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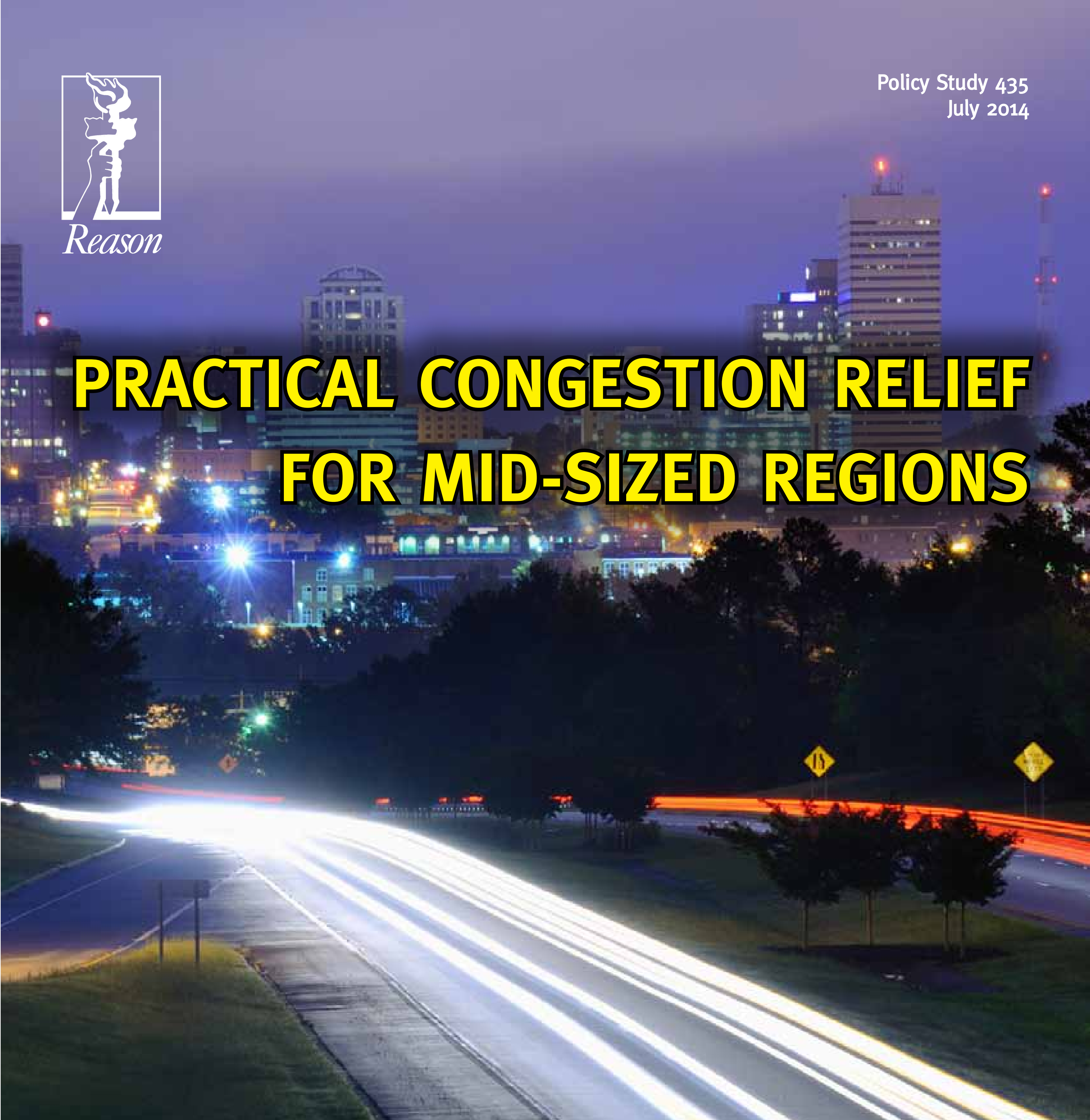

PRACTICAL CONGESTION RELIEF FOR MID-SIZED REGIONS

by David T. Hartgen, Ph.D., P.E. (Maine, Retired),
Elizabeth San Jose, Caleb A. Cox and M. Gregory Fields
Project Director: Baruch Feigenbaum

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Executive Summary

Rising traffic congestion is an increasing irritant in mid-sized regions with urbanized area populations between 200,000 and 1 million persons. Along with jobs, education and crime, traffic congestion regularly ranks as a top priority in local opinion surveys. While congestion is increasing more rapidly in mid-sized regions than in large regions, it is more easily solvable in the former than in the latter.

This report assesses how effectively the transportation plans of 26 mid-sized regions deal with congestion. It reviews traffic forecasts against plans for improvements by quantifying how much congestion relief each plan contains. Then, it determines the potential for congestion relief contained in the plans by reviewing each proposed project for cost and effectiveness. Finally, the report offers practical suggestions for each region.

The study finds that the 26 regions measure congestion differently, making direct comparisons difficult. However, the plans predict, on average, about a 44% increase in population and a 56% increase in traffic over the next several decades. Most of this forecasted growth will be in the suburbs. Worsening congestion is caused more by population growth and limited road capacity than by unnecessary travel. Average commuter delay will double and total regional commuting delay will increase three-fold. Currently, only about 2% of commuters use transit and the mode share is predicted to remain at that level, so even large increases in transit use would have a limited effect on congestion.

On average, the regions plan to spend about $927 million in short range (4+ year) transportation improvements. Of this, transit spending will average about $119 million, or about 13%. The most common major initiatives in the short range plans are Interstate maintenance and arterial resurfacings, but some mid-

sized regions have major transit initiatives. Long range plans will spend about $5.157 B over 20 to 25 years, including approximately 18% on transit. And these costs do not include inflation. The per-commuter expenditure for transit riders is about nine times higher than the per-commuter expenditure for solo drivers in short range plans and 12 times higher in long range plans. Most plans are unbalanced modally and most are fiscally unrealistic, with uncertain or insufficient funding. But even with these expenditures, all 26 regions report that congestion will be *worse* after expenditures. Most plans do not make congestion relief a major goal. Instead, congestion management plans concentrate on congestion *measurement* rather than congestion relief. Few plans report the impact of planned actions on congestion. Regardless of congestion, air quality will improve due largely to fleet turnover; transportation systems improvements will have very little effect.

The plans have the potential to significantly impact congestion, if funds are targeted to congestion-relieving projects. The 26 regions together contain about 4,648 projects that affect congestion, in total costing about $85.4 B, slightly more than half of their budgets. If implemented, these projects would save commuters about 438,000 hours daily compared with doing nothing. Over 90% of the savings comes from new freeways, new arterials and freeway/arterial widenings. But the most cost-effective projects, in terms of cost per hour of time saved, are building one-way street pairs, widening urban arterials and using signal optimization, all of which cost less than $5–6 per hour of time saved. The overall benefits of these congestion-relieving projects, in user savings and regional productivity, are about two times their cost.

Regardless, most plans do not adequately address increases in congestion. Only five of the 26 regions have realistic plans for their projected growth. Only four have plans that sufficiently reduce delay to hold congestion at current levels. Typically, these are slower-growing regions that have fewer than 300,000 persons. Seven other regions, with populations of between 300,000 and 600,000, come close to keeping congestion at current levels; with the recent slowdown in traffic growth, this group may be able to maintain or reduce delay. On the other hand, most regions with more than 600,000 persons probably will not have enough delay reduction in their plans to hold congestion at current levels. They seem to have systemic deficits between the contents of their plans and projected congestion increases, and either do not have enough fiscal resources or are directing them in such as way as to make increased congestion highly likely, in spite of their plans. Finally, a few regions have structurally deficient plans that contain such a distorted view of trends that they are likely to experience sharp increases in congestion.

The report concludes that the rising congestion is *not* inevitable for mid-sized regions and can be rolled back with concerted action. The report provides suggestions for regions, the states and the federal government. Overall, it calls for mid-sized regions to refocus their transportation plans and aggressively address rising congestion before it threatens their economic health.

Note: Most of the data in this report predates the Great Recession of 2008–09 and the ensuing economic slowdown. These events mean that the specifics of the report for individual regions should be updated with recent forecasts and plans. If revised, the report would likely show slower projected growth and possibly lower costs for planned projects, but also fewer fiscal resources. The key "cutoff" region size above which congestion reduction is extremely difficult increases from approximately 600,000 residents to approximately 800,000. As a result, more regions than before—those with fewer than 800,000 residents—can reduce congestion even as traffic grows *if* they act aggressively to implement cost-effective projects in a timely fashion.

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Abbreviations

The following abbreviations, which are commonly used in transportation planning literature, appear in this report:

AADT, ADT	Average daily traffic
AASHTO	American Association of State Highway/Transportation Officials
AC	American Community (Survey)
AHUA	American Highway Users Alliance
AQ	Air quality
Art	Arterial
Avg	Average
B, b	Billion
CC, cc	Central county
Empl	Employment, employee
FF, ff	Free-flow (speed)
Frwy, fry	Freeway
FHWA	Federal Highway Administration
HR	Heavy Rail
ITS	Intelligent Transportation System
K, k	Thousand
LM	Lane-mile
LMC	Lane-miles of capacity
LRP	Long Range (Transportation) Plan
LOS	Level of service (a measure of traffic flow and capacity)
M, m	Million
MPO	Metropolitan Planning Organization
Pop	Population
Rur	Rural
TTI	Travel Time Index
TIP	Transportation Improvement Program
Urb	Urban
USDOT	US Department of Transportation
VMT	Vehicle-miles of travel
V/C	Volume/capacity ratio

Part 1

Issues and Approach

Traffic congestion is recognized as a significant and growing problem in U.S. metropolitan areas; numerous studies have highlighted its adverse impacts. The Texas Transportation Institute's most recent review of congestion estimated that congestion costs Americans over $100 B annually in lost time, unreliability and wasted fuel.[1] And Reason Foundation recently estimated the *business costs* of congestion at $80 B annually.[2] In response to these and other studies, USDOT has developed a "congestion initiative" with a focus on urban demonstrations and inter-regional corridors.[3] Recent federal guidance requires urban areas with 200,000 people or more to prepare congestion management plans and update them at least every four years, although many states update their plans every two years.[4] As a result, many states and localities highlight congestion mitigation in their transportation plans. Even though the Great Recession (2008–09) reduced national traffic volumes, growth has returned and national VMT is back to pre-recession levels. This means that traffic congestion is likely to remain a public concern.

Despite these initiatives, surprisingly little attention is focused on *relieving* congestion. The recent USDOT Report to Congress indicates that congestion has moderated since 2001, and pays less attention to it than prior reports.[5] Most cities also seem to have taken a hands-off view, asserting that "we can't do anything about it" or "the roads will just fill up anyhow, so why try?" This has resulted in less attention nationally, guaranteeing the predicted outcome. In a recent review of the readiness of 22 large urban regions to deal with infrastructure needs, the authors found that large regions were unprepared to deal with expected growth, and that virtually all were predicting significant *increases* in congestion in spite of spending billions of dollars on transportation improvements.[6] The problem is that most transportation plans spend resources on projects that do not reduce congestion.

This view (that congestion increases are inevitable) is unfortunate since the problem is mostly solvable in smaller and mid-sized urbanized areas. These regions are generally less dense than larger regions, are growing less rapidly, are more auto-oriented, have fewer transit needs, have fewer instances of severe congestion and may have fewer claims on scarce transportation dollars. A recent study of 17 North Carolina cities ranging from 50,000 to 800,000 people found that in smaller regions with fewer than 300,000 persons, transportation plans had sufficient focus to keep congestion at approximately current levels.[7] However, in three larger North Carolina regions plans as structured did not have sufficient focus to stem congestion growth. The North Carolina study found that what is needed is more focus on the problem, particularly in mid-sized and smaller regions.

Many recent studies have been conducted to assess congestion impacts. A 2006 study by the American Automobile Association recently found that 64% of respondents felt that congestion had significantly worsened.[8] The Hartgen Group estimated that congestion would double in all regions over the next 25 years but more than double in smaller regions.[9] Congestion is increasing more rapidly in medium-sized and smaller regions, even though they have lower absolute congestion levels. About $533 B would be needed to relieve severe congestion nationwide, but only about $120 B of that is needed for the 350 urbanized areas under one million in population. This study also found that in the 50 transportation plans reviewed, over half of the funds were slated for transit improvements, and just 43% for highways. In another study of the business impacts of congestion, the Hartgen Group found that about 34% of businesses thought traffic congestion was a moderate or significant problem in their business activities; the cost of congestion to businesses was about $70 B annually, about the same as commuting costs.[10] FHWA has also studied the issue and identified major freight bottlenecks.[11] Although growth rates have slowed since the Recession, population increases and continuing reliance on auto mobility mean that more, not less, traffic congestion is likely in the future.

There have been many studies of potential solutions. The American Highway Users Alliance (AHUA) has issued several studies including one that focused on bottlenecks that found fixing a major bottleneck reduces rush hour delays by 74%.[12] Another AHUA study focusing on congestion from summer recreational traffic found that traffic congestion is increasing faster on rural roads, which shoulder much more of the summer vacation travel than urban roads.[13] AASHTO has developed a series of recommendations for congestion relief focusing on maximizing use of traffic pricing and management.[14] There is no shortage of information regarding the problem, or warnings of its increasing magnitude.

