2.2 million for lesser streets. Overall, the average unit cost is about $5.1 million per lane-mile.

Table 8: Costs by Roadway Type						
Roadway Type	**Current 2003 Miles***	**Current Est. Lane-Miles***	**Additional Lane-Miles Needed***	**Percent of Current System to be added**	**Cost of Additional Lane-Miles ($Billion)**	**Cost per Added Lane-Mile ($Million)**
Urban Interstate and OFE	21,400	113,600	38,600	33.90	362	9.4
Urb OPA	44,400	177,400	20,700	11.70	75	3.6
Urb Min Arterial	75,100	150,200	1,300	0.80	96	2.2
Urb Collector	75,900	151,800	41,900	27.50		
Local	553,800	1,107,600	800	0.07		
Other			900			
Total	**770,600**	**1,700,600**	**104,100**	**6.20**	**533**	**5.1**

* Rounded to nearest 100 for convenience.

C. Lane-Miles Needed and Costs by Urbanized Area and Region

The additional capacity needed to eliminate severe congestion is not evenly distributed across the 403 urbanized areas. Of the $533 billion in total costs, 10 cities with over three million population account for 61.0 percent (Table 9). Regions between one million and three million population account for about 18.4 percent of the total, and those between 1 million and 500,000 population account for about 9.0 percent. Smaller regions account for 11.6 percent of the total costs.

Table 9: Costs of Relieving Severe Congestion by City Size ($B)							
City Size	**Interstate and OFE**	**Other Principal Arterial**	**Minor Arterials**	**Total**	**Percent of Total Cost**	**Percent of Total US Pop**	**Cost per Hour of Delay Saved**
3+M	$251.1	$36.0	$38.5	**$325.6**	61.0	23.7	$ 2.72
1-3 M	70.7	10.7	16.7	**98.2**	18.4	16.6	1.83
500k-1M	20.1	12.0	16.0	**48.1**	9.0	8.1	3.73
250-500K	14.7	10.5	15.2	**40.4**	7.6	6.3	10.44
50-250K	5.5	5.1	10.6	**21.2**	4.0	10.4	6.43
Total All	$362.3	$74.4	$96.9	**$533.5**	100.0	65.2	$ 2.76

In terms of delay saved per dollar expended, the urbanized regions also show differences. The largest regions typically have lower cost per hour of delay saved because congestion is more pervasive even though expansion costs are higher. Overall, the cost per hour of delay saved is about $2.76, with the larger regions lower and the smaller ones higher.[28]

1. The 10 Largest Urbanized Areas

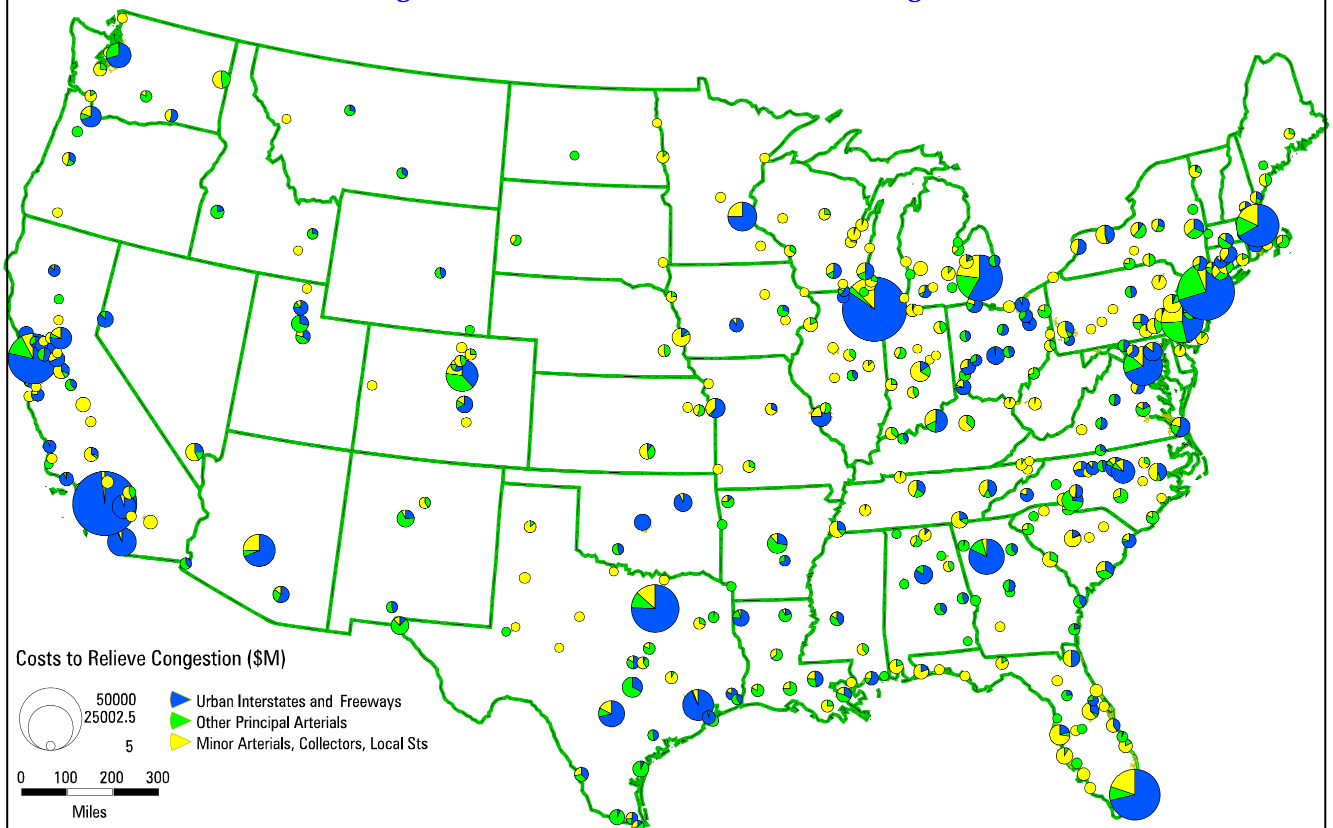
As the next table (Table 10) indicates, the 10 largest regions have a third of the U.S. urban population, a third of the urban lane miles with traffic that exceeds their capacity (Volume/Capacity ratios above 1.0), and a fourth of the urban lane-miles needed to relieve congestion, but almost 2/3 of the total costs. This is not surprising—the costs for capacity additions in major cities are likely to be extremely high as available rights-of-way (ROW) are often fully built out and potential ROW is often cost-prohibitive forcing creative (and costly) alternatives to normal highway construction. Cost per hour saved is generally lower in the larger regions; Detroit's cost per hour saved is higher because it has less congestion relative to size, so while it needs a lot of capacity, the amount of congestion relieved is less, so the delay saved is less.

Table 10: Costs of Relieving Severe Congestion for the Top Ten Cities in Population ($B)

City	2003 Pop (000s)	2030 Pop (000s)	2030 Lane Miles expected to be congested	2030 Lane Miles Needed	Total Costs of Lane Miles Needed ($Billion)	Cost per Hour of Delay Saved
New York	17,717	21,295	3,827	2,446	$38.6	1.24
Los Angeles	12,520	15,652	3,594	3,695	67.7	2.62
Chicago	7,702	9,522	2,793	3,875	53.8	3.52
Philadelphia	5,287	5,879	1,475	1,929	19.6	3.75
Miami	5,104	7,551	1,919	3,400	30.0	3.39
Dallas	4,312	7,014	2,646	3,656	26.1	3.52
Washington	4,277	5,973	1,130	1,803	16.2	1.52
San Francisco	4,120	4,968	1,304	2,261	29.2	3.72
Boston	3,988	4,636	990	1,493	20.3	4.56
Detroit	3,939	4,277	1,136	2,301	24.1	9.05
Subtotals	68,966	86,767	20,813	26,858	325.6	
National Totals	189,510	245,523	59,688	104,122	533.5	
% of Total	36.4	35.3	34.9	25.8	61.0	

A closer look at the urbanized areas across the U.S. reflects the trends noted above: the larger areas have the bulk of the costs, and the costs are more concentrated in the interstates and arterials (Figure 2). The larger circles show the larger concentration of costs, with urban interstates, freeways, and principal arterials making up most of the costs in major urbanized areas. The overall pattern reflects this concentration of higher costs in the larger areas, with heavier concentrations of costs on the east and west coasts and in states with large metropolitan regions. The five general regions of the United States will be more fully analyzed below. Appendix C contains a complete listing of each state and its regions' congestion circumstances.

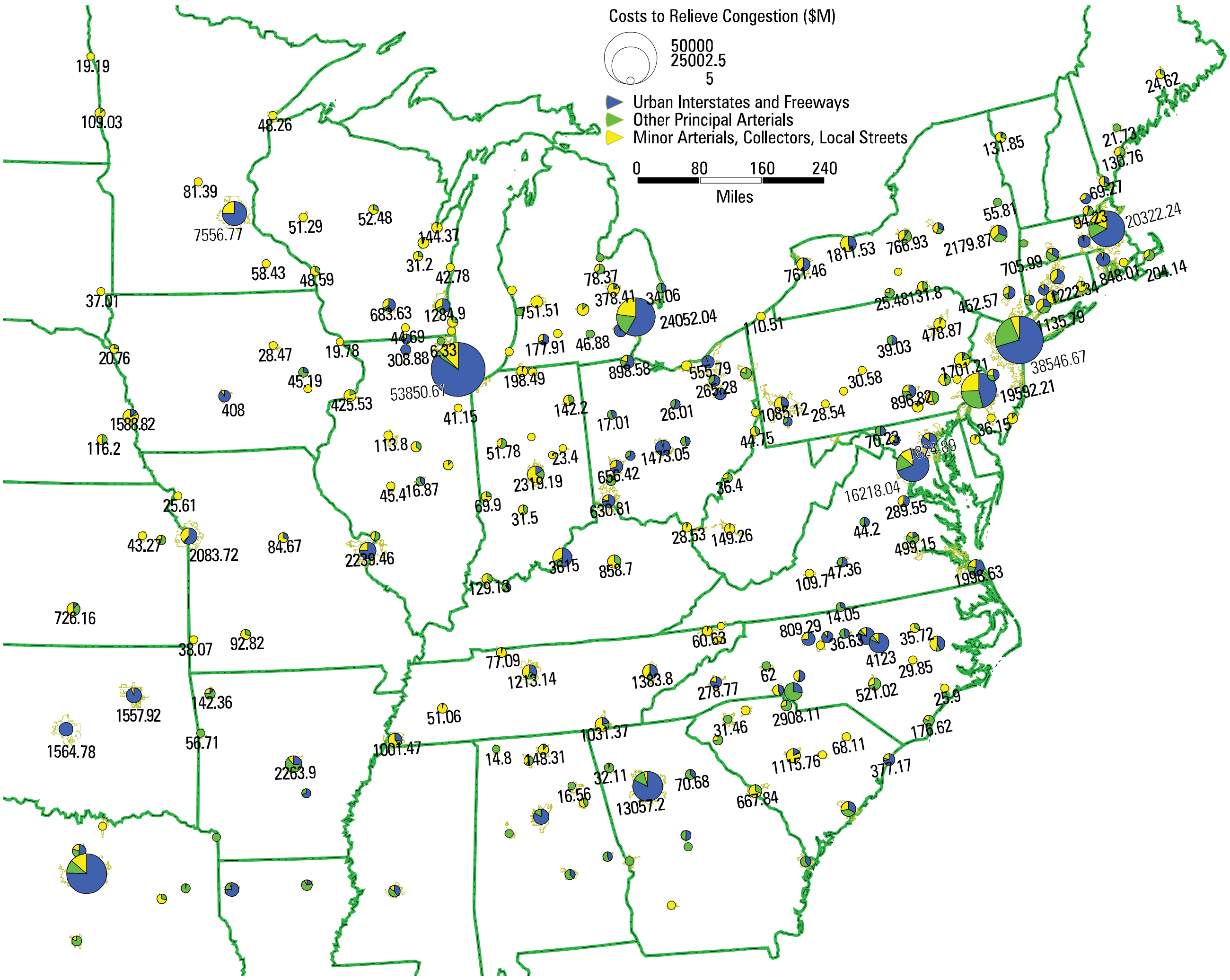
Figure 2: Urban Areas in the United States Requiring Congestion Relief with Costs to Relieve Congestion