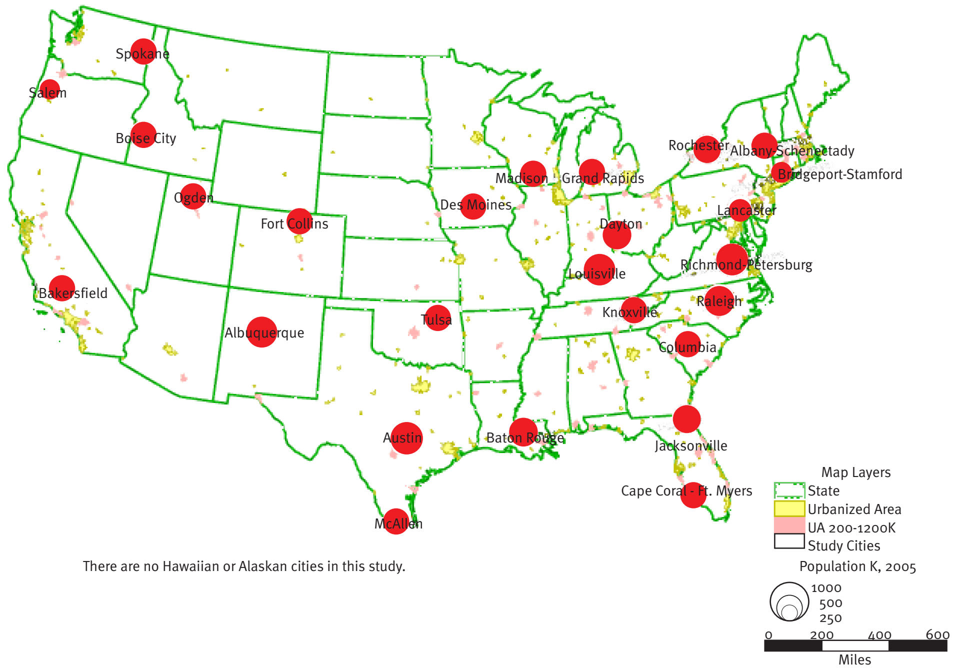
However there are far fewer studies that detail congestion reduction in smaller or medium-sized regions. Most studies focus on the largest regions, where congestion is more severe. It is more challenging to address congestion in larger regions because of higher construction costs and more projects competing for limited funding. In mid-sized regions with populations between 200,000 and one million, congestion is typically less severe, solutions are more straightforward and there is less competition for scarce funds.

A national assessment of how mid-sized cities can deal with rising congestion can encourage elected officials to focus on the issue. The goals of this study are to:

- Evaluate the transportation plans of selected mid-sized regions with regard to congestion relief;
- Determine how close regions will come to relieving congestion with their current plans;
- Identify other specific actions needed to relieve congestion, and
- Suggest specific actions for the selected regions.

To undertake this study, 109 urbanized areas with 2005 urbanized area populations between 200,000 and 1.2 million were identified. Data on each region (traffic, congestion indices, transit use, wealth and voting) were then evaluated to identify 26 urbanized areas for detailed study. Figure 1 indicates the selected regions.

Figure 1: Selected Urbanized Areas 200,000 to 1.2 million Population



The following table summarizes key population, traffic and congestion statistics for the selected regions. Regions are listed in order of urban area population size, as reported in the long range plan of each region. "Mid-sized regions" are defined as regions with between 200,000 and 1.2 million people. The largest region studied was Austin (1.2 million); the smallest was Salem, Oregon (203,000).

Table 1: Population and Traffic, Selected Mid-Sized Regions*

Region (in size order)	200(5) Population, (in thousands)	200(5) Daily VMT, Millions	200(5) Travel Time Index Congestion Index	2030 Population, (in thousands)	Population Percent Increase	2030 Travel Time Index Congestion Index
Austin TX	1,160	5.839	1.31	2,750	137.1	1.56
Louisville KY	947	5.729	1.23	1,132	19.5	1.36
Richmond VA	827	6.389	1.09	1,149	38.9	1.15
Dayton OH	822	5.759	1.10	800	-2.7	1.15
Raleigh NC	728	6.062	1.18	1,421	95.0	1.33
Bakersfield CA	694	4.019	1.07	1,099	58.3	1.14
Albuquerque NM	692	5.190	1.17	955	38.0	1.30
Rochester NY	665	5.465	1.07	1,250	11.0	1.13
Jacksonville FL	644	5.061	1.21	1,050	63.0	1.38
McAllen TX	627	4.571	1.06	998	59.2	1.11
Baton Rouge LA	611	4.210	1.06	794	29.9	1.11
Knoxville TN	598	4.432	1.06	895	49.7	1.11
Boise ID	554	5.814	1.06	978	76.5	1.11
Tulsa OK	551	6.285	1.09	866	57.2	1.16
Grand Rapids MI	544	6.528	1.10	924	42.5	1.19
Ft Myers FL	530	5.541	1.12	852	60.7	1.18
Albany-Schenectady-Troy NY	511	4.165	1.08	558	9.2	1.15
Ft Collins CO	500	5.578	1.06	865	73.0	1.11
Columbia SC	497	5.147	1.07	658	32.4	1.13
Ogden UT	482	5.262	1.06	677	40.5	1.11
Lancaster PA	471	4.787	1.06	586	24.4	1.11
Des Moines IA	456	6.485	1.06	751	64.7	1.11
Spokane WA	442	5.593	1.04	564	27.6	1.07

Table 1: Population and Traffic, Selected Mid-Sized Regions*

Region (in size order)	200(5) Population, (in thousands)	200(5) Daily VMT, Millions	200(5) Travel Time Index Congestion Index	2030 Population, (in thousands)	Population Percent Increase	2030 Travel Time Index Congestion Index
Madison WI	427	5.989	1.06	580	35.8	1.11
Bridgeport CT	309	4.770	1.22	329	6.5	1.39
Salem OR	203	4.440	1.09	300	47.7	1.17
Total	15,492	139.110		23,781	53.5	

*A few regions have base years other than 2005, and forecast years beyond, where plans used other years.

Total congestion in each of the 26 selected regions was determined by following the next five steps:

- First, commuting data from the 2005 American Community Survey (modal shares, commuter totals, commuting times) were consolidated with other information from the Federal Highway Administration (region size, density, and traffic volumes by functional class and Travel Time Indices).[15] This provided a demographic and traffic profile for each region.
- Next, we obtained the key transportation planning documents (e.g., short range plans, long range plans, air quality plans and congestion management plans) from websites for all 26 regions.[16] From these documents we extracted selected data into spreadsheets describing individual projects. We also extracted information about the Transportation Improvement Program (TIP) and Long Range Plan (LRP) projects contained in these plans. The review identified 9,983 individual projects across all 26 regions, of which 4,648 would probably affect congestion.
- We then estimated the *savings in congestion delay* from each project, using changes in speed and improvements in traffic delay, and summed this for each region.
- Finally, we estimated the *increase in congestion delay* caused by regional growth. This amount is then compared with the savings in delay from the projects, to see how each region's plan can reduce that increase.
- We used these comparisons to develop specific recommendations for further reducing congestion, if needed, for each region.

A more detailed description of these procedures can be found in the Appendices.

As noted above, this method uses base year data for 2005–06, the latest available when the study was conducted, and transportation plans from the period 2003–06. Since most of these plans have since been updated and more current base year data are now available, the findings of the study should be considered as examples of the estimates of the congestion reduction that might be achieved. Regions should therefore use the most current TIPs and long range plans in revising their congestion reduction estimates.

Part 2

Findings

A. Overview

Most regions are experiencing increasing traffic congestion and are expected to continue to do so. (After a three-year lull, from 2007–2010, traffic congestion is once again increasing and in 2013 has reached pre-Recession levels.) There are many projects competing for funding; planning requirements encourage expenditures for projects serving numerous objectives other than congestion relief. Driven by competing priorities, many cities and states are focusing on other objectives and de-emphasizing congestion relief. Most long range transportation plans propose large expenditures, but predict *worse* congestion *after* the expenditures. Therefore, additional actions (changes in priorities, more money, more-effective projects) will be needed if congestion is to be held constant or reduced below current levels.

The following three schematic figures show the nature of congestion growth. Figure 2 shows the "worsening congestion" scenario, in which a region's plan cannot reverse congestion back to the 2005 level. Even the implementation of additional actions cannot achieve this.

Figure 2: A Worsening Congestion Problem

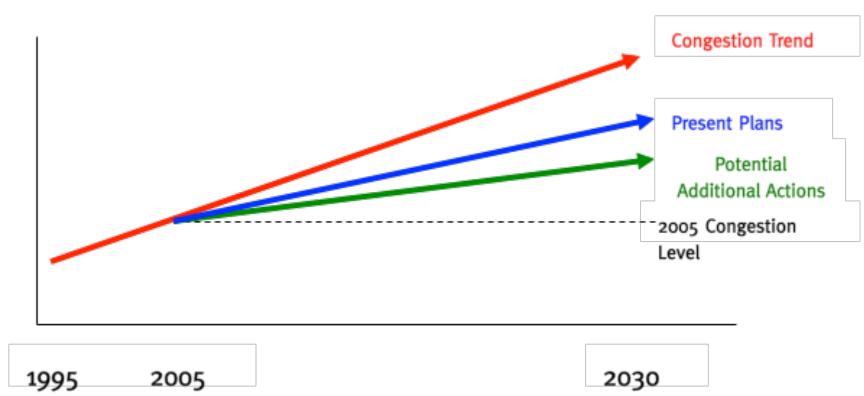


Figure 3 shows the "moderate congestion" scenario, in which a region's current plan alone will not reverse congestion back to the 2005 level, *but* with the implementation of additional potential actions the modified plan can achieve this.

Figure 3: A Moderate Congestion Problem

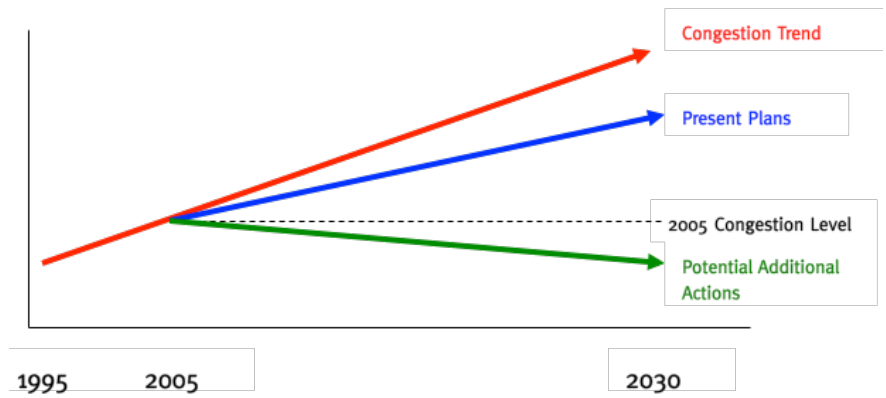
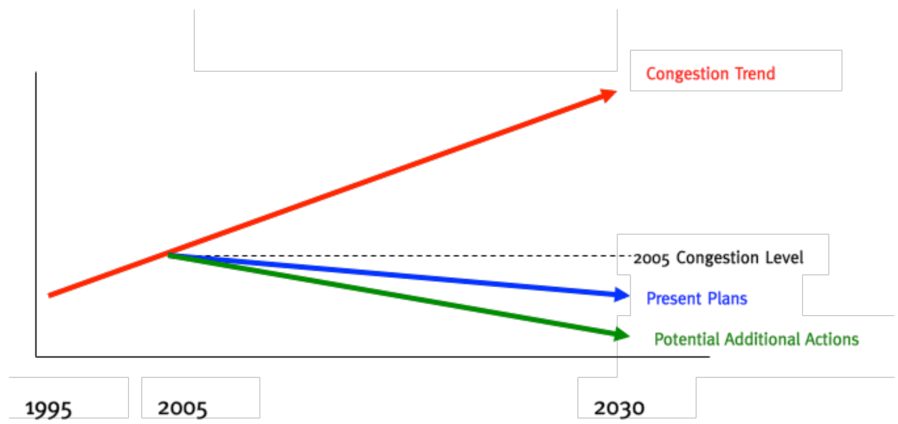


Figure 4 shows an "improving congestion" scenario, in which a region's plan will bring the congestion levels below the 2005 levels, and with the implementation of additional potential actions can reduce congestion to well below 2005 level.