2. The Northeast/North-Central United States

Figure 3 and Table 11 show needs for the Northeast/North-Central United States. With 25 states, this region is estimated to have 47.7 percent of the future U.S. urbanized area population and 46.6 percent of future severe congestion needs. The two states with the largest needs in this region, Illinois and New York, account for 18.7 percent of the U.S. total. Within the region, metropolitan New York, Chicago, Boston, Washington, Philadelphia, and Detroit dominate the requirements, each with more than $16 billion in needs. Numerous mid-sized areas also require $1-5 billion each. However, even small urbanized areas in rural states such as Maine and Vermont have congestion-relief needs. Maine's needs are concentrated in Portland ($130.8 million), Lewiston ($21.7 million) and Bangor ($24.6 million).

Figure 3: Urban Areas in the Northeast/North Central United States Requiring Congestion Relief with Costs to Relieve Congestion ($Million)



3. The Southeast United States

Figure 4 and Table 12 show the pattern of congestion needs for the Southeast region. Although the region as a whole is less congested than the Northeast, the needs are still large. Texas and Florida, the top two states in the region, together contain 16.4 percent of the national total needs. Dallas and Miami, each needing more than $26 billion, are the top areas in the region, with Atlanta, Houston and San Antonio each needing at least $5.6 billion. Many other urbanized areas need $1-2 billion each. (New Orleans is estimated to need $598 million, assuming its recovery from Hurricane Katrina puts it back on its trend.)

Table 11: Costs of Relieving Severe Urban Area (UA) Congestion for the 25 States in the Northeast/North- Central United States ($Billion)					
State	**2003 UA Pop (000s)**	**2030 UA Pop (000s)**	**2030 UA Lane Miles expected to be congested**	**2030 UA Lane Miles Needed**	**Total Costs of Lane Miles Needed ($B)***
Illinois	9,114	11,044	3,037	4,459	55.0
New York	21,089	24,573	4,735	4,511	45.0
Michigan	6,732	7,666	1,785	3,668	27.1
Pennsylvania	9,978	10,698	2,456	4,465	25.5
Massachusetts	5,575	6,493	1,214	1,961	21.9
Washington, DC	4,277	5,973	1,130	1,803	16.2
North Carolina	3,507	5,257	1,537	4,361	12.4
Minnesota	2,803	3,756	1,427	2,531	7.7
Ohio	8,062	8,954	1,212	1,610	5.6
Tennessee	3,334	4,467	1,291	2,754	5.0
Kentucky	1,372	1,703	391	1,234	4.6
Missouri	3,930	4,757	1,163	1,972	4.6
Connecticut	2,837	3,234	585	1,618	3.4
Virginia	3,269	4,021	735	989	3.1
Indiana	2,167	2,691	762	2,269	3.1
Wisconsin	3,019	3,519	877	1,687	3.0
Maryland	2,689	3,299	546	580	2.3
Rhode Island	1,218	1,411	267	257	0.85
New Jersey	734	913	164	388	0.65
Iowa	961	1,184	165	304	0.57
New Hampshire	391	521	141	218	0.30
West Virginia	509	487	77	154	0.28
Maine	268	314	50	82	0.18
Vermont	133	168	28	61	0.13
Delaware	80	107	25	42	0.06
Subtotals	98,048	117,210	25,801	43,980	248.5
National Totals	189,510	245,523	59,688	104,122	533.5
% of Total	51.7	47.7	43.2	42.2	46.6

*Cities grouped into major state, so costs may include work in nearby states.

Figure 4: Urban Areas in the Southeast United States Requiring Congestion Relief with Costs to Relieve Severe Congestion ($Million)

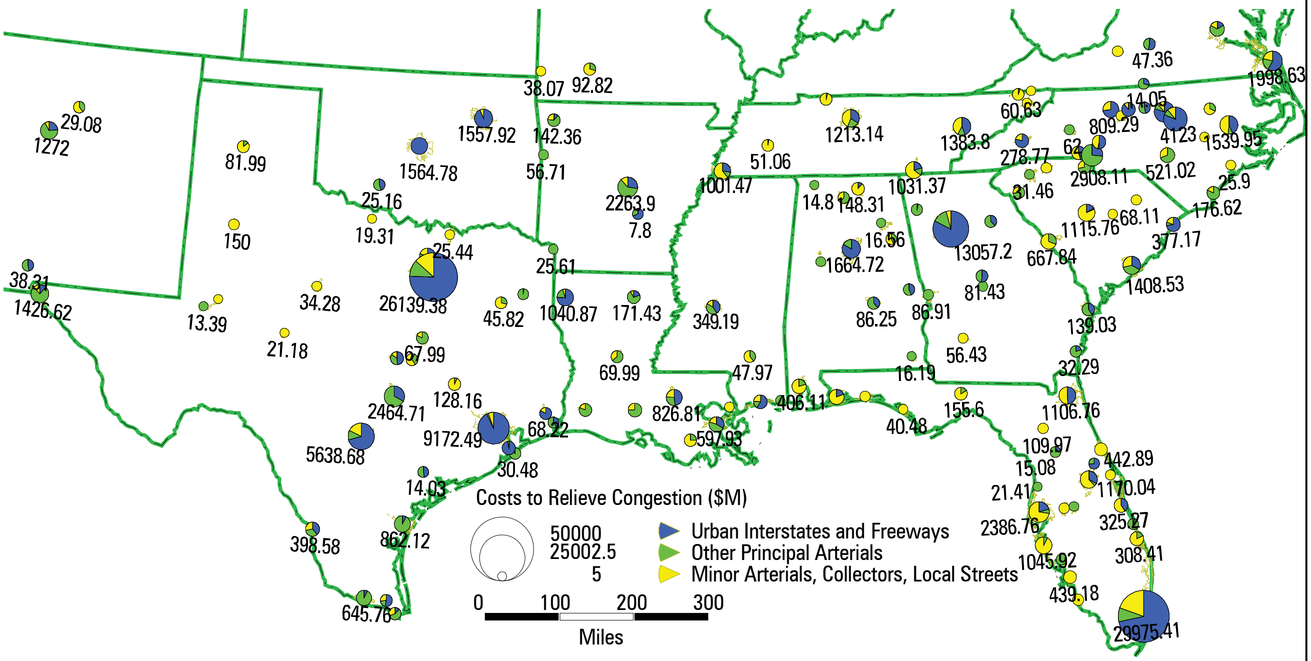


Table 12: Costs of Relieving Severe Urban Area (UA)Congestion for the Southeast United States ($B)					
State	**2003 UA Pop 000s**	**2030 UA Pop 000s**	**2030 UA Lane Miles expected to be congested**	**2030 UA Lane Miles Needed**	**Total Costs of Lane Miles Needed ($B)***
Texas	13,244	19,951	7,986	12,929	$49.1
Florida	13,122	19,474	3,990	8,536	38.7
Georgia	4,311	6,716	1,516	3,220	14.3
South Carolina	1,720	2,285	726	1,934	4.9
Louisiana	2,534	2,829	846	1,248	3.3
Oklahoma	1,483	1,844	363	727	3.1
Alabama	1,906	2,239	458	967	2.5
Arkansas	692	938	271	1,207	2.5
Mississippi	743	953	139	254	0.72
Subtotals	39,755	57,229	16,296	31,024	119.2
National Totals	189,510	245,523	59,688	104,122	533.5
% of Total	21.0	23.3	27.3	29.8	22.3

*Cities grouped into major state, so costs may include work in nearby states.

4. The Southwest United States

Figure 5 and Table 13 reflect the Southwest Region, where California dominates the congestion needs picture, with 22.9 percent of the national total. Within California, Los Angeles and San Francisco comprise about 80 percent of the California total. These two urbanized areas together have almost 18 percent of the national need, almost as much as New York and Illinois combined. Other states also have important needs. Major urbanized areas with significant needs are Phoenix and Denver, each with close to $10 billion in needs.

Figure 5: Urban Areas in the Southwest Requiring Congestion Relief with Costs to Relieve Congestion ($Million)

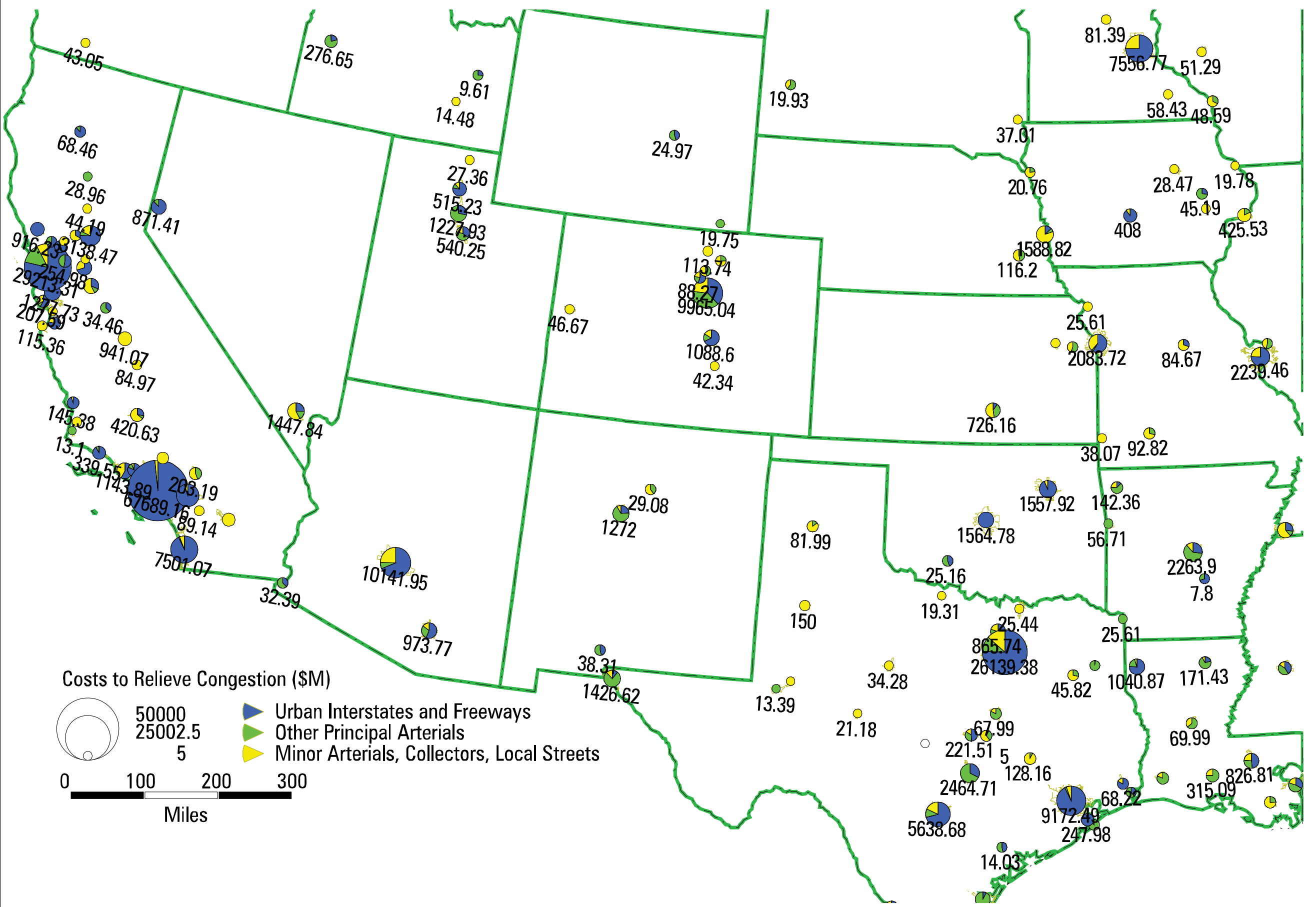


Table 13: Costs of Relieving Severe Urban Area (UA) Congestion for the 8 States in the Southwest United States ($Billions)					
City	**2003 UA Pop (000s)**	**2030 UA Pop (000s)**	**2030 UA Lane Miles expected to be congested**	**2030 Lane Miles Needed**	**Total Costs of Lane Miles Needed ($B)***
California	30,487	39,874	8,730	13,132	121.9
Colorado	3,246	5,048	1,111	4,668	11.4
Arizona	3,909	6,888	4,082	3,813	11.3
Utah	1,830	2,797	505	948	2.3
Nevada	1,147	1,483	281	919	2.3
Nebraska	852	1,107	262	966	1.7
New Mexico	738	1,058	249	556	1.4
Kansas	601	730	148	578	0.81
Subtotals	42,810	58,985	15,368	25,579	153.2
National Totals	189,510	245,523	59,688	104,122	533.5
% of Total	22.6	24.0	25.7	24.6	28.7

*Cities grouped into major state, so costs may include work in nearby states.

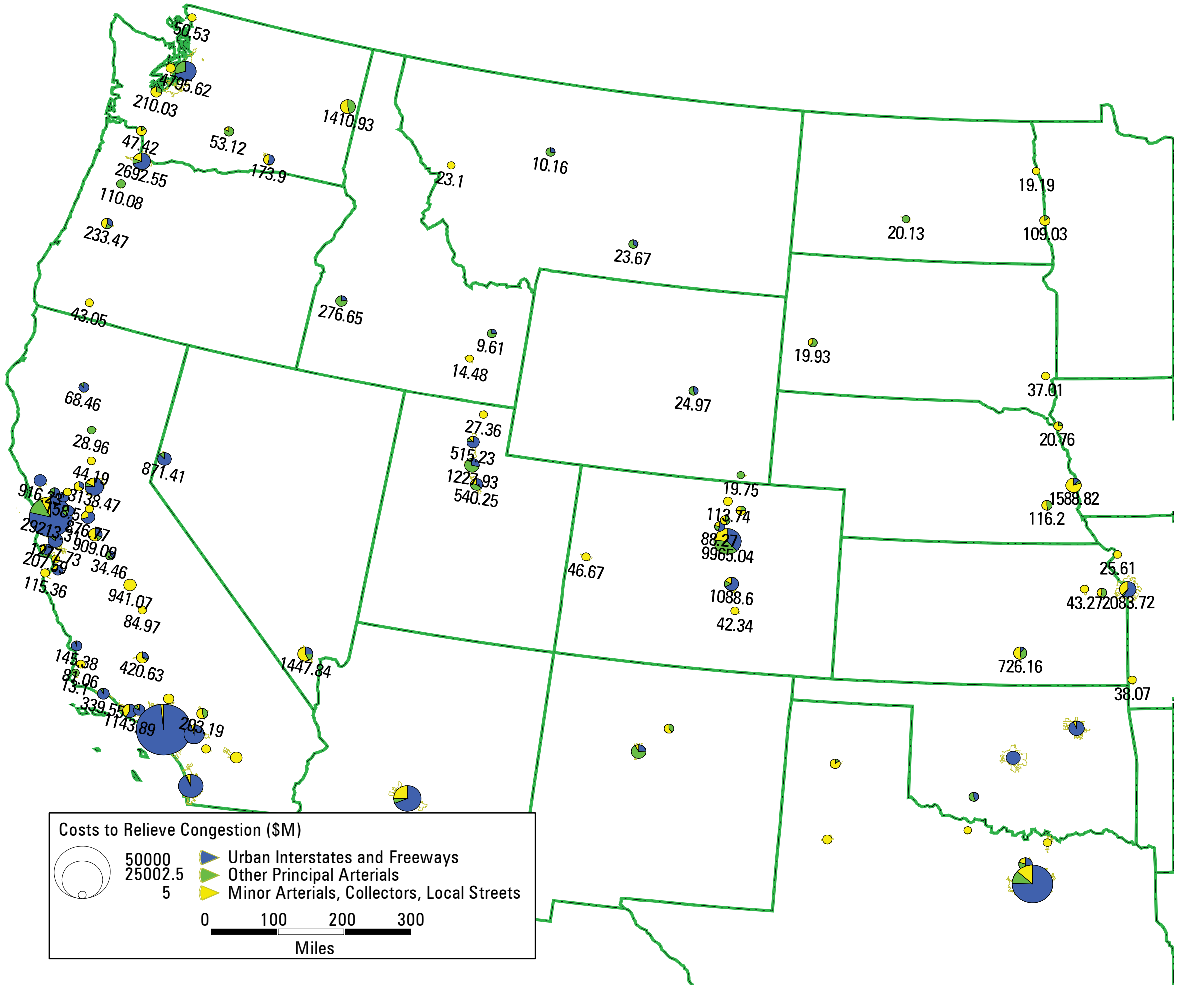
5. The Northwest United States

The Northwest Region as a group has only about 2 percent of the national severe-congestion needs, but two states and urbanized areas dominate its requirement. Seattle and Portland, each with over $2.5 billion in needs, are the largest urbanized areas; these two have 70 percent of the region's needs. However, even rural states like Montana and Idaho have some needs. In Idaho, for instance, Boise ($277 million), Idaho Falls ($14.5 million) and Pocatello ($9.6 million), have some localized congestion needs. In Montana, Missoula ($23.1 million), Great Falls ($10.2 million), and Billings ($23.7 million) constitute the state's modest need.

Table 14: Costs of Relieving Severe Congestion in the Northwest United States ($B)					
State	**2003 UA Pop (000s)**	**2030 UAPop (000s)**	**2030 UA Lane Miles expected to be congested**	**2030 UA Lane Miles Needed**	**Total Costs of Lane Miles Needed ($B)***
Washington	4,081	5,497	1,063	1,477	$6.9
Oregon	2,372	3,478	660	1,020	3.2
Idaho	536	841	180	278	0.37
North Dakota	276	322	55	108	0.15
South Dakota	190	260	26	51	0.06
Montana	245	293	24	31	0.06
Wyoming	129	154	25	22	0.05
Subtotals	7,829	10,845	2,033	2,987	10.7
National Totals	189,510	245,523	59,688	104,122	533.5
% of Total	4.1	4.4	3.4	2.9	2.0

*Cities grouped into major state, so costs may include work in nearby states

Figure 6: Urban Areas in the Northwest United States Requiring Congestion Relief ($M)



6. Alaska and Hawaii

The severe congestion needs of Alaska and Hawaii are relatively modest. In Hawaii, Honolulu ($1023.7 million) and Kailua-Kaneohe ($50.1 million) constitute the state needs, while Anchorage ($815.3 million) and Fairbanks ($33.5 million) represent Alaska's need.

Table 15: Costs of Relieving Severe Congestion for Alaska and Hawaii ($B)

State	2003 UA Pop (000s)	2030 UA Pop (000s)	2030 UA Lane Miles expected to be congested	2030 UA Lane Miles Needed	Total Costs of Lane Miles Needed ($B)
Hawaii	742	832	121	321	1.1
Alaska	326	423	68	230	0.85
Subtotals	1,068	1,255	189	551	1.9
National Totals	189,510	245,523	59,688	104,122	533.5
% of Total	0.6	0.5	0.3	0.5	0.4

Figure 7: Urban Areas in Alaska and Hawaii Requiring Congestion Relief and Costs to Relieve Congestion ($M).