Figure 4: An Improving Congestion Problem

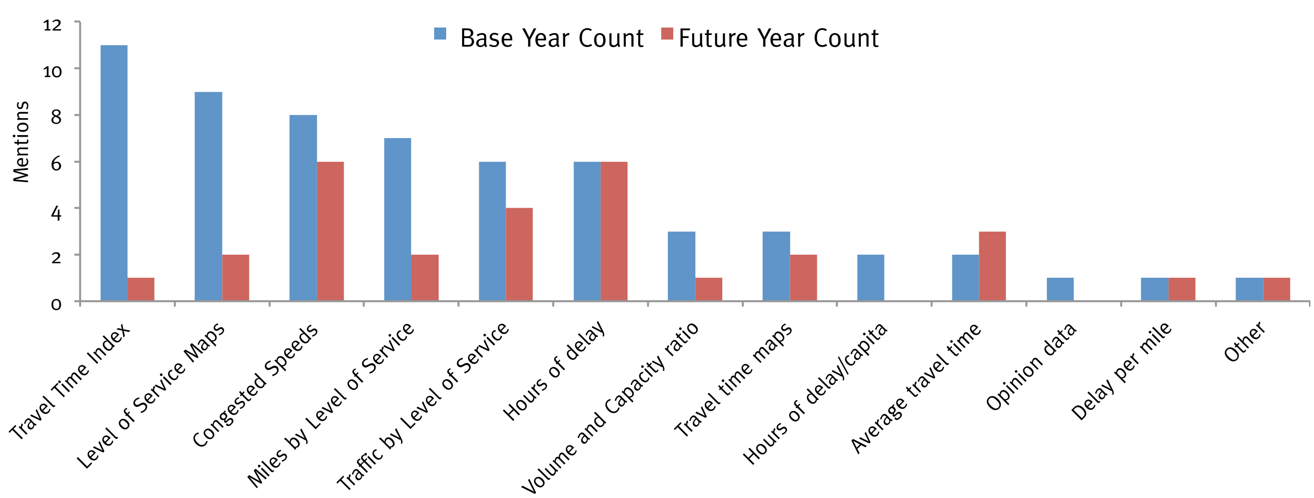


This study finds that some slow-growing regions may actually have enough congestion reduction elements in their current plans to reduce congestion *below current levels*. Examples include Dayton, Ohio; Des Moines, Iowa; McAllen, Texas and Ogden, Utah. On the other hand, some quick-growing regions may not be able to hold congestion to current levels even with major actions. Examples include Albuquerque, New Mexico; Austin, Texas; Bakersfield, California; Jacksonville, Florida; Louisville, Kentucky; Raleigh, North Carolina and Richmond, Virginia.

B. How is Congestion Measured?

The 26 regions in our study use different methods to measure congestion. Figure 5 summarizes the reported measures. There were 13 different methods being used to measure traffic congestion in the 26 different regions and most regions used more than one method. The most commonly used measure for current congestion is the Travel Time Index or similar measure, followed by maps showing roads at various congestion levels such as "volume/capacity ratios" or "level of service." "Congested speeds" and "miles by level of service" were each used by at least seven mid-sized regions. The major approaches are described in Appendix 1. A newer method, using cell-phone-based travel time delays, is also in practice but was not mentioned. This method is not available for smaller regions.

Figure 5: Measures of Congestion Reported by Mid-Sized Urbanized Areas



Forecasts of congestion are more limited in scope. For forecasts, the most commonly used measures are congested speeds, VMT by level of service and hours of delay. These measures are typically part of the traffic forecasting models used by the regions to evaluate projects and air quality. Forecasts of congestion indices (TTI) or maps of congestion are not typically used, although congestion maps would be easily available from traffic assignment models. If these measures were more widely used, then we would not need *approximations* of congestion impacts from new projects, as used in this study.

C. Congestion Trends

The regions vary widely in measures of congestion. Only one comparison measure is widely available for regions, is tracked over time and is computed in a consistent fashion: the Travel Time Index (TTI).[17]

Figure 6 shows comparative TTI statistics for our 26 regions, by size. Overall, the 26 regions have a 2005 average TTI of 1.11, meaning that, on average, travel times in the peak hours take about 11% longer than in the off-peak.[18] Generally, the larger regions tend to have more severe congestion than the smaller regions. Over the next 25 years, congestion is predicted to increase for all regions.[19] By 2030 peak-hour travelers will take 19% longer to reach their destination than in the off-peak. Congestion (delay) will almost double, on average. Austin is predicted to have the greatest increase in average delay, from 31% of peak travel time to 56% of peak travel time. Bridgeport and Jacksonville show about the same increase from 22% to 39% and 21% to 38%, respectively. These forecasts might be a bit lower now if updated with current, slower growth rates.

Figure: 6: Travel Time Indices, 1995–2030

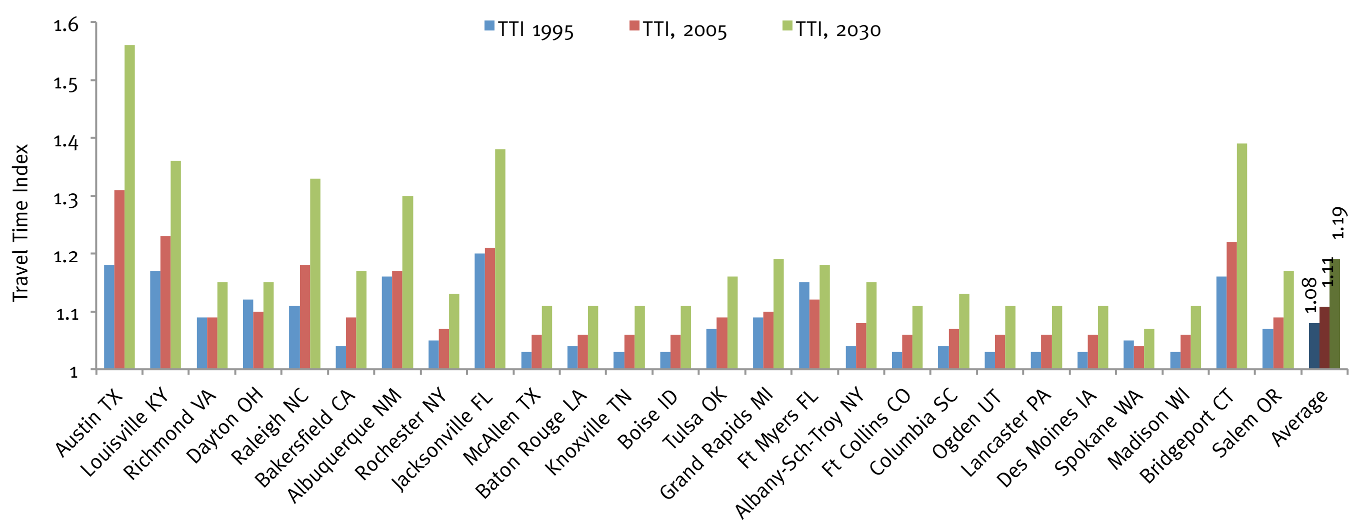


Table 2 provides more detail on the specific measures and forecasts used by various regions, as reported in their 2003-2006 Long Range Plans. *Congestion is predicted to worsen in almost every region, despite completion of its transportation plan.* Of the 26 regions we studied, 24 predict somewhat worse or significantly worse congestion in the future. Only two predict improvements, and these seem modest. Dayton, a slower-growing region, predicts a slight improvement in the percent of VMT congested, but a significant worsening of delay. Tulsa, with moderate growth, asserts that its plans will allow it to actually improve peak speeds slightly.

All other regions predict worsening conditions, often significantly so. Albany, Albuquerque, Austin, Bakersfield, Jacksonville, Knoxville and Ogden all predict nearly a doubling of delays. Albany, Austin and Jacksonville predict significant drops in peak hour speeds. Albuquerque, Austin, Boise, Fort Collins, Jacksonville, Knoxville, Raleigh and Salem all predict a large increase in the percent of their road systems or VMT congested. Even though the measures used in different regions are not entirely compatible and local circumstances vary, the overall pattern is clear: *almost all mid-sized regions predict that congestion is likely to increase sharply in the next several decades, even with planned expenditures*. If updated, these forecasts may have congestion increasing more slowly, but these regions will still have major congestion in the future.

Table 2: Congestion Forecasts* by MPOs

Urbanized Area *(in order by size)*	Congestion Measure	Base Year (2005)	Future Year (2030)*
1. Austin TX	Percent roads with congestion. Hours of delay per day. Travel time index Average speed.	10% 58,600 1.22 36.1	23% (+130%) 419,600 (+617.81%) 1.32 (+8.2%) 31.2 (-13.57%)
2. Louisville KY	Maps of major roads by LOS. Travel time index.	Yes 1.23	None shown, but text has maps of congestion by LOS.
3. Richmond VA	Percent of roads congested. Travel time index. Annual hours of delay/capita. Average congested speed.	59 1.10 10 36.84	 35.54 (-3.66%)
4. Dayton OH	% VMT at LOS E-F. Hours of delay per day. VMT at level of service D-F.	1.6 %. 3,580 4.5%	1.4 % Without Plan: 6290 + 76% Plan: 4484 + 25%. 4.5%, (6.5% without Plan)
5. Raleigh NC	Percent congested VMT.	12.1%	26.3% (+117%)
6. Bakersfield CA	Average travel time. Hours of delay. Average hours of congestion. Maps of congested roads. Reverse commuting to LA.	16.15 min (1998). 63,696 hrs. 32,309 hrs. Yes Yes	(No Build): 18.14 min. with Long range plan: 17.44 min (+8%). 169,696 hrs (+166%) 278,714 hrs (+765%)
7. Albuquerque NM	Daily vehicle-miles traveled/capita. Total pm vehicle-miles traveled, thousands. VMT pm congested. Percent pm vehicle-miles traveled congested. Lane-miles congested, peak. Travel times between key points.	22.2 1,439 61,773 4.3%	 167,896 (9%; up 7.4% fr 04) 248 (2030) "Increase 99% by 2030"
8. Rochester NY	Map of roads congested. Network average speeds by road class.	Maps show roads>0.9 V/C Yes	Roads congested if no-build
9. Jacksonville FL	Hours of delay. Percent system at level of service F. Congested speed.	476,000 15.24 28.03	961,000 (+101.9%) 21.37 (+40.2%) 25.39 (-9.4%)
10. McAllen TX	Travel time index. Routes by level of service.	1.06 Routes by level of service	1.11 no build, 1.06 build Future roads by level of service
11. Baton Rouge	None stated		
12. Knoxville TN	Vehicle miles traveled at level of service D. Hours of delay.	400,000 1.5% 65,096 (7%)	2,078,000 5.2% 159,441
13. Boise ID	Travel time index. Roads by Sanderson Index.	1.06 5% high congestion	TTI 1.11 est 23% high congestion (50% without Plan)
14. Tulsa OK	Percent vehicle-miles traveled congested. Average speed.	30% congested 36.8	 Speed 37.5, with Plan
15. Grand Rapids MI	Average speeds by road class. Congested corridors.	Rural Interstate 56.2, Rural primary 34.9, Urban Interstate 53.9, Urban primary 30.4. Also a list of congested corridors	Rural Interstate 53.3, Rural primary 33.3, Urban Interstate 48.6, Urban primary 29.9
16. Ft Myers FL	Travel time index. Daily hours of delay. Percent of lane-miles congested. Hours of delay, annual. Daily percent VMT by level of service.	1.18 2,712,000 50% (Cape Coral) 9.5 m hours of delay annually. Not reported.	Not Reported
17. Albany-Schenectady-Troy NY	Average Speed Travel times between key points Hours excess delay	26 peak, 32 off peak 36.4 minutes 6,605 hours/day	20 peak, 23 off peak 47.5 minutes 10,878 hours/day
18. Ft Collins CO	Percent Arterials level of service E-F	4%	12% 'Build", 14% Null
19. Columbia SC	Project sections by volume/capacity ratio.	Yes	Projects by volume/capacity, (existing and committed roads) (no "plan' congestion reported)
20. Ogden UT	Annual delay/capita.	8.5 hours	With long range plan 14.5 hours (71% increase)
21. Lancaster PA	Intersections/roads by level of service	Yes	Not Reported
22. Des Moines IA	Travel times	Yes	Not Reported

Table 2: Congestion Forecasts* by MPOs

Urbanized Area *(in order by size)*	Congestion Measure	Base Year (2005)	Future Year (2030)*
	Traffic volumes	Yes	
23. Spokane WA	Map of roads by level of service	Map of roads and intersections Volume/capacity › 0.75	2030 Build and Null Maps with roads and intersections by level of service
24. Madison WI	Miles of road by level of service D-F.	95 at LOS D, 30 at LOS E-F	Not Reported
25. Bridgeport CT	Miles congested, Level of service map	Yes	Yes
26. Salem OR	Miles of arterials congested	7.58, (3.5%)	60.5, a 9-fold increase

*(Compared to base year: Better, Marginally Worse, Significantly Worse)

The regions' findings generally agree with the independent forecasts that congestion will worsen substantially even with transportation plan expenditures.

D. Causes of Congestion

Congestion consists of both recurrent and non-recurrent elements. Non-recurrent congestion results from many causes and includes mostly unpredictable events (breakdowns and crashes), partially predictable events (weather) and very predictable events (construction work zones).[20] Recurrent congestion is the rush hour overloading of the roadways. The fundamental cause is a mismatch between supply and demand.