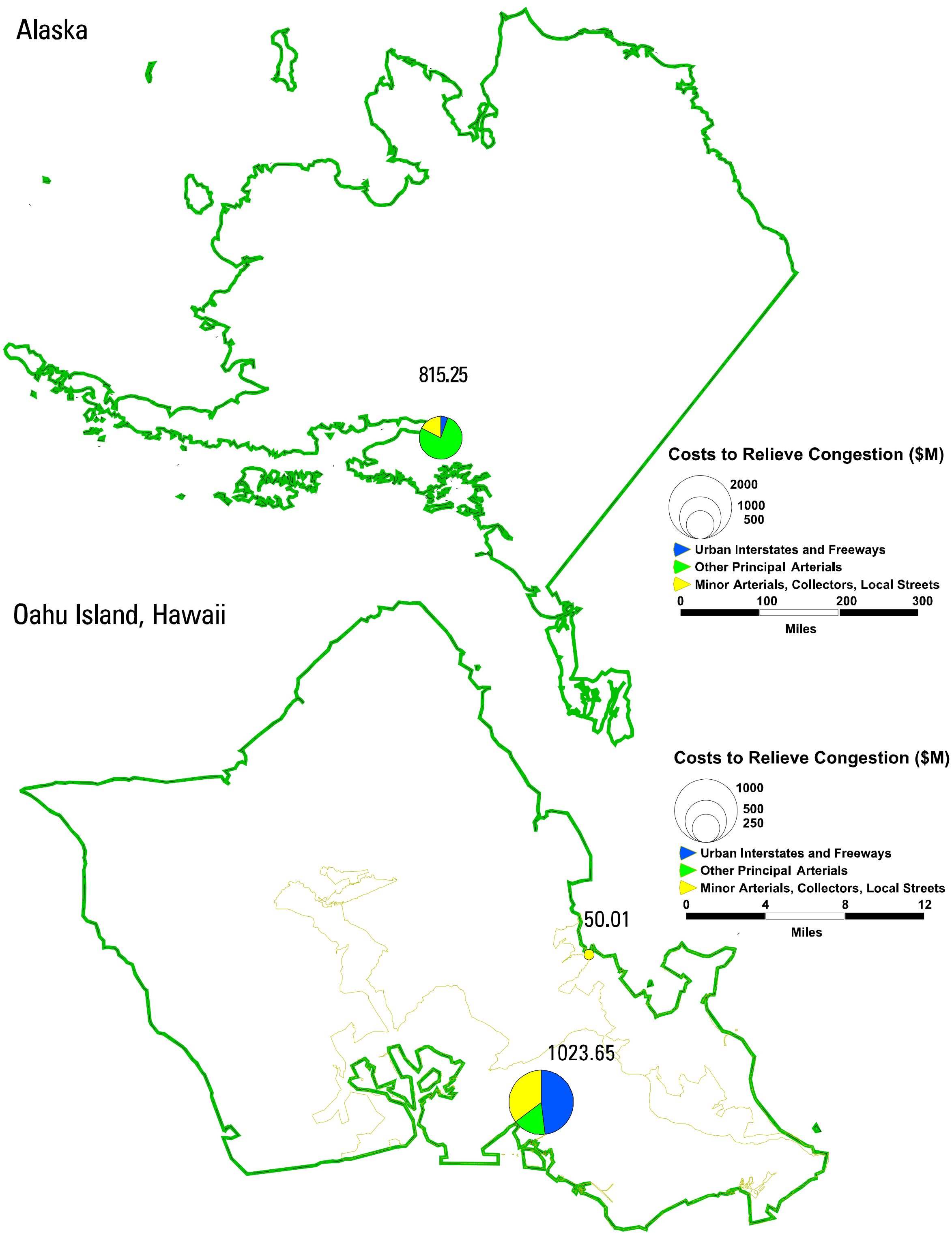


Table 16: States Ranked by Congested Lane Miles in 2030		Table 17: States Ranked by 2030 Urban Area Lane Miles Needed		Table 18: States Ranked by Total Costs of Lane Miles Needed	
State	2030 Urbanized Area Lane Miles Congested	State	2030 Urban Area Lane Miles Needed	State	Total Costs of Lane Miles Needed ($B)
1. California	8,730	1. California	13,132	1. California	121.90
2. Texas	7,986	2. Texas	12,929	2. Illinois	55.00
3. New York	4,735	3. Florida	8,536	3. Texas	49.10
4. Arizona	4,082	4. Colorado	4,668	4. New York	45.00
5. Florida	3,990	5. New York	4,512	5. Florida	38.70
6. Illinois	3,037	6. Pennsylvania	4,465	6. Michigan	27.10
7. Pennsylvania	2,456	7. Illinois	4,459	7. Pennsylvania	25.50
8. Michigan	1,785	8. North Carolina	4,361	8. Massachusetts	21.90
9. North Carolina	1,537	9. Arizona	3,813	9. D.C.	16.20
10. Georgia	1,516	10. Michigan	3,668	10. Georgia	14.30
11. Minnesota	1,427	11. Georgia	3,221	11. North Carolina	12.40
12. Tennessee	1,291	12. Tennessee	2,754	12. Colorado	11.40
13. Massachusetts	1,214	13. Minnesota	2,531	13. Arizona	11.30
14. Ohio	1,212	14. Indiana	2,269	14. Minnesota	7.70
15. Missouri	1,164	15. Missouri	1,972	15. Washington	6.90
16. D.C.	1,130	16. Massachusetts	1,961	16. Ohio	5.60
17. Colorado	1,111	17. South Carolina	1,934	17. Tennessee	5.00
18. Washington	1,063	18. D.C.	1,803	18. South Carolina	4.90
19. Wisconsin	877	19. Wisconsin	1,687	19. Kentucky	4.60
20. Louisiana	846	20. Connecticut	1,618	20. Missouri	4.60
21. Indiana	762	21. Ohio	1,610	21. Connecticut	3.40
22. Virginia	735	22. Washington	1,477	22. Louisiana	3.30
23. South Carolina	726	23. Louisiana	1,248	23. Oregon	3.20
24. Oregon	660	24. Kentucky	1,234	24. Oklahoma	3.10
25. Connecticut	585	25. Arkansas	1,207	25. Virginia	3.10
26. Maryland	546	26. Oregon	1,020	26. Indiana	3.10
27. Utah	505	27. Virginia	989	27. Wisconsin	3.00
28. Alabama	458	28. Alabama	967	28. Alabama	2.50
29. Kentucky	392	29. Nebraska	966	29. Arkansas	2.50
30. Oklahoma	363	30. Utah	948	30. Utah	2.30
31. Nevada	281	31. Nevada	919	31. Nevada	2.30
32. Arkansas	271	32. Oklahoma	727	32. Maryland	2.30
33. Rhode Island	267	33. Maryland	580	33. Nebraska	1.70
34. Nebraska	262	34. Kansas	578	34. New Mexico	1.40
35. New Mexico	249	35. New Mexico	556	35. Hawaii	1.10
36. Idaho	180	36. New Jersey	388	36. Alaska	0.85
37. Iowa	165	37. Hawaii	321	37. Rhode Island	0.85
38. New Jersey	164	38. Iowa	304	38. Kansas	0.81
39. Kansas	148	39. Idaho	278	39. Mississippi	0.72
40. New Hampshire	142	40. Rhode Island	257	40. New Jersey	0.65
41. Mississippi	139	41. Mississippi	254	41. Iowa	0.57
42. Hawaii	121	42. Alaska	230	42. Idaho	0.37
43. West Virginia	77	43. New Hampshire	218	43. New Hampshire	0.30
44. Alaska	68	44. West Virginia	154	44. West Virginia	0.28
45. North Dakota	55	45. North Dakota	108	45. Maine	0.18
46. Maine	50	46. Maine	82	46. North Dakota	0.15
47. Vermont	28	47. Vermont	61	47. Vermont	0.13
48. South Dakota	26	48. South Dakota	51	48. South Dakota	0.06
49. Wyoming	25	49. Delaware	42	49. Montana	0.06
50. Delaware	25	50. Montana	31	50. Delaware	0.06
51. Montana	24	51. Wyoming	22	51. Wyoming	0.05

D. Risk Analysis of the Cost to Relieve Severe Congestion

Costs to add capacity were calculated using estimates of construction costs, induced travel, bridge-widening construction, and elevated-tunnel construction costs (see Appendix B). But there is a fair amount of uncertainty in those numbers. To determine the likely range of costs, an uncertainty analysis of the cost was conducted using the Crystal Ball® software package. This software uses a *range* of numbers for each factor affecting the cost rather than just one, and produces a *range* of estimates rather than just one. (See Appendix H for the full risk analysis.)

The analysis found that there is a 95 percent certainty that the costs to relieve severe congestion will fall between $454.6 billion and $623.0 billion, in today's dollars, an 80 percent probability that the costs to relieve severe congestion are less than $573 billion, and a 90 percent probability that they are less than $593 billion. Hence, our estimates are well within the most likely range.

Finally, we conducted a sensitivity analysis of the impact of the factors that were varied in Crystal Ball® on the final cost distribution. These results show that the higher construction costs for the interstates and freeways, and differences in state construction costs are the key factors influencing overall cost. They account for about 60 percent of the uncertainty in the final cost. Although major bridge-widening needs and elevated sections are individually expensive, they are a relatively small part of total costs.

E. Additional Costs of Removing Moderate Urban Congestion

The analysis so far focuses on severe urban congestion, defined formally as congestion in which traffic exceeds the capacity of the carrying facility, "Level of Service (LOS) F" in transportation parlance. But congestion at lower levels, known as LOS levels D and E, is also common although not so deleterious to travel times. Since congestion is rising in all urban areas, our first focus was on the capacity needed to relieve severe congestion, and the costs of doing so.

Moderate congestion can also be reduced by the provision of more capacity and of course by other means. To evaluate the costs of reducing moderate congestion by capacity improvements we undertook an analysis similar to the detailed LOS F, with several important differences. Primarily we used state-level data, not urbanized area data; this obviated the need for the 32 participating urbanized areas to provide additional traffic assignment information. Otherwise, the methodology (see Appendix B) was similar, using comparable unit costs of construction and criteria for widening.

Data from 2003 show about 15,900 miles of road in urbanized areas with congestion levels between 80 and 95 percent of capacity—approximately levels of service D and E, or moderate congestion. This is somewhat more than the 11,700 miles estimated to be severely congested. Using similar growth rates from 2003 to 2030, it is estimated that by 2030 this number will increase to 42,000 miles.