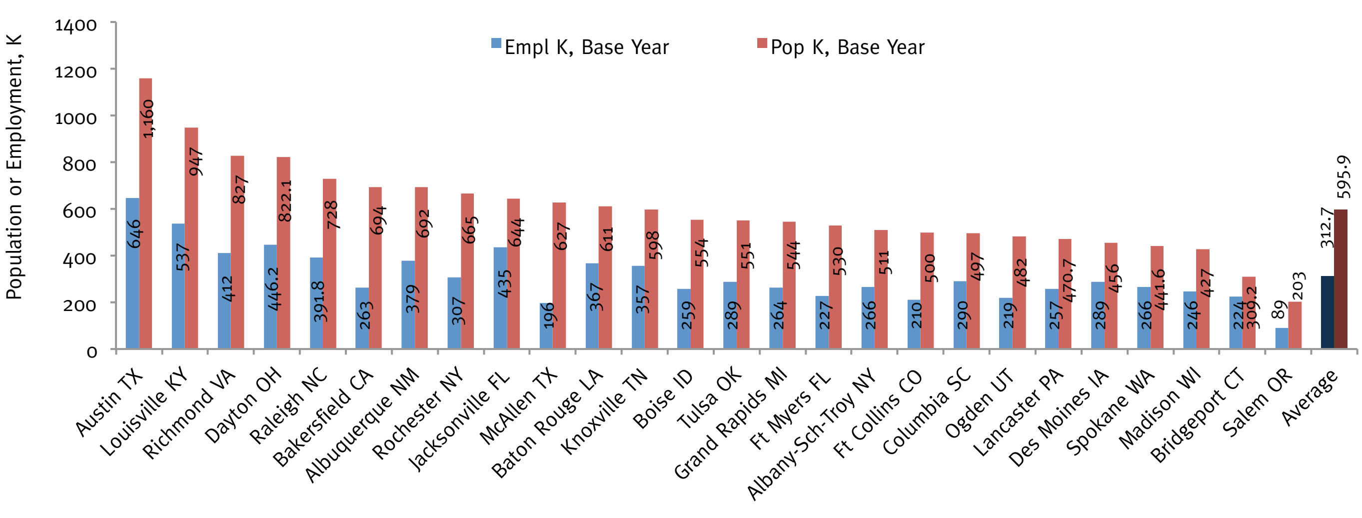
The primary factors affecting congestion in most regions are: traffic volume versus capacity "bottlenecks" (about 40%), incidents/accidents (about 25%), weather (15%), construction (10%), poor signal timing (5%) and other non-recurring incidents (5%).[21]

"Induced demand" is often cited as one cause of traffic congestion.[22] Induced demand is the theory that after a highway is widened, additional vehicles will use the highway, thus highway improvements "induce" or encourage further travel. While induced demand has been found to exist in a few large metro areas, it generally represents a small part of traffic growth and is often exaggerated. *The primary cause of increasing congestion is the growth of regions relative to limited roadway capacity.*

1. Growth

In order to document regional growth, we examine the base year population and employment for the 26 regions; these data are shown in Figure 7. The average population for our urbanized areas is 595,000 residents. Austin is the largest region of the 26 studied, with 1.16 M residents; Salem is the smallest with 203,000 residents. On average 48% of residents are employed (the rest are in school, retired or unemployed); Jacksonville has the highest percentage at 69%, and McAllen has the lowest at 32% of the population.

Figure 7: Base Year Population and Employment



Over the next 25 years, these regions predict an average 44% increase in population and 56% increase in VMT as shown in Figure 8.[23] Dayton is the only region that actually predicts *negative* growth in population, but even Dayton predicts an increase in VMT. Southwestern regions generally predict larger population increases, attributed to their favorable geographic location. Recently the South has been the fastest growing region of the United States; 70 of the 100 fastest growing counties are in the South.[24] Northeast regions such as Rochester and Albany have static economies and are growing more slowly. Of the 26 regions, Dayton forecasts the slowest growth, -2.7%, and Austin the most rapid, 138%.

VMT growth is predicted to be higher than population growth in most regions, but the difference is slowing. In the past VMT grew two to three times faster than the population, due to increasing connectivity, rising wealth and rising private mobility. But since 2000, VMT growth rates have slowed to 1.2–1.5 times faster than the population as these factors have become less significant.[25] Many of these MPOs' forecasts were made before the Recession and did not consider gas price increases or the economy slowing. These factors suggest that growth is somewhat overstated for most regions; while VMT is growing, the actual future rate is likely to be significantly lower than the 1970–2000 rate.

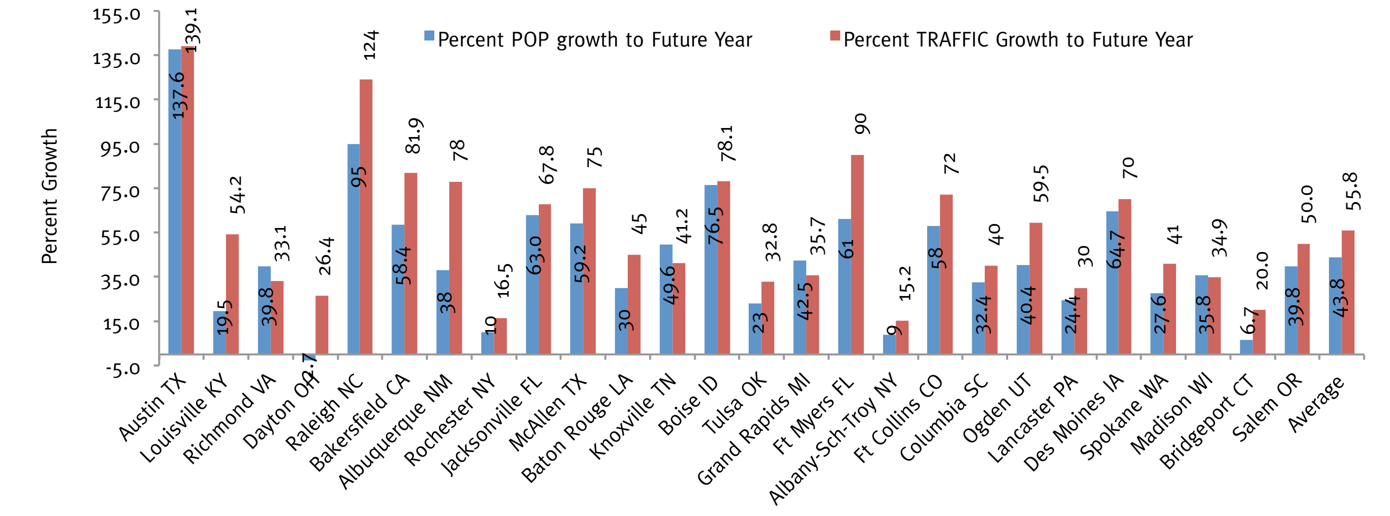


Figure 8: VMT and Population Growth

An additional important consideration is *where* growth is expected to occur *within* each region. Of the 26 regions we reviewed, 17 considered the location of geographic growth, and of those, seven predicted that the most growth would be in the suburban areas. This implies generally lower density and increased suburbanization of population and jobs, more travel at the edges of regions, declining importance of the Central Business District (CBD) and weakened justification for rail transit service, which might be better served by improved bus service.

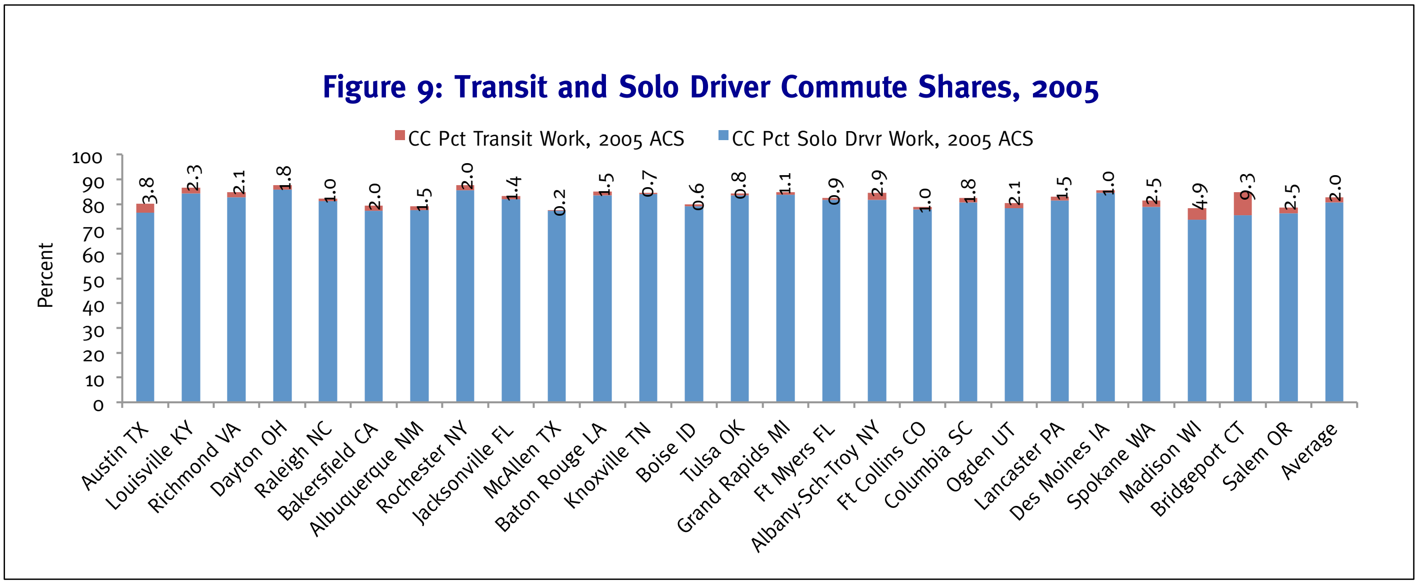
Table 3: Regions' Comments on Growth Location

Geographic Location of Growth	Mentions
Do Not Mention	9
Mostly Suburban	7
Mostly Central City	4
County Central	4
Balanced between Central City and Suburbs	2
Total	26

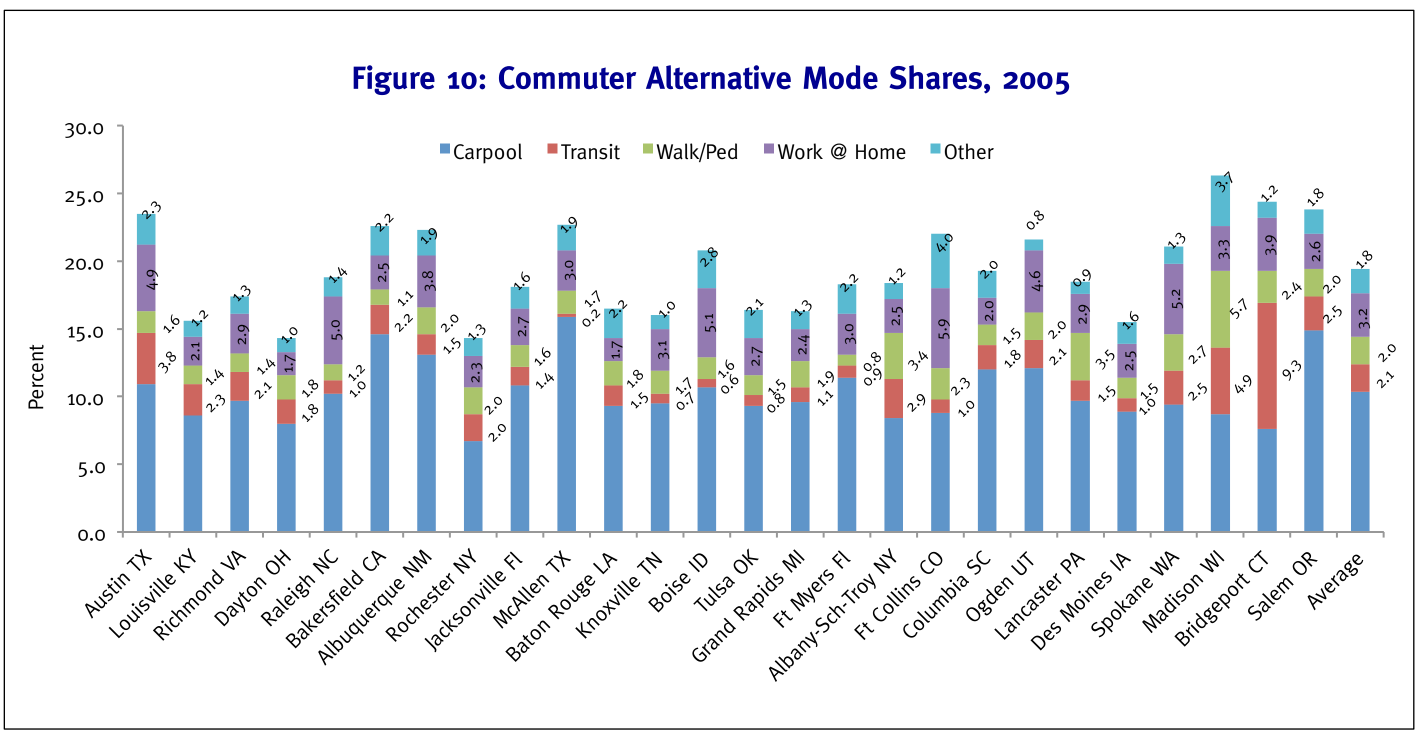
2. Increasing Private Vehicle Use for Commuting

Solo auto driving is the most common mode of commuting in all 26 mid-sized regions. Of the 26 mid-sized regions we reviewed, all show that the greatest portion of workforce commuting is the solo driver. On average, solo drivers are about 80.8% of the commuting workforce. About 92% of commuters either drive alone or carpool to work, whereas the transit portion averages about 2.0% as shown in Figure 9. National studies document a slight decline in private vehicle mode shares since 1995[26] but not enough to affect congestion.