Since this congestion is moderate rather than severe, it would be imprudent to add more than just two lanes (one on each side) to provide additional capacity for this traffic. In addition, there is unlikely to be significant pent-up demand for use of these facilities, as there would be for severely congested facilities. Therefore the additional lane-miles needed to deal with this congestion are just twice the mileage of moderately congested facilities, or 84,000 lane-miles. This compares with an estimated 104,000 lane-miles needed to deal with severe congestion.

Because this example requires less expansion, the costs of this expansion are significantly less too. We estimate that the effort would cost about $270.5 billion, in 2004 dollars. This compares with an estimate of $533.4 billion for dealing with severe congestion. Thus, if both severe and moderate congestion were targeted, the cost of significant reduction would be in the range of $803.9 billion, in 2005 dollars.

Table 19: Mileage and Costs of Removing Moderate Urban Congestion

	2003 Miles 0.80-0.95 (000s)	2030 Miles 0.80-0.95 (000s)	2030 Lane-Miles Needed to Remove (000s)	Cost to Provide Additional Capacity ($B)
Interstate and OFE	3,801	10,395	20,790	117.1
Other Primary Arterials	3,924	10,206	20,412	65.0
Minor Arterials	4,828	12,469	24,937	50.7
Major Collectors	3,300	8,966	17,931	37.6
Total	**15,853**	**42,035**	**84,070**	**270.5**

State-level details of this assessment are provided in Appendix D.

This assessment does not deal with the advisability of removing moderate congestion. While a case could be made that any congestion, moderate or severe, should be removed since it is economically inefficient, the specific benefits of widening a particular road to remove LOS F, or E, or D congestion, would have to be evaluated on a case-by-case basis. Our assessment merely deals with the overall magnitude of the problem and the likely scale of dealing with it nationally.

F. Rural Congestion

Not all traffic congestion is urban: anyone who has felt the frustration of sitting in a line on a rural road going to a ski area or a beach resort understands that rural congestion can and does occur, and can be significant.

Although this study focuses primarily on urban congestion, we did take a brief look at rural congestion.[29] The methodology is similar to that used to review LOS D and E congestion: we looked at state-level data only, not county or urban-fringe data. Costs for widening rural roads are significantly cheaper than for urban roads, and the extent of the network that might have to be treated is considerably less too. Therefore, our findings are modest, compared with urban congestion. Appendix B describes our methodology in more detail.

Tables 20 and 21 summarize the findings. Overall, about 2,800 miles of rural highway are currently severely congested (have volume/capacity ratios of 0.95 or higher). Another 4,000 miles are moderately congested. Using similar growth rates for our urbanized areas, but aggregating to the state level, we estimate that about 8,200 miles are likely to be severely congested in 2030, and 11,700 miles are likely to be moderately congested; this is probably an overstatement since rural traffic is not growing as fast as urban traffic. Details for each state are shown in Appendices E and F.

Since most of these roads have little potential for significant pent-up demand, most could be widened by just two lanes to deal with this severe congestion. Thus, about 16,400 lane-miles of additional capacity would be needed to deal with severe congestion, and another 23,400 miles for moderate congestion by 2030. However, most of this mileage is in lower-cost environments with flat or rolling terrains that are not nearly as expensive as urban environments. Therefore, the cost of this additional mileage is estimated at about $14.2 billion, in 2005 dollars, for severe congestion, and $19.7 billion for moderate congestion, over the next 25 years.

Table 20: Mileage and Costs of Relieving Severe Rural Congestion

	Rural LOS F Analysis			
	2003 Miles congested (000s)	2030 Miles congested (000s)	2030 Lane-Miles Needed (000s)	Cost to Provide ($B)
Interstate	607	1,558	3,117	**2.5**
Other Primary Arterials	948	2,823	5,646	**5.5**
Minor Arterials	729	2,268	4,535	**4.0**
Major Collectors	516	1,528	3,057	**2.1**
Total	2,800	8,177	16,354	**14.2**

Table 21: Mileage and Costs of Relieving Moderate Rural Congestion

	Rural LOS D-E Analysis			
	2003 Miles 0.80-0.95 (000s)	2030 Miles 0.80-0.95 (000s)	2030 Lane-Miles Needed (000s)	Cost to Provide ($B)
Interstate	1,392	3,745	7,490	**5.8**
Other Primary Arterials	954	2,793	5,586	**5.4**
Minor Arterials	1,065	3,315	6,630	**5.8**
Major Collectors	575	1,862	3,724	**2.8**
Total	3,986	11,715	23,429	**19.7**

E. Comparison with Long-Range Plans

To bring these findings into perspective, we have prepared an analysis of how the implied costs to relieve severe congestion compare with the planned expenditures in 43 selected urbanized areas. The sources of the costs shown here are the latest long-range plans, as described in the Websites of each urbanized area's MPO. Most plans are for 2030, although a few are for 2025. The urbanized areas are in order by 2003 population. Table 22 summarizes the findings.

According to the table, the urbanized areas reviewed plan to spend, in total, about $1.47 trillion over the next 25 years on their transportation plans. Of this, 43.1 percent will be on highway-related projects (capital and maintenance), 52.8 percent on transit (capital and maintenance), and 3.6 percent on other projects, primarily pedestrian/bike facilities and enhancements. With the exceptions of New York City and Chicago, most of the transit commuting shares are under 10 percent, and many are in the range of 1-2 percent for smaller regions. Overall, the cost of removing severe congestion in these urbanized areas ($413 billion) as estimated in this study, amounts to 28.0 percent of the total cost of the long-range plans as now formulated by the MPOs. Although in some areas these costs are substantially higher as a percentage of the total and in others lower, it is clear that in many areas, removal of severe congestion would be a relatively small portion of the plan focus if it were adopted as a policy. This is particularly true for smaller urbanized areas, where the costs of removing severe congestion are in the range of 10 percent of plan costs.

Of course, some of the MPO expenditures are for congestion relief and might overlap with our estimates. Most of the expenditures planned by MPOs, however, serve other purposes. To the extent that their goals include congestion relief, this would offset some costs and rising construction prices. But in most cases, their plans would not eliminate severe congestion or even reduce congestion below current levels.

Table 23 aggregates the costs in Table 22 by city size and divides them out by commuter trips over 25 years. The table shows that the cost per commuter trip to relieve LOS F congestion ranges between $0.65 and $0.13 per trip. Although this estimate is just for those cities for which we reviewed the long-range plans, it gives a feel for the range of values.

Table 22: Costs to Relieve Congestion versus Present Plan Costs

Urbanized Area	2003 UA Pop K	LRP Total Highway Costs	Auto Commute Share** (%)	LRP Total Transit Costs	Transit Commute Share*** (%)	LRP Other Costs	Total LRP Plan Cost	Cost to Relieve LOS F Congestion	Percent of Total LRP
New York	17,170	$78.7 B	38.9	$249.0 B	48.7	$0	$327.8 B	38.5 B	11.8
Los Angeles	12,520	48.5 B	88.0	66.9 B	4.8	0	115.4 B	67.7 B	58.7
Chicago	7,702	33.5 B	81.3	27.5 B	11.9	0	61.0 B	53.9 B	88.3
Philadelphia	5,287	21.9 B	82.3,	22.8 B	10.0	12.7 B	57.4 B	19.6 B	34.1
Miami	5,104	6.0 B	90.7	13.3 B	3.9	0	19.3 B	30.0 B	155.6
Dallas-FW	4,312	30.6 B	92.2	13.5 B	2.1	1.0 B	45.1 B	26.1 B	58.0
Wash. D.C.	4,227	36.9 B	46.6	56.4 B	38.8	0	93.3 B	16.2 B	17.4
San Fran.	4,120	42.0 B	80.8	76.0 B	9.2	0	118.0 B	29.2 B	24.8
Boston	3,988	4.5 B	82.7	43.8 B	9.4	0	48.3 B	20.3 B	42.1
Detroit	3,939	31.5 B	93.4	9.3 B	1.6	0.2 B	41.0 B	24.1 B	58.7
Seattle	2,946	49.4 B	81.9	46.3 B	7.9	5.9 B	101.6 B	4.8 B	4.7
Atlanta	2,924	29.6 B	90.7	21.5 B	3.0	1.9 B	53.0 B	13.1 B	24.6
San Diego	2,872	8.1 B	88.1	15.9 B	3.9	8.3 B	32.2 B	10.1 B	31.5
Houston-Galv	2,620	46.7 B	91.2	17.9 B	3.3	12.7 B	77.3 B	9.2 B	11.9
Minneapolis	2,482	5.6 B	75.0	2.6 B	14.2	0.7 B	8.8 B	7.6 B	85.9
Baltimore	2,076	13.2 B	72.3	11.8 B	18.2	0.5 B	25.5 B	1.8 B	7.2
Denver	2,050	53.9 B	88.4	23.4 B	4.1	10.5 B	87.8 B	10.0 B	11.3
Portland OR	1,685	14.2 B	74.5	5.5 B	12.9	na	19.7 B	2.7 B	13.7
San Jose	1,664	1.1 B	90.3	6.9 B	2.8	0.6 B	8.5 B	1.3 B	15.0
Cincinnati	1,606	5.7 B	83.6	1.6 B	8.2	0.1 B	7.4 B	0.6 B	8.5
San Antonio	1,333	6.5 B	91.4	4.0 B	2.9	0	10.5 B	5.6 B	53.7
Columbus OH	1,195	4.0 B	92.2	1.3 B	2.7	0.2 B	5.4 B	1.5 B	27.1
Salt Lake	877	3.2 B	91.4	17.3 B	2.4	2.4 B	23.0 B	1.2 B	5.4
Austin	757	15.4 B	92.2	6.2 B	1.8	0.3 B	21.9 B	2.5 B	11.3
Charlotte	725	1.2 B*	91.1	6.3 B	2.6	5 M	7.6 B	2.9 B	38.3
Tucson	720	9.6 B	87.8	3.4 B	3.0	1.4 B	14.4 B	1.0 B	6.8
El Paso	629	4.4 B	93.6	1.8 B	1.9	0	6.2 B	1.4 B	23.0
Akron	614	2.3 B	91.1	0.3 B	3.4	62 M	2.7 B	0.3 B	9.7
Raleigh	528	5.7 B	93.1	2.2 B	1.9	3 M	7.9 B	3.3 B	41.2
Bakersfield	443	4.2 B	88.2	1.4 B	2.1	15 M	5.7 B	0.4 B	7.4
McAllen TX	376	3.9 B	93.1	72 M	0.0	42 M	4.0 B	0.6 B	16.2
Spokane	357	1.2 B	88.8	1.4 B	1.2	0.4 B	3.0 B	1.4 B	47.0
Little Rock	338	2.8 B	95.6	0.8 B	0.7	25 M	3.6 B	2.3 B	63.8
Corpus Christi	295	741 M	93.4	163 M	0.3	0	904 M	862 M	95.4
Boise	254	2.2 B	91.5	na	0.8	na	2.2 B	0.3 B	12.4
Eugene	239	1.2 B	83.2	0.8 B	2.1	28 M	2.0 B	0.2 B	11.4
Lincoln	227	1.5 B	90.9	na	1.2	na	1.5 B	0.1 B	7.8
Lubbock	206	0.9 B	95.5	0.2 B	0.1	0	1.1 B	0.2 B	13.7
Fredericksburg	168	2.1 B	--	na	--	na	2.1 B	0.3 B	13.8
Binghamton	137	690 M	87.2	130 M	1.4	0	820 M	132 M	16.1
Sioux City	108	609 M	--	121 M	--	0	730 M	21 M	2.8
Missoula	74	118 M	--	66 M	--	21 M	205 M	23 M	11.3
Elmira NY	57	658 M	--	130 M	--	4 M	792 M	26 M	3.2
Total	**101,951**	**$636.7 B**	**NA**	**$780.0 B**	**NA**	**$60.0 B**	**$1,476.7 B**	**$413.4 B**	**28.0**