Several regions have considerably higher transit use, due to local circumstances. Bridgeport, Connecticut has a considerably higher transit commuting percentage, 9.3%, because the New Haven Rail Road (NHRR) serves commuters to New York City. Madison also has a higher transit share of commuters (4.9%), possibly because of the high student population. Austin has 3.8%. College towns often have higher transit mode proportions, and often higher percentages of walk-to-work, telecommuting and bike, than other regions. On the other hand, transit shares tend to be lower in smaller non-college regions: McAllen has only 0.2% of commuters using transit.



Modes other than drive alone total about 19% of overall commuting and are displayed below in Figure 10. Approximately 10% use carpool, 2% use transit, 2% walk, 3% work at home and 2% use other means. Work-at-home (telecommuting) shares have increased substantially in the last decade.



3. Inadequate Capacity Expansion

One key reason for increasing congestion is that the road system of most regions has not been expanded commensurate with traffic growth. As a result, average traffic density (traffic per lane-mile of road) has increased over time, filling excess capacity. Total U.S. road-miles have increased about 3% and Interstate-miles about 13% between 1980 and 2007, yet traffic (vehicle-miles) grew about 110%.[27]

4. Other Factors

There are several other factors that affect congestion. First, growth in commercial traffic has been higher than that of household travel. While both are increasing, commercial traffic is expected to grow more rapidly as household has slowed.[28] Second, lower density suburban growth may have increased average trip lengths. Third, the increasing length of peak hours, increasing "trip chains" and increasing weekend traffic all affect weekday peak-hour congestion. Fourth, weekend traffic often produces congestion around major shopping areas in smaller regions; weekend traffic varies from weekday traffic in that it has higher family-carpool rates and lower transit/walk/bike mode shares. While important, these considerations are beyond the scope of this study.

E. Transportation Plans

Having reviewed briefly the congestion statistics for our 26 regions, we turn to a review of the regions' plans for addressing congestion.

The major transportation plans are:

- **Transportation Improvement Programs (TIPs):** short-term (four+ years) lists of projects approved locally, which the region intends to build over the near horizon. Federal law requires that projects using federal funds be on the TIP; in practice, many regions use the TIP as a running list of all projects, regardless of funding source.
- **Long Range Plans (LRPs):** By contrast, regional metropolitan transportation plans ("long range plans," or LRPs) are intended to provide a vision and an implementation process for the region's transportation needs over a 20+ year horizon. They are required to contain a variety of elements and must be fiscally constrained using projected funding typically from the end of the TIP to the 20+ year planning horizon. Increasingly, these plans are being extended to cover 25–30 years, rather than 20 years.[29]

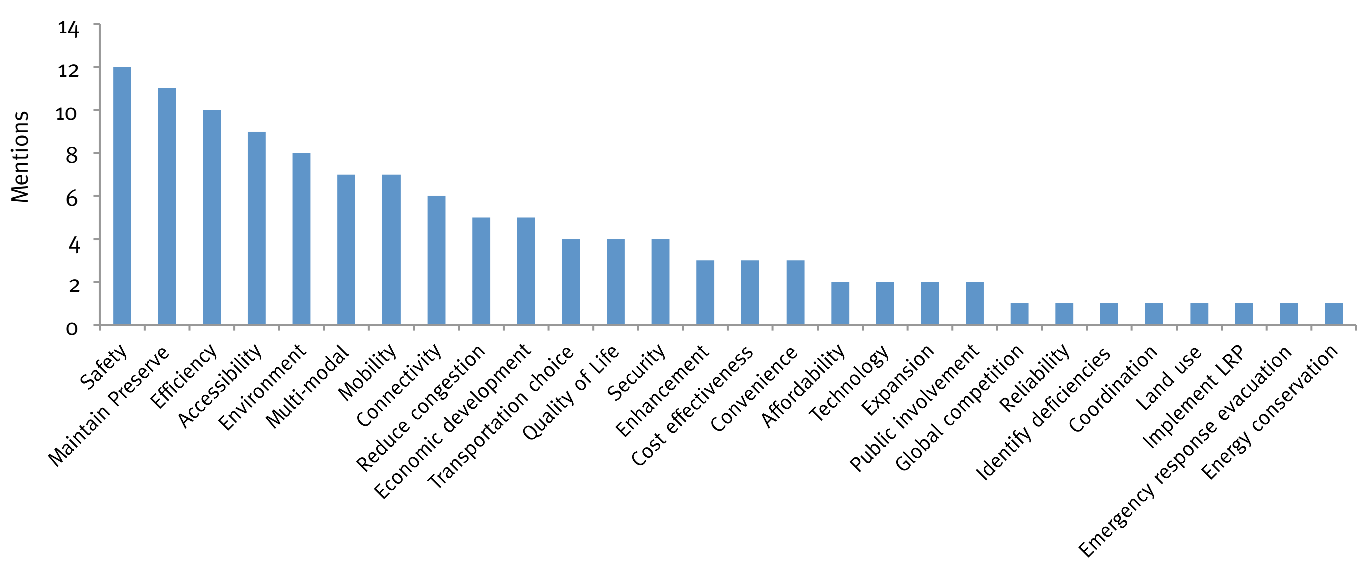
1. Vision and Goals

One of the most important elements of the LRP is its statement of vision, or direction, for the region's transportation system, and specific goals that the plan is intended to meet or move toward. Our review indicates that there is a wide variation in how mid-sized regions perceive their transportation systems and what they expect from them. In reviewing the three most popular LRP goals for these regions, the highest responses (33 total mentions) focused on 1) safety, 2) maintenance and preservation of existing roads and 3) efficiency. *Surprisingly, reducing congestion and encouraging economic growth were ranked 9th and 10th overall.* (Figure 11) *Clearly, most mid-sized regions do not consider congestion reduction a significant issue.* These plans were all prepared before the recent downturn in the U.S. economy or the election of President Obama, and so results for more recent plans might be different; regardless, a 9th and 10th place rating for congestion and economic growth seems remarkable.

It is important to note that some of these other goals relate indirectly to congestion. System efficiency, or using the least input to get the greatest outputs, is related to reducing congestion as more efficient systems can handle more traffic at a lower cost. Reducing congestion and decreasing travel times would greatly increase mobility. Connectivity, cost effectiveness, expansion and reliability are also strongly related to congestion. Combined efficiency, mobility and reducing congestion received 22 mentions.

As congestion is often the cause of reduced efficiency and mobility, leaders may prioritize reducing congestion but in different words. Politicians may identify the problem as efficiency even if congestion is the underlying cause. It is important that transportation decision-makers understand how the entire transportation network functions.

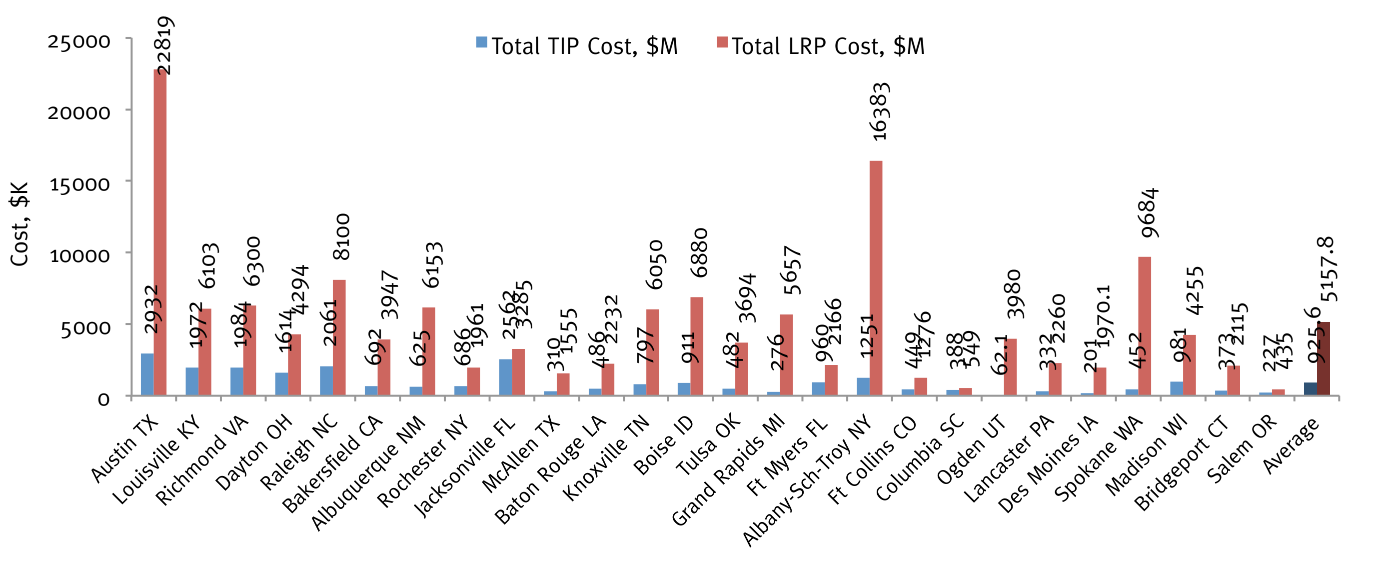
Figure 11: Long Range Plan Goals, 26 Mid-Sized Regions



2. Plan Costs

On average, the 26 mid-sized regions plan to spend $926.5 M in their TIPs, versus about $5.158 B in their Long Range Plans (LRPs), with dollar amounts declining with region size. Generally, each region shows that significantly more money is needed to fulfill its LRP than in the TIP, on average about 5.6 times more. This is expected since the timeframe of the LRP is four to seven times that of the TIP, future costs are higher and often the LRP contains larger projects. However, the range is quite high: Ogden has the highest difference, needing 64.1 times more money for the LRP than the TIP, but this may be due to the integrated nature of the region into the Salt Lake City area. Spokane is second, expecting to need 21.4 times more money for the LRP as the TIP. At the other end of the spectrum, Salem (1.9) and Columbia (1.4) are the two regions needing the least amount of increase from TIP to LRP. Since all of these regions have updated their plans, a re-review might show different costs. Additionally, new regulations require costs to be in inflated (year of expenditure) dollars. This change will lead to higher estimated costs.

Figure 12: TIP and LRP Total Costs, $M



Figures 13 and 14 show the distribution of TIP expenditures by mode, compared with similar expenditures for large regions. The TIPs range in cost from $201 M to $2.9 B. In mid-sized regions an average of $119 M (13%) would be spent on transit projects and transit operating expenses, compared with about $758 M, or about 82% for highways. This contrasts sharply with the distributions for larger regions, which show about 44% of TIP funds targeted at transit improvements, and almost 10 times as much planned funding ($9.1B vs. $926 M).[30] However, compared with the modal shares for transit commuting, generally 2% of commuters in mid-sized regions, the transit expenditures in such regions are substantial.

Figure 13: Average TIP Modal Expenditure Shares ($M), Mid-Sized Regions

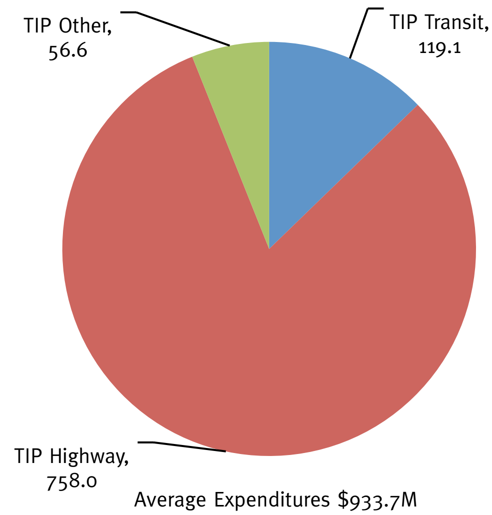
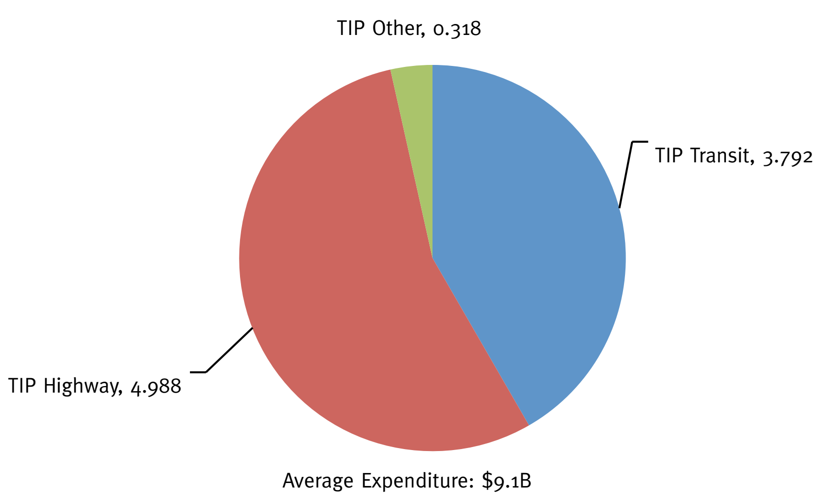


Figure 14: Average TIP Modal Expenditure Shares ($B), Large Regions



The costs for mid-sized regions' LRPs average about $5.157 B, or about five times the TIP costs. In contrast to the TIP, however, about 18% of the LRP costs are transit-focused (the average funding share is about 15%). This is lower than that of large regions (about 44%) but much higher than the transit shares of commuting, which are about 2%. The LRPs range in cost from $436 M for Salem to $22.8 B for Austin.

Figure 15: LRP Modal Expenditure Shares ($M), 26 Mid-Sized Regions

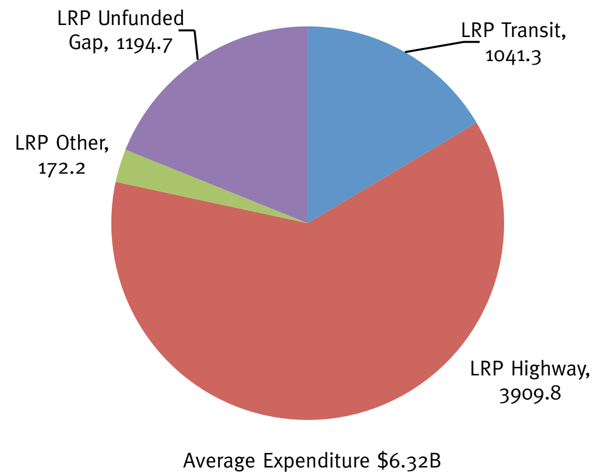
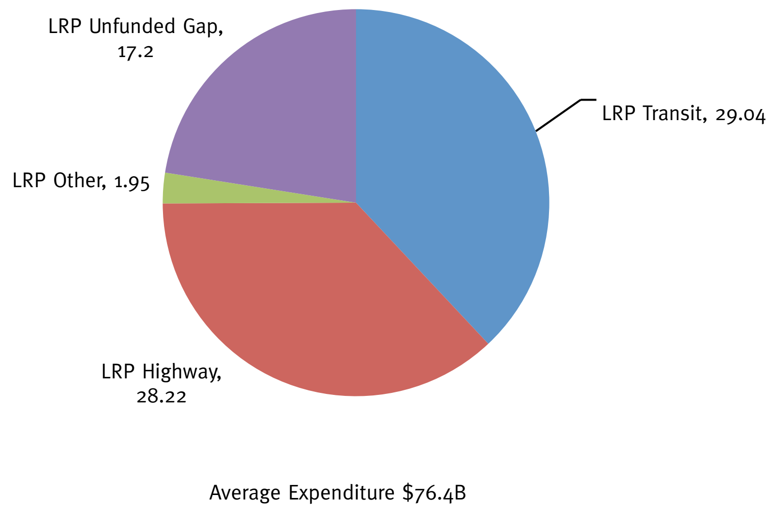


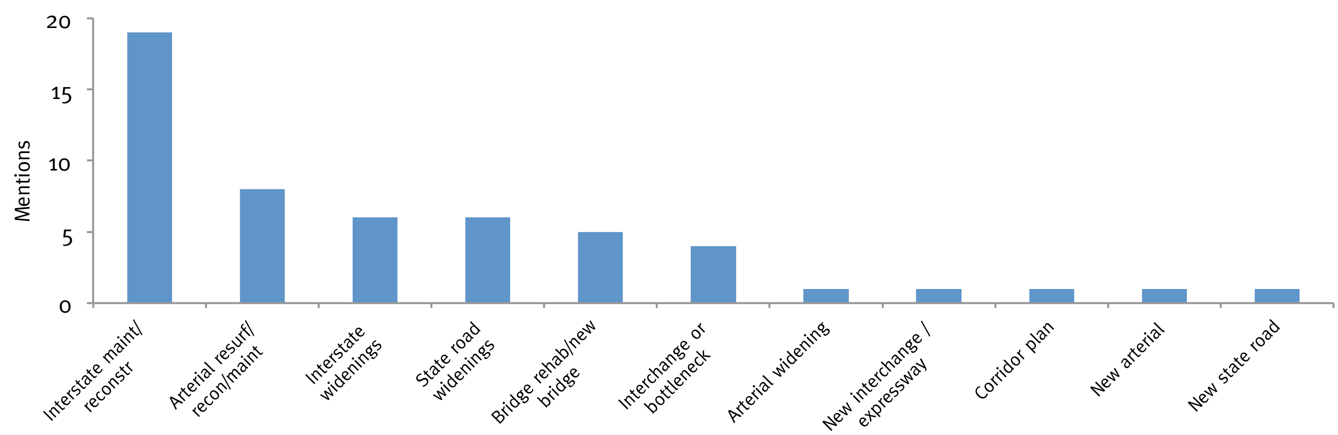
Figure 16: LRP Modal Expenditure Shares ($B), Large Regions



3. Major Projects

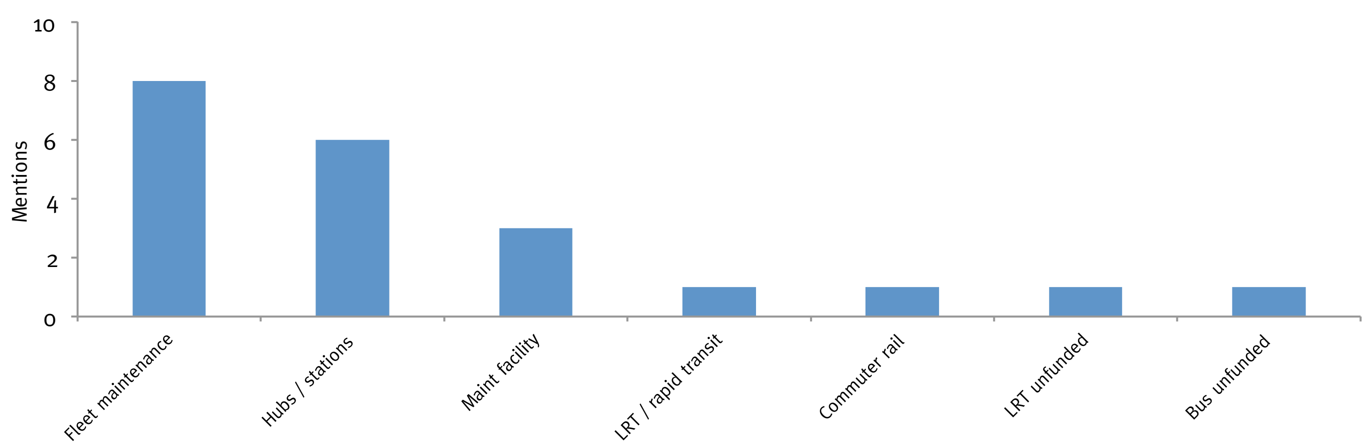
Major highway projects, while not numerous, appear regularly in the TIP lists of mid-sized regions. Using $50 M as an arbitrary criterion for "major project", the following figure shows the distribution of major highway projects by type. The main focus of most mid-sized regions is to *maintain, preserve or widen existing major arterial roads, state roads and Interstates.* Construction of *new* roads or Interstates is minimal and limited to just three cases: Jacksonville lists a $2.8 B Interstate project, Knoxville mentions an $88 M six-lane state road addition, and Richmond lists a four-lane $194 M major arterial road addition. More recent plans would undoubtedly revise these project costs.

Figure 17: Major Highway Projects in the TIPs



One of the major differences between the modal distributions of medium-sized regions and larger regions is the funding for major transit projects. Whereas most large regions have major transit initiatives in their TIPs, *most mid-sized regions do not have major transit initiatives*. In the 26 mid-sized regions we reviewed, there were 21 reported major transit projects in their TIPs, but only two were new transit systems. Jacksonville has a future rapid transit project in the TIP, and Raleigh has a reported $899 M unfunded light rail transit project.[31] Austin has a commuter rail listed as a major transit project, but only $15 M is listed for the TIP. Most mid-sized regions have transit projects that will focus mainly on the maintenance or replacement of their bus fleet and/or the building of stations or hubs for transit.

Figure 18: Major Transit Projects in the TIPs of 26 Mid-Sized Regions



The long range plans of mid-sized regions also tend to be titled toward highway projects, rather than transit initiatives. The following table summarizes the types of major highway and transit initiatives in these 26 plans. On the highway side, the most common initiatives are Interstate widenings and repairs, and widenings of major state highways, which together account for 60% of major highway initiatives and about 33% of the money. The primary exceptions are major new corridors and new/repaired bridges. On the transit side, the major initiatives are for commuter rail improvements (some of the regions are within the commuter rail corridors of larger regions) and bus fleet improvements, followed closely by LRT initiatives. However several of these are unfunded with cost estimates likely to be low.[32] Overall, the transit initiatives are a substantially smaller share of funds for mid-sized regions than for large regions, but nevertheless they account for about 12% of major initiative funding.

Table 4: Major LRP Initiatives, 26 Mid-Sized Regions

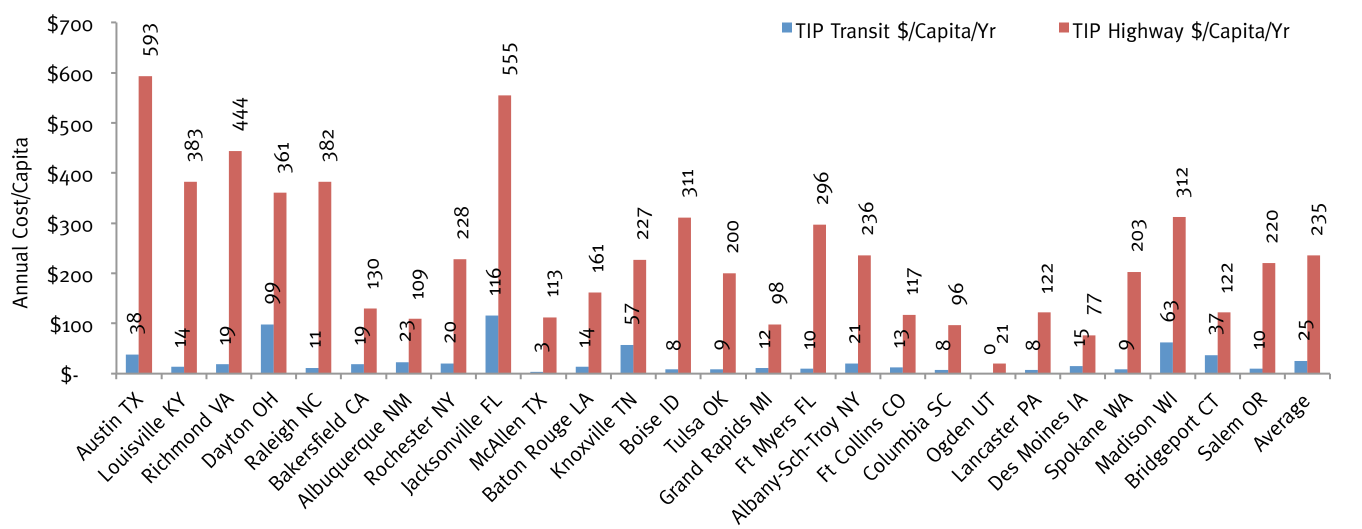
Highway Projects	Mentions	Amount* (in millions)	Transit Projects	Mentions	Amount* (in millions)
Interstate Widening/Repair	32	3,314	Commuter Rail	7	679
State Highway Widening	24	6,610	Bus Fleet Expansion	7	759
Bridge Repair/New	7	2,280	Light rail transit	6	950
Interstate Exits/	7	660	Bus rapid transit	6	1,193
Toll Roads	6	3,785	Transportation Center	4	N/A
New Expressway	6	636	Park/Ride	2	89
Parkway Widening	4	290	Express Bus Expansion	2	20
Interstate Repair	3	154	Energy/Fuels	1	125
Other Major Highway Corridor	3	10,400			
Total	92	28,129	Total	35	3,815

*Some project costs not included

4. Cost per Capita and Cost per Commuter

On an *annual per capita* (resident) basis, the average TIP reflects expenditures of $25 per person annually for transit, and $235 per person annually for highways. These annual expenditures vary widely for both transit and highway. On the transit side, the dollar amounts were as low as $0.03 per person and as high $116 per capita annually, but as noted below, are much higher per transit *commuter*. For highways, they vary from $21 to $593 per capita annually.