***A $3.57 billion road plan has recently been proposed.

** Based on 2003 American Community Survey Data for metro area. Combines single occupancy driving and carpooling

***Based on 2003 American Community Survey Data for metro area. Includes taxi.

Table 23: Average Costs per Resident to Relieve Congestion versus Present Plan Costs, Weighted by Population					
City Size	Average Population (000)	Average LRP Plan Cost ($ B)	Average LRP Cost per Commuter Trip ($)	Average Cost to Relieve LOS F Congestion ($ B)	Average Cost to Relieve Congestion, per Commuter Trip
3+ Million	9,503.4	137.1	2.31	38.9	0.65
1-3 Million	2,294.7	42.6	2.97	6.5	0.45
500K-1M	708.8	12.9	2.90	1.8	0.40
250K-500K	354.3	3.5	1.56	1.0	0.44
50K-250K	179.7	1.4	1.21	0.2	0.14

*Based only on cities reporting in **Table 22**

Such funds might be available through the reallocation of expenditures within the plans, if congestion relief were given higher priority. But the challenge of adding capacity to reduce congestion is not the focus of most MPOs. Most appear to have adopted a policy that congestion will be addressed by other means and at a lower priority.

The following are typical of comments that propose to reduce congestion by non-capacity means:

Eugene, Oregon

> *"The intent is to defer motor vehicle capacity increasing transportation system improvements until existing constraints can be overcome or develop an alternative mix of strategies (such as land use measures, TDM, short-term safety improvements) to address the problem."*
>
> *"Encouraging the use of transportation modes other than the single-occupant vehicle will become more important as the region grows and traffic congestion levels increase."*
>
> *The most important goal is "identifying the means to reduce reliance on the automobile by increasing the transportation choices available in the region."*
>
> *"The ability of the region to fund capacity-increasing roadway projects will be limited by other allocation decisions."*[30]
>
> — Lane Council of Governments, Central Lane Regional Transportation Plan

Jacksonville, FL

> *"To give priority to improvements that do not require additional travel lanes."*
>
> *"To expand and enhance pedestrian and bicycle access to all areas."*
>
> *"To coordinate with the region's congestion management system in relieving existing congestion and preventing congestion where it has not yet occurred."*[31]
>
> —First Coast MPO, 2030 Long-Range Transportation Plan

Cincinnati, Ohio

> *"Traditionally, the solution to congestion has been to expand roadway construction capacity. It has become apparent, however, that metropolitan areas cannot build their way out of congestion."*[32]

—OKI Regional Council of Governments,
OKI 2030 Regional Transportation Plan 2004 Update

Austin, Texas

While Austin has a Congestion Management System, none of the transportation improvement strategies include adding more lanes. The improvement strategies include upgrading traffic signals, modifying bus routes, installing reversible travel lanes, and promoting alternative transportation modes (ridesharing, transit, bicycling, walking, etc.).[33] Austin has $262M of bike projects in the 2030 LRP.

—Capital Area MPO, Capital Area MPO Mobility 2030 Plan

Other cities place low priority on congestion reduction:

Bakersfield, California

Does not specifically list congestion relief as a goal.

> *"Delay the need for future increases in highway capacity and congestion relief through implementation of Transportation Control Measures."*

> *"Promote sustainable community design that supports transit use and increases non-motorized transportation while still meeting the mobility needs of residents and employees."*[34]

—Kern Council of Governments, Long Range Transportation Plan

Charlotte, North Carolina

> *"The transportation industry is giving more attention to safeguarding the natural environment, and construction practices have changed to improve the way transportation projects affect their surroundings."*

> *"The increased demands on transportation funding continue to create a backlog of unfunded projects…."*

> *"MUMPO's plan is to increase choices in transportation….."*[35]

—Mecklenburg-Union MPO, 2030 Long Range Transportation Plan

Columbia, South Carolina

The congestion management goals do not include adding lane capacity. The primary goal is "to develop a means to reduce traffic demand….by reducing the percentage of single occupancy vehicles and promoting public transit."[36]

— Columbia Area Transportation Study, Long-Range Inter-modal Transportation Plan 2025

Raleigh, North Carolina

Out of four goals and several objectives within each goal, addressing congestion was goal #4 and the last objective: "Maximize the highway system efficiency using means other than adding general-purpose traffic lanes."[37]

—Capital Area MPO, Capital Area MPO Mobility 2030 Plan

Detroit, Michigan

Out of five strategies to reduce congestion, adding capacity is the last resort.

> *"Road widening to increase capacity when other strategies are not applicable or do not reduce congestion to an acceptable level."*[38]

—Southeast Michigan Council of Governments,
2030 Regional Transportation Plan for Southeast Michigan

The unmistakable impression one draws from reviewing these plans is that urbanized areas transportation plans are not focused on congestion reduction, and to the extent that it is a priority, the approach is to increase choices for other modes rather than to provide additional highway capacity.

A few cities appear to be assessing the implications of what congestion reduction might cost:

San Antonio, Texas

To reduce congestion from 1.47 Texas Congestion Index (TCI, similar to TTI—Travel Time Index) to 1.12, "the region must find an additional $8 billon in funding."[39]

—San Antonio & Bexar County MPO,
Mobility 2030 San Antonio Mobility-Bexar County Metropolitan Transportation Plan

Atlanta

In perhaps the most stunning case of attention to congestion, Atlanta's Congestion Mitigation Task Force has passed resolutions calling for raising the weight placed on congestion relief from 11 percent to 70 percent in project selection, and setting a TTI value of 1.35 (presently 1.44) as a performance index for planning and project selection.[40]

—Congestion Mitigation Task Force, Final Report and Recommendations

Texas

As noted above, the Governor's Business Council has adopted a goal of 1.18 for the Texas Congestion Index (similar to the TTI) for Texas urbanized area, and estimated the needed additional funding at $54 billion to achieve it.[41]

—Governor's Business Council Transportation Task Force

Washington

> *"In Washington…the growth of travel demand has outpaced expansion of …system capacity…leaving .a growing backlog of capacity needs. The …imbalance affects … daily lives and almost every sector of economic activity"*[42]

—WSDOT Transportation Commission,
Urban Areas Congestion Relief Analysis Work Progress Report

Part 4

User Benefits of Congestion Reduction

Users benefit from congestion reduction in many ways, but even looking at just a few of them—reduced travel time, lower operating costs and lower accident costs—shows the benefits can be substantial. The data below are taken from two sources. First, several of the 32 cities that provided detailed data for the fine estimates made in this study included additional detailed information from their traffic assignments which permits calculation of user benefits. This calculation is relatively conservative and does not include the savings from wasted fuel (that extra fuel consumed during the slower speeds or the stop-and-go conditions of congested travel). These additional fuel costs are estimated to be about 8 percent of the delay costs in the 2005 Urban Mobility Report, which is based on 2003 data.[43] These costs could be as high as 10 percent of delay costs, if current gasoline prices are used. Second, a more general measure—cost per hour of delay saved—is calculated for each urbanized area by estimating total delay saved by commuters over 25 years, and comparing that to estimated costs of congestion relief.

We use this data to show in some detail the benefits, using Detroit and Atlanta, two of the cities that provided additional traffic assignment data. These two cities are quite different—south v. north, fast growing v. slow growing, high congestion v. less congested, etc—and so the benefit results from them give an idea of the range possible. We also show the benefits for all cities by size.

Table 24 shows the findings for Detroit. The expansion of capacity to eliminate LOS F congestion results in an 11.6 percent reduction in vehicle-hours of travel and a 12.2 percent increase in speed. Note that the total regional travel, about 155 million miles daily, is not changed significantly (induced travel might increase this total somewhat). The travel time savings amount to about 531,000 hours daily.

User benefits are shown in the bottom of the table. At $10/hour (a conservative estimate), the value of the time saved traveling without severe congestion over 20 years is about $26.6 billion.[44] Savings from fatal accidents and operating costs increase the total to about $30.3 billion. Compared to the estimated cost of the added lane-miles for Detroit ($24.1 billion) the results appear to be mildly positive (i.e., the benefit/cost ratio in greater than 1). Of course these benefits do not include the other benefits, such as increased choices, or increased access to goods and services. Detroit is not a particularly congested place, so the benefits may be understated.