Figure 19: Annual Cost per Capita, for TIPs



A more relevant measure may be *annual spending per modal commuter*, which captures the modal expenditures relative to the size of the commuting market. This measure shows the opposite trend: *the average amount spent is $5,098 per transit commuter annually, versus about $556 per solo auto driver*. *In other words, on average, the TIPs for these regions propose to spend about nine times more per transit commuter than per solo driver, as shown in the figures*. Knoxville has the largest proposed TIP annual spending per transit commuter, at $22,849, while its proposed highway solo driver commuter annual cost is only $452. The closest-balanced of the regions is Ogden with $72 per transit commuter versus $58 per solo driver commuter cost.

Figure 20: Annual Cost per Commuter, TIPs

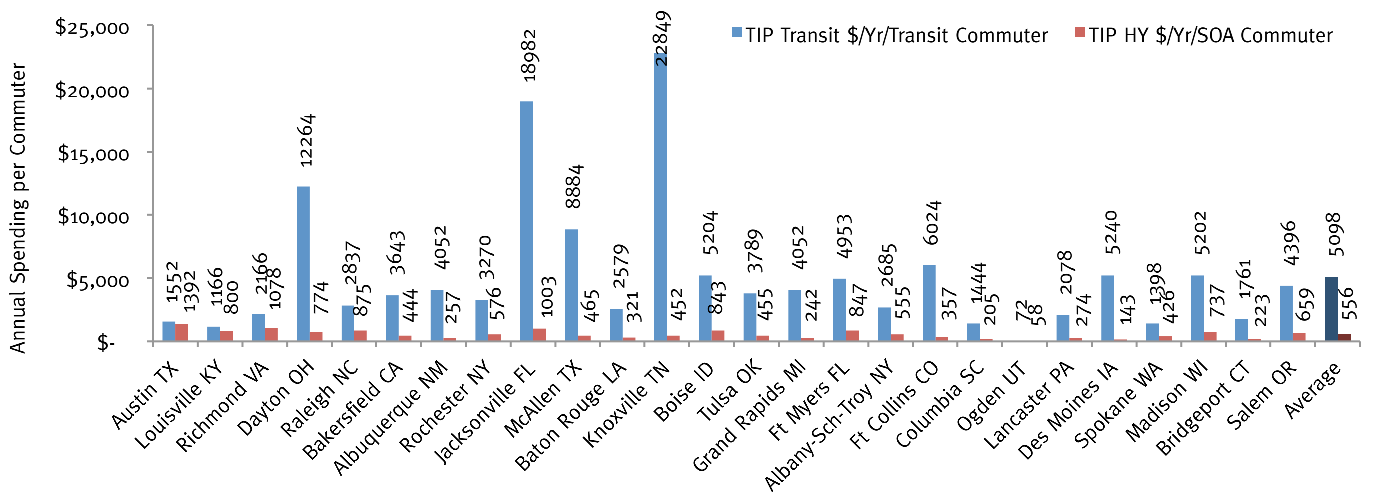
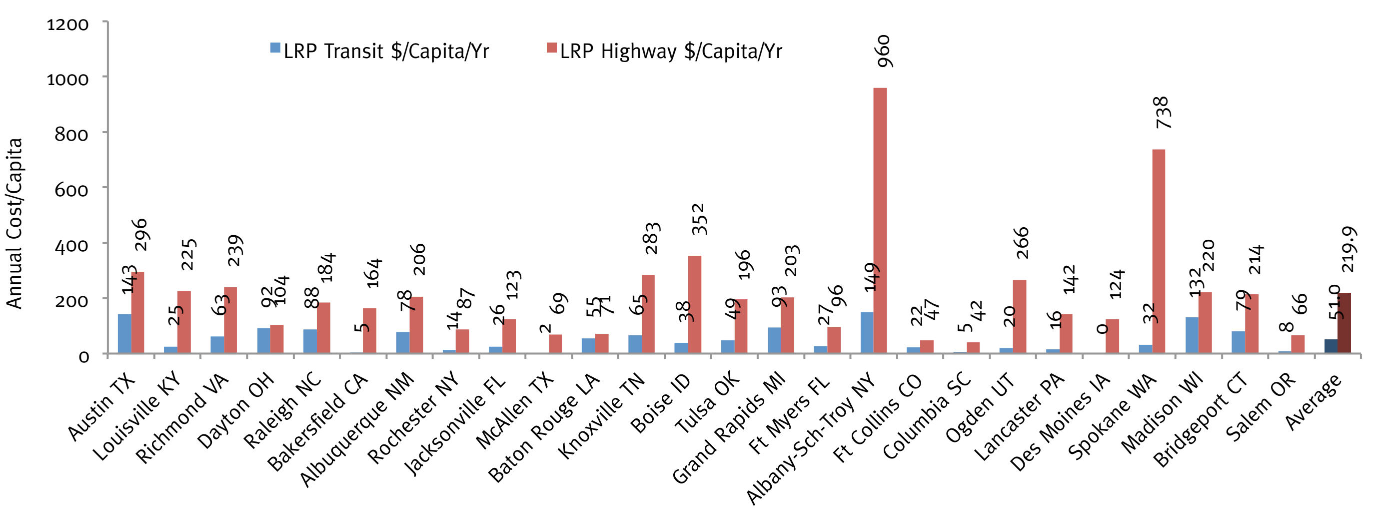


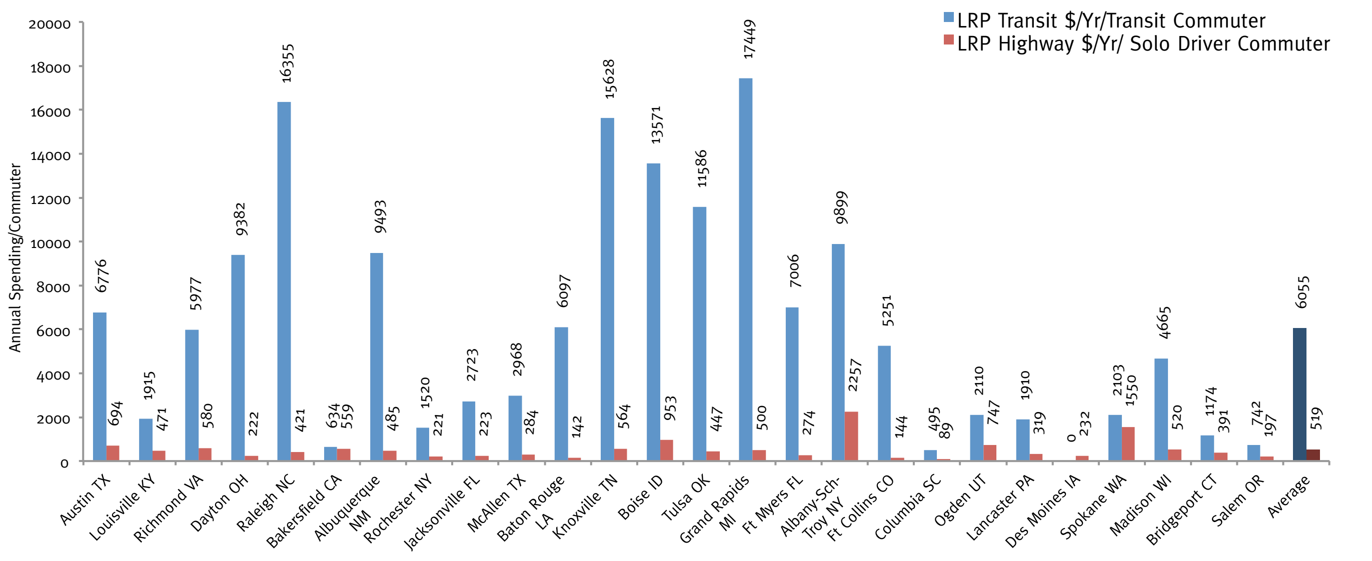
Figure 21: Annual Cost per Capita, LRPs



On a *per capita annual basis*, the average LRP is estimating expenditures of $51 per capita for transit, and $220 per capita per year for highways. However these annual expenditures vary widely. On the transit side, the dollar amounts were as low as $0 per person per year in Des Moines, and as high $149 per person annually in the Albany-Schenectady-Troy region. For highways, they vary from $42 per person per year in Columbia, South Carolina to $960 per person annually in Albany-Schenectady-Troy.

On a per *commuter* basis the findings are reversed: annual transit costs per transit commuter are significantly higher than annual highway costs per solo driver commuter. The average is $6,055 annually per transit commuter, versus only $519 annually per solo driver commuter. This ratio, about 12 to 1, is even higher than the 9 to 1 ratio observed in the TIP, indicating greater attention to transit commuters in the long term than in the short term. Some of these expenditures are truly remarkable: Grand Rapids has the largest proposed annual transit commuter expenditure: $17,449, versus just $500 per year per auto solo commuter. Even at the lower end of costs, the ratio is extreme: Rochester proposes to spend $1,520 annually per transit commuter versus $221 annually per solo driver commuter.

Figure 22: Annual Cost per Modal Commuter, Long Range Plans



Part of this discrepancy results from the disparity between the percentage of people who commute by transit and the percentage of transportation funding that transit receives. The following graph illustrates the transit commuting percentage of the workforce versus the percentage of TIP and LRP money that is allocated to transit in each plan. Most regions have only a limited number of workers commuting by transit, on average about 2% percent, yet most are spending five to ten times more per commuter on transit improvements than on highway improvements.

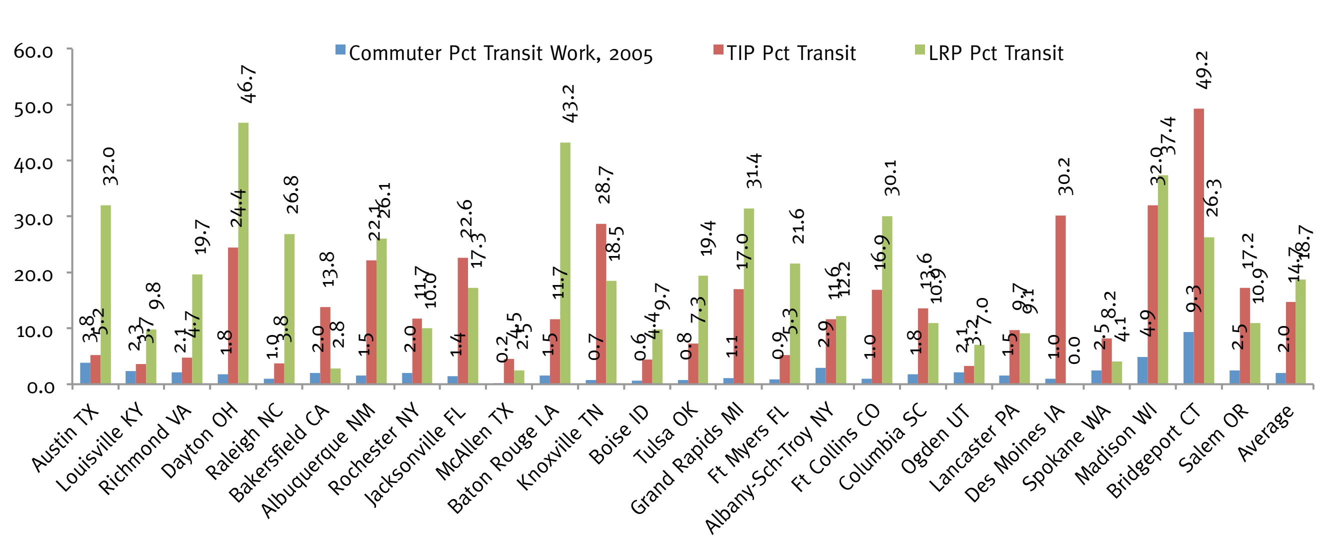
Many transit advocates counter that higher transit spending will lead to higher transit ridership. In mid-sized regions this is not typically true. The success of transit is due to urban spatial structure and land use, not the presence of a train line. Older cities developed before World War II such as Bridgeport and New York City have higher ridership because they were built when the primary transportation modes were train and foot. These cities have higher densities and different development patterns because of the limited transportation technologies available during that time period. Cities developed after World War II, such as Atlanta and Austin, were built around the automobile. In these cities, commuters were able to travel farther distances in the same time. Since these cities were developed around the automobile, they have lower densities.

Geographic factors are also important. Manhattan, New York is an island; businesses that want to locate in Manhattan compete for a limited amount of never expanding real estate. Mountains constrain some of San Francisco's development. These geographic factors cannot be artificially created in other places.

Several cities have attempted to retrofit themselves to denser development patterns. This is often called New Urbanism. However, New Urbanism has a poor track record of increasing transit usage. Government policies such as guaranteed home mortgages and political decisions such as where to build new transit lines also have complicated matters.

While different development requirements can encourage transit use, by themselves they do not make transit successful. For example, Portland, Oregon, which has some of the nation's strongest land use controls—including urban growth boundaries, a limitation on new highways, rapid expansion of a light-rail and commuter rail system, disproportionate spending on transit and incentives towards transit-oriented development—has a relatively small transit share of 6.3%.[33] This is far below New York's transit share of 30.3% or San Francisco's share of 14.5%. It is also below nearby Seattle's, which has much less restrictive policies, transit share of 8.0%. And it is not much higher than Denver's, which has built a similar but smaller light-rail network, share of 4.7%. Put another way, Portland's transit share of 6.3% is barely ahead of its 5.7% telecommuting share. Transit users costs taxpayers millions of dollars to build and maintain the system. Telecommuters cost taxpayers nothing.

Figure 23: Transit Commuting and Expenditure Shares

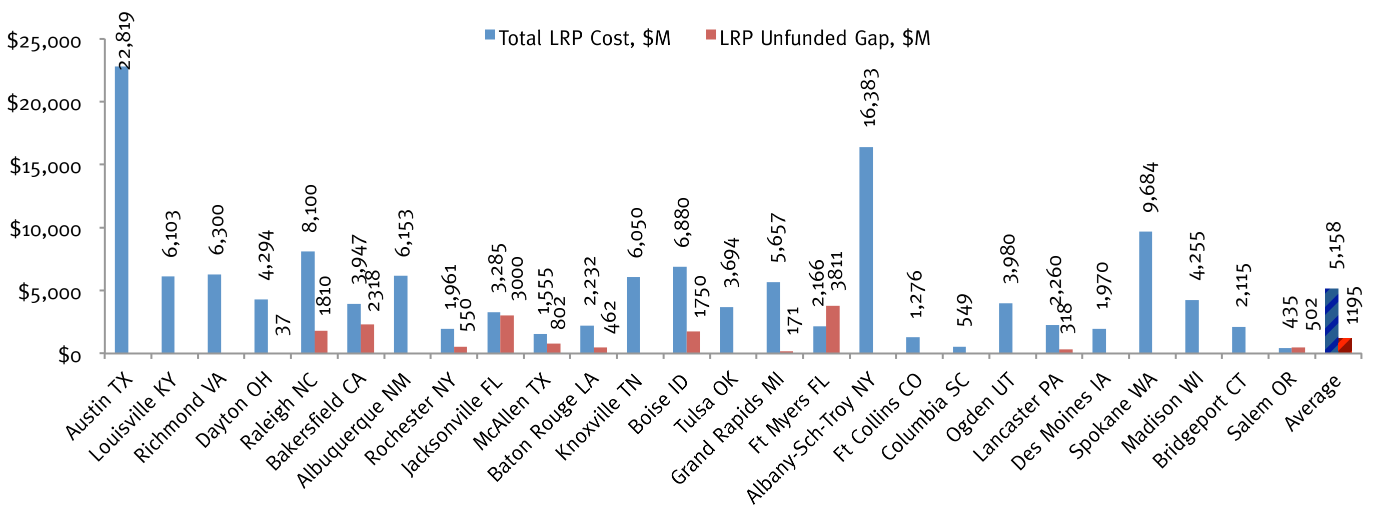


This is not to say that transit is useless. Transit, correctly designed, can help quickly and efficiently move people from home to work. And transit can be built and operated cost-effectively. However, cities that spend large amounts of money hoping for increased ridership in the absence of a strong market for transit, will be disappointed.

5. Unfunded Gap

Federal law requires that transportation plans be fiscally constrained, that is, they must conform to a "reasonable expectation" of future funding. In spite of this, 12 of the 26 regions have an "unfunded gap" beyond the "reasonably available" level, in addition to what is needed to fund the Long Range Plan. The average "unfunded gap" is about $1.2 B, versus the total LRP costs of $5.2 B, so LRPs are about 23% "unfunded." On the high end, Ft. Myers indicates that an additional $3.8 B (unfunded gap) is needed to accompany the $2.2 B (total LRP costs) to complete its LRP vision. But Dayton identifies only a $37 M unfunded gap in addition to the $4.3 B (total LRP cost) needed to complete its LRP goals.

Figure 24: Unfunded Gap, Long Range Plans



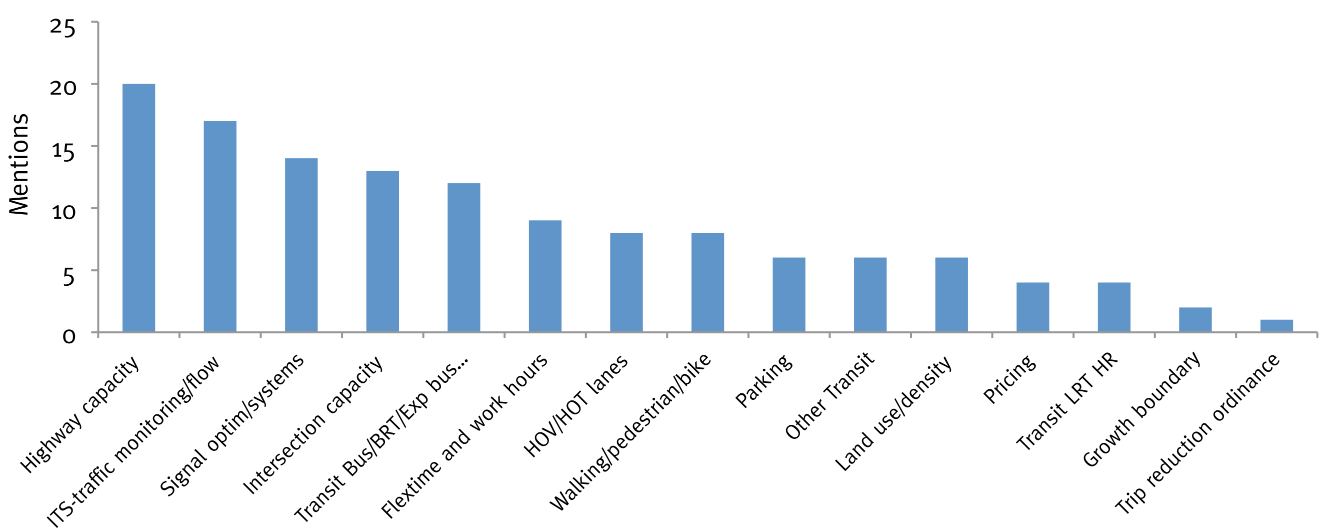
6. Congestion Management Process

Federal rules require that transportation planning in transportation management areas (urbanized areas with more than 200,000 people) have a "congestion management process" that addresses congestion management while ensuring "safe, effective management and operation of the intermodal transportation system" through travel demand reduction and operations management."[34] Further, the process must "result in multimodal performance measures and strategies….that manage demand and reduce single-occupant vehicle travel." If general-purpose additional lanes are proposed, they must contain features that could enable demand management.

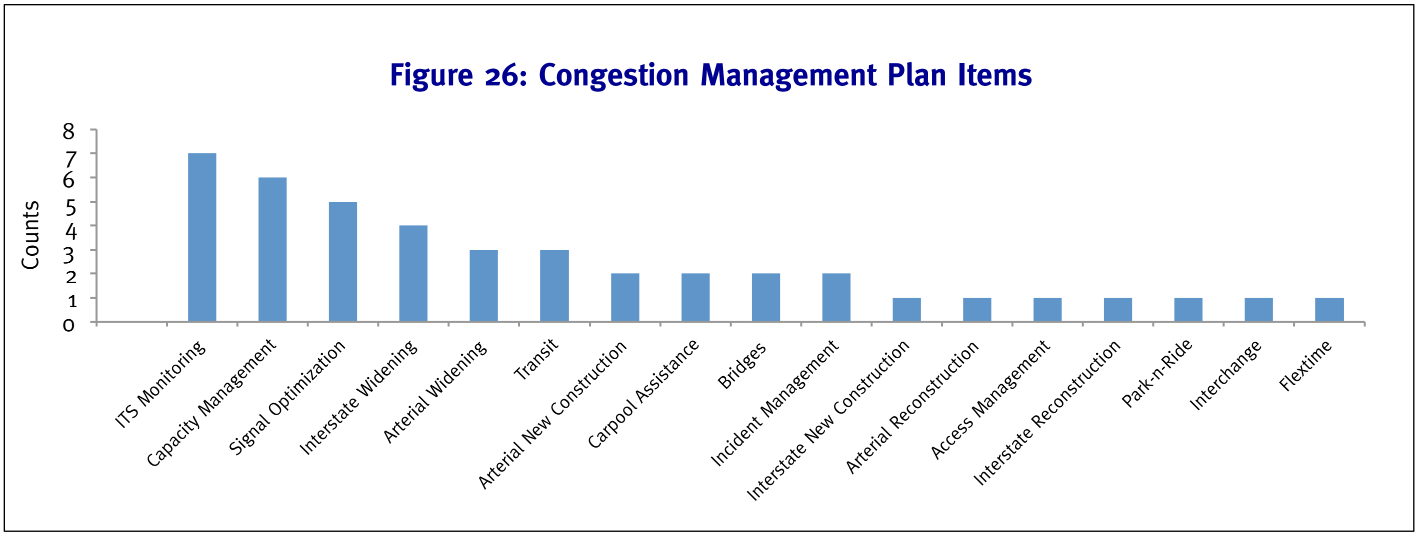
Federal rules also narrowly define the congestion management plans (CMP) *process.* Congestion management processes must also: 1) Monitor and evaluate performance, 2) Define congestion management objectives and performance measures, 3) Coordinate data collection, 4) Identify and evaluate anticipated performance and benefits of strategies (including, where necessary, additional capacity), 5) Provide an implementation schedule and 6) Periodically assess measures. [35] Also, in ozone or carbon monoxide non-attainment TMAs, federal funds cannot be used for additional single-occupant vehicle capacity (except bottleneck elimination or safety) unless the project is part of the congestion management process, and unless reasonable demand reduction strategies have been evaluated and found wanting.

Clearly, the rules for congestion management are intended to be restrictive regarding additional general-purpose capacity. But our review of congestion management plans shows that they are largely highway-oriented. Most of the major elements are directed at highway capacity, ITS-monitoring/flow, signal optimization and intersection capacity. A few trip reduction ordinances are included as an element in some CMPs. The Grand Rapids region mentions that several municipalities plan to create ordinances that will encourage trip reduction. Boise, Baton Rouge, Ft. Collins and Richmond mention congestion pricing as a way to lessen congestion. Ft. Collins is looking at lowering the tolls during off-peak hours to encourage peak-hour diversion and lower traffic congestion.

Figure 25: Congestion Management Plan Elements in 26 Mid-Sized Regions



The content of congestion management plans for mid-sized regions varies widely. However most contain common elements. The most commonly mentioned items are ITS monitoring (16%), followed by capacity management (14%) and signal optimization (12%). Plans also mentioned Interstate widening (9%) and arterial widening (7%), but these actions do not play as much of a role, nor does transit (7%). Building new arterial roads is only mentioned in two plans, and new Interstates are mentioned just once.



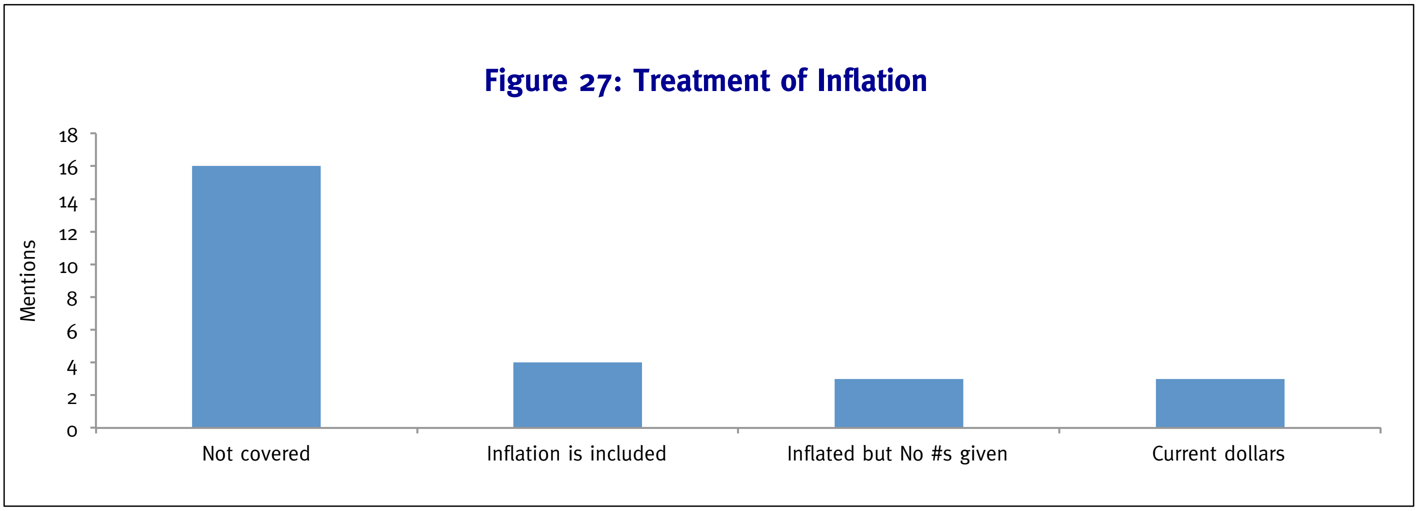
Not only are the congestion management plans for mid-sized regions