Table 24: User Benefits Analysis for Detroit			
	Daily vehicle miles traveled (VMT) (Millions)	**Daily vehicle hours traveled (VHT) (Millions)**	**Average Speed**
2030 LRP Assignment	157.774	4.593	34.35
2030 Unconstrained	156.575	4.062	38.55
Diff	-1.199	-0.531	4.2
% Diff	-0.76	-11.57	12.23
Savings: Miles	1.199		
Savings: Hours	0.531		
Life Savings	Years	20	
	Days/year	250	
	Value of Time	$10.00/hr	
	Operating cost/mile	$0.60	
	Ave fatal accident cost	3.0 M	
	Ave acc rate/100 M VMT	1.5	
	Lives saved over 20 years	89.92	
Lifetime value of travel time saved		$26.6 billion	
Lifetime value of operating cost saved		$3.4 billion	
Lifetime value of lives saved		$269.8 M	
Total savings over 20 years		**$30.3 billion**	
Cost to Relieve LOS F Congestion		**$24.1 B**	
Benefit/Cost Ratio		**1.26**	

Table 25: User Benefits Analysis for Atlanta				
		AM and PM vehicle miles traveled (VMT) (Millions)	**AM and PM vehicle hours traveled (VHT) (Millions)**	**Average Speed**
2030 LRP Assignment		103.899	5.942	17.49
2030 Unconstrained		103.268	4.328	23.86
Diff		-0.63	-1.61	6.37
% Diff		-0.61	-27.16	36.46
Savings	Miles	0.63		
	Hours	1.61		
Life Savings		Years	20	
		Days/year	250	
		Value of Time	$12.00/hr	
		Operating cost/mile	$0.60	
		Ave fatal accident cost	3.0 M	
		Ave acc rate/100 M VMT	1.5	
		Lives saved over 20 years	47.25	
Lifetime value of time saved			$96.6 billion	
Lifetime value of operating cost saved			$1.9 billion	
Lifetime value of lives saved			$141.8 M	
Total savings over 20 years			**$98.6 billion**	
Cost to Relieve LOS F Congestion			**$13.1 B**	
Benefit/Cost Ratio			**7.53**	

Table 25 contrasts Detroit against a more congested city, Atlanta, showing results for peak-period travel only. The expansion of that city's network to eliminate severe congestion would result in a

27.2 percent reduction in peak-period travel times and a 36.5 percent increase in peak-period speed, saving regional commuters about 1.61 million hours a day in travel time. At $12 an hour (also conservative, given Atlanta's higher average earnings), this time savings would be valued at $96.6 billion over 20 years. Savings from reduced operating costs and reduced fatal accidents would bring the total savings to $98.6 billion. Compared to the implementation costs of $13.1 billion, this is a substantial benefit. Even if the benefits are over-stated and the costs understated, the benefit-cost ratio is likely to be highly positive.

These examples are probably extreme. Detroit represents a "low-case" situation for a region with relatively high construction costs and relatively low congestion. Atlanta represents lower construction costs and higher congestion. Nevertheless they represent the range of results one might expect from a more detailed assessment of the impacts of congestion removal on traffic flow and particularly on travel time savings.

To estimate benefits for each region we also developed an estimate of the cost per hour of delay saved for each urbanized area. Appendix C shows the detailed results for each region, which are summarized in the following table.

Table 26: Cost of Capacity Expansion Per Hour of Delay Saved

Urban Area Size	Average Annual Delay Saved, Hours	Total Cost over 25 years, ($M)	Average Cost per Hour of Delay Saved ($)
3+ M	4,780,230,762	325,599.10	2.72
1-3 M	2,151,708,742	98,185.99	1.83
500K-1M	515,696,950	48,123.03	3.73
250-500K	154,626,517	40,359.34	10.44
50-250K	131,988,660	21,229.19	6.43
Total	**7,734,251,631**	**533,496.60**	**2.76**

Nationwide, commuters would save about 7.7 billion hours of delay annually. The cost of capacity increases per hour saved, averages about $2.76, with larger regions showing lower cost per hour of delay saved. In Appendix C, only a handful of urban regions have costs per hour of delay saved greater than $20. These numbers compare favorably with the federal guidelines for transit 'New Starts,' currently $21/ hour of "transportation benefit."

Additional savings, not quantified here, would include lower fuel use, reduced accident rates and vehicle operating costs, shipping costs and truck travel time reductions, and greater reliability.

In addition to these savings, which are real for commuters, communities also gain significantly by more accessibility. Workers have more choices of employment within a given travel time of home, shoppers have a greater range of markets and products, and employers have a larger pool of workers for jobs. These real benefits result in lower costs of goods and services to urban societies. Although some travel time savings are lost by traffic attracted to faster routes (thus lowering speeds), for most capacity improvements, this effect is minor. Our work in North Carolina studying over 300 road improvement projects estimated that about 92 percent of the additional capacity provided by road improvements would be converted into travel time savings and greater choices.[45]

Part 5

Conclusions

A. The Magnitude of Present and Future Congestion

U.S. urban area population is expected to increase about 30 percent over the next 25 years. As Table 27 shows, that means that the number of congested lane-miles of urban roads will increase 51 percent. Increases in congestion will come not because Americans are wasteful drivers or extravagant, but simply because there will be more people living in urbanized areas, competing for already limited road space in peak travel times.

Urban congestion will continue to increase unless significant action is taken to reduce it. Traveler delay in urbanized areas will double over the next 25 years, with the greatest relative increases coming in the smaller regions.

Table 27: Severely Congested Facilities, 403 Urbanized Areas			
Roadway Type	**2003 Lane-Miles Severely Congested***	**2030 Lane-Miles Severely Congested***	**Percent Change**
Urban Interstate	17,800	27,400	54.3
Urban Other Freeway			
Urban Other Principal Arterial	9,000	12,400	37.5
Urban Minor Arterial	12,700	19,900	56.1
Urban Collector			
Urban Local			
Total	39,500	59,700	51.1

Severely congested= facilities for which peak-hour traffic volumes exceed capacity

* Rounded to nearest 100 for convenience.

B. Capacity Needs to Eliminate Severe Congestion

Increasing congestion cannot be confronted by just one strategy alone, but must be dealt with using a variety of actions. Capacity increases, road pricing, information systems technologies, incident and accident management, traffic operations, signal optimization, and—where justified—better transit service, can all be part of the mix. Options should be carefully evaluated for effectiveness, based on cost per hour of delay saved.

However, the key longer-term strategy is likely to be increased highway capacity. This is because only significant increases in highway capacity, combining added infrastructure and more efficient operation, provide the means of keeping up with projected growth of population and traffic. It will require 104,000 additional lane-miles in our urban areas—about 6.2 percent of the current urban lane–miles—to eliminate severe congestion.

C. The Cost of Dealing with Congestion

In the 403 largest urbanized areas of the United States, about $533 billion in 2005 dollars will be needed over the next 25 years to deal with the most severe congestion.

These costs are $21 billion per year over 25 years. They are about 15 percent of likely government expenditures for highway transportation over the next 25 years. The cost is about 28 percent of what the urbanized areas already plan to spend for their transportation plans. On a per-trip basis, the costs range from as little as 9 cents/trip for smaller cities to about 75 cents/trip for large cities. Some of these funds are already in those plans, since each plan has some congestion-reduction funding in it already.

Severe congestion needs are spread throughout the United States. Although the 10 largest urbanized regions account for about 61 percent of needs, congestion relief is important not just for big cities. All states and all cities have legitimate interests in reducing congestion, because congestion reduces their competitiveness and increases people's costs of daily travel. The cost per hour of delay saved, averaging $2.76, is generally lower in larger regions because traffic and delay is so much higher there. However, even in smaller regions the cost is quite low per hour of delay saved.

If moderate levels of urban congestion are also addressed, another $270.5 billion will be needed. If rural congestion—a growing phenomenon—is also addressed, another $14.2 to $33.9 billion will be needed, depending on what magnitude of congestion is addressed. These findings are summarized in the following table.

Table 28: Summary of Needs and Costs

Region	Severe Congestion	Moderate Congestion	Totals
Urbanized Areas	Lane-Miles 104,220 Cost $533.4 Billion	Lane-Miles 84,070 Cost $270.5 Billion	Lane-Miles 188,290 Cost $803.9 Billion
Rural Areas	Lane-Miles 16,354 Cost $14.2 Billion	Lane-Miles 23,429 Cost $19.7 Billion	Lane-Miles 39,783 Cost $33.9 Billion
Totals	Lane-Miles 120,574 Cost $547.6 Billion	Lane-Miles 107,499 Cost $290.2 Billion	Lane-Miles 228,073 Cost $837.8 Billion

Some might ask, "won't we need another $533 billion for the following 25 years, and so on, and so on? Won't traffic just keep growing?" After more than two decades of delayed investment, we must first deal with the accumulated backlog of under-investment. Making this expenditure now helps the United States maintain competitiveness over the 25-year horizon, but it does not remove the responsibility to make more improvement beyond then. It is likely that additional improvements might be needed in the next quarter century, and no one should think of the 'transportation congestion problem' as solvable with this expenditure. But once we catch up, keeping up should not be as difficult or anywhere near as expensive. As long as we value private mobility and freedom of choice, personal travel will continue to grow, though probably less rapidly in the future. For hundreds of years the United States basically kept up with its mobility needs by improving its transportation systems, and must continue to do so if it is to remain economically healthy.

D. These Costs Are Reasonable Compared to Planned Transportation Spending

It is possible for America to 'build out' of severe congestion, and it is relatively inexpensive to do so. The $533 billion estimate for relieving severe congestion ($21 billion/year) is about one-quarter of the total cost of the 25-year transportation plans we reviewed, and is about 15 percent of the total highway budget over 25 years; it would be a maximum of about 30 percent increase in capital expenditures, if all current capital work were not capacity-increasing. It is about three times what is now being spent annually on 'new starts.' Moreover, at $2.76 per hour of delay saved, the cost is considerably lower than most comparable costs for other transportation improvements.

Looked at another way, on a per-trip basis, the costs range from as little as 9 cents/trip for smaller cities to about 75 cents/trip for large cities. Some of these funds are already in urban areas' long range transportation plans, since each plan has some congestion-reduction funding in it already.

A real concern is whether additional urban highway capacity can be provided, given current environmental constraints and often strong community opposition. The locations for much needed capacity may be in corridors with major right-of-way constraints. While, of course, each project must pass environmental screens, failure to plan or to evaluate the possibility just because a widening is deemed unwanted or expensive is not good practice. Communities are seeing that other options may not be effective and that progress must nevertheless be made if worse congestion is to be avoided. Newer environmentally friendly and so-called 'context-sensitive' designs, and innovative designs for constricted locations, can permit construction.[46]

Options for pricing, in conjunction with new capacity provision, should not be overlooked. In many locations where additional capacity is needed, the options for priced lanes or tolled-HOV combinations may be feasible. Pricing will also help pay for some needed capacity and thus reduce the burden on traditional funding sources. However, for portions of systems that are isolated or arterial in character, location-based pricing may not be feasible. No mileage-based pricing mechanisms are yet available that would permit 'universal' time-of-day pricing, and that might not be permissible, even if it were feasible. In our view, pricing options remain an important part of the demand-supply equation in combination with capacity increases, but will not substitute for the need for additional capacity.

E. The Likely Benefits

The primary benefits of investing in congestion relief will flow to both users and non-users. Specifically:

Benefits to users will be primarily in the form of savings in travel time, with smaller benefits in reduced operating costs and reduced accident costs. The examples for Detroit and Atlanta and the cost per hour of delay saved for each region show that significant savings are likely if projects are targeted at congestion relief, and that these savings are likely to be cost-effective. These real savings put time and money in consumers' pockets and can be reinvested in other goods and services that directly help the economy. Important secondary user benefits include increased reliability of travel times, reduced travel stress, and improved reliability of activity scheduling. Although these benefits have been traditionally more difficult to quantify, they are nevertheless substantial and real.

Other non-user benefits are also substantial. They include significantly increased choices of both labor supply and consumer purchases through greater reach of destinations within travel times. This lowers the cost of goods and services through competition.

Benefits to businesses include reduced delivery costs through reduced travel times for trucking operations, lower operating costs and lower accident rates. Important secondary business user benefits include improved just-in-time delivery, reliability of shipments, smoother supply-chain management, and more regular production operation. These savings in lower logistical costs are often passed on to consumers through competition. In the aggregate they help to maintain America's competitive edge in the global economy and make domestic transportation costs very 'flat' relative to other nations, a significant advantage.

Cities that reduce congestion also benefit substantially, through increased economic competitiveness and lower costs relative to neighbors. In fact, cities that don't improve their access through reduced congestion costs may find their competitive edges slipping away to more favorable locations.[47]

F. Summary

A concerted and focused effort will be required to address the challenge of congestion relief. By enumerating the problem, this report hopes to shed light on its magnitude and costs, but also finds that the problem is tractable. By challenging the transportation community to act, we hope to re-establish the vision of transportation excellence that brought the nation to its present state of transportation quality. We envision that congestion can be significantly reduced and system reliability improved by a combination of new capacity and pricing (particularly on the higher systems), in combination with aggressive actions to improve system efficiency and operations. We look forward to the day when the transportation community proudly replaces the phrase "We can't build our way out of congestion" with the phrase, "We significantly reduced congestion."

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Endnotes

1 David Shrank and Tim Lomax, The 2005 Urban Mobility Report, Texas Transportation Institute, College Station, TX, May 2005. Available at http://mobility.tamu.edu.

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5 US Department of Transportation, *2002 Status of the Nation's Highways, Bridges and Transit: Conditions and Performance*, Washington DC 20590, 2004, p. 7-6.

6 Governor's Business Council, Shaping the Competitive Advantage of Texas Metropolitan Regions: The Role of Transportation, Housing and Aesthetics, Governor's Business Council Transportation Task Force, Austin, TX, Draft October 2005.

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8 Governor's Congestion Mitigation Task Force, Final Report and Recommendations, Atlanta, GA Dec. 6, 2005.

9 Transportation Research Board, Critical Issues in Transportation, National Academy of Sciences, Washington, DC, December 2005.

10 Urbanized areas are used as the 'geography' in the study because they form the basis of formal urban transportation planning, published historical traffic and network data is readily available, and the Texas Transportation Institute uses them for congestion monitoring. Although this data (primarily the HPMS database) has some problems, primarily an expanding geography over time, it is significantly better as a data set than others.

11 *Severe congestion* is defined as that occurring when the peak-hour volume of traffic on a road is greater than the carrying capacity of the road, that is, the volume/capacity ratio is greater than 1.0. *Moderate congestion* is defined as occurring when the peak-hour volume of traffic on a road is between 80 percent and 95 percent of the carrying capacity of the road. These definitions correspond closely to Levels of Service F and E-D, respectively, in the widely used Highway Capacity Manual. See Appendix B for a more complete discussion.

12 Technically, 'gridlock' refers to cases in which connected streets are jammed by traffic.

[13] 85 regions for which congestion data is available from the Texas Transportation Institute, plus Durham, NC, which had been consolidated with Raleigh NC in the TTI reports.

[14] The Highway Performance Monitoring System is a federally-managed data reporting system in which the states annually report conditions and performance of about 116,700 sections of roadway nationwide. The data is used in a wide range of state and national reports and is the basis of many tables in Highway Statistics, FHWA's annual report. HPMS is the only state-to-state consistent report of highway conditions.

[15] A 'vehicle-mile-of-travel' (VMT) is a commonly used measure of travel, defined as one vehicle traveling one mile.

[16] 'Induced travel' represents travel shifted from other modes, time periods, days, and possibly additional land uses increases as a result of the increased access of major road improvements. It is distinguished from 'diverted travel' which is traffic diverted from other routes to faster routes after widening. Both forms of additional travel are accounted for in this study.

[17] Numbers in the text are rounded for convenience. See Appendix C for specific numbers for urbanized areas.

[18] The 'Travel Time Index' is computed from the sample of HPMS road sections in the region. For each section, data is obtained annually on average daily traffic, section length, posted speed, peak hour traffic and roadway characteristics. Based on capacity estimates, operating speeds and running travel times for peak and off peak are then estimated for each section. The overall index is then computed by weighting these travel times by the traffic on each section. The Index can be thought of as how long, relatively, it would take to travel a typical road section in the peak hour versus the off-peak. Other statistics (delay, speed, fuel) are then estimated from this data.

[19] The amount and cost of 'induced travel' is controversial, ranging from estimates near zero to near 100 percent in some studies. Anthony Downs refers to 'triple convergence' to describe diversion to widened roads from other routes, time periods and modes; these are generally handled quite well by current forecasting methods. New traffic caused by regional growth is not handled so well. It is this form of change that most planners mean by 'induced travel'. To be (conservatively) high, we estimated increases of about 15 percent for large regions and smaller amount for smaller regions. See Appendix B for details.

[20] Samuel, Peter, Innovative Highway Design, Report for the Mobility Project, Spring 2006.

[21] If 'year of construction' estimates are used, nominal costs would be higher. We estimate that about $692 billion (in 'year of construction' dollars) would be needed.

[22] USDOT, 2002 Conditions and Performance Report, op. cit.

[23] W. Cox and A. Pisarski, Blueprint 2030: Affordable Mobility and Access for all of Atlanta and Georgia, Report to the Governor's Mitigation Task Force, Atlanta GA, June 21, 2004, p. 6.

[24] Governor's Business Council Transportation Task Force, o. cit., p. vii.

[25] Recent work by FHWA looking at unit costs suggests that the previous numbers used in HERS double-count the individual state adjustments and that overall costs in some categories are substantially higher. Alam M Timothy D and Sissel S., New Capital Cost Table for Investment Economic Analysis, Record 1932, Transportation Research Board, Washington, DC 20590, p. 33-42. And recent cost increases for construction components may have raised costs substantially at least temporarily.

[26] Federal Highway Administration, *Highway Statistics, 2003,* Table HF10, Disbursements for highways, all levels of government, Washington DC 2004.

[27] Traffic planners describe roads by 'functional class' referring to the intended purpose that various roads are intended to serve. For instance, traffic on 'urban interstates' are more likely to be traveling longer distances for commuting between regions or states; and traffic on 'urban principal arterials' would be more likely to be a mixture of land-use-oriented and short-distance intra-urban traffic.

[28] These might be compared with the criteria that the Federal Transit Administration uses in evaluating 'New Starts' projects, currently $21.00 per hour of transportation benefit.

[29] The Road Information Program (www.trip.org) has recently reviewed the extent of 'recreational congestion' and identified some of the nation's worst 'recreational congestion' hotspots.

[30] Lane Council of Governments, *Central Lane Regional Transportation Plan*, Chapters 1, pages 1,4,& 5; Chapter 2, pages 4, December 2004, www.thempo.org

[31] First Coast MPO, 2030 *Long-Range Transportation Plan*, Goals & Objectives, Goal C, pages 1-2, 2004, www.firstcoast2030/com.

[32] OKI Regional Council of Governments, *OKI 2030 Regional Transportation Plan 2004 Update*, Congestion Management Strategies, page 6-8, 2004, www.oki.org

[33] Capital Area MPO, Capital *Area MPO Mobility 2030 Plan*, Comparison of 2025 AMATP & Recommended CAMPO Mobility 2030 Summary Presentation, 2005, www.campotexas.org.

[34] Kern Council of Governments, Long *Range Transportation Plan*, Chapter 2, Transportation Planning Policies, page 6, 2004, available at www.kerncog.org.

[35] Mecklenburg-Union MPO, *2030 Long Range Transportation Plan*, 2005, Chapter 7.0, Financial Plan, page 7-1, www.charmeck.org

[36] Columbia Area Transportation Study, *Long-Range Inter-modal Transportation Plan 2025*, 2003, Chapter 1, page 4.

[37] Capital Area MPO 2030 Long Range Transportation Plan, Raleigh, NC. September 15, 2004. www.campo-nc.us/lrt/2030.

[38] Southeast Michigan Council of Governments, *2030 Regional Transportation Plan for Southeast Michigan*, November 2004, page 13, www.semcop.org

[39] San Antonio & Bexar County MPO, *Mobility 2030 San Antonio Mobility-Bexar County Metropolitan Transportation Plan*, 2004, Chapter 2, page 6.

[40] Congestion Mitigation Task Force, Final Report and Recommendations, GDOT, December 6, 2005.

[41] Governor's Business Council Transportation Task Force, op.cit.

[42] WSDOT Transportation Commission, Urban Areas Congestion Relief Analysis Work Progress Report, Olympia WA: February 2005.

[43] Schrank, David and Tim Lomax. *The 2005 Urban Mobility Report*. College Station, TX: The Texas Transportation Institute, Texas A&M University System, May 2005. Available at: http://mobility.tamu.edu/ums/report/.

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[44] Traditional transportation benefit-cost assessments often value time at about ½ the prevailing wage rate, assuming a mix of trip purposes. Since these are primarily congestion-related benefits, a higher value, $10-12/hour, is more appropriate.

[45] Hartgen, David T., *Highways and Sprawl in North Carolina*, Charlotte, NC: University of North Carolina at Charlotte, 2003. Available at: http://www.johnlocke.org/policy_reports/display_story.html?id=41.

[46] Peter Samuel, *Innovative Roadway Design: Making Highways More Likable,* Reason Foundation, forthcoming, 2006.

[47] Contrary to popular belief, taxes that governments receive from increased economic activity are not a benefit since they represent a transfer of resources from the private sector to the public sector; if left in the private sector they might have been equally or more productive to the economy.

Mobility Project Advisory Board

The Mobility Project Advisory Board provides overall program guidance, suggestions on research, and feedback on studies. It does not necessarily endorse the conclusions of individual studies.









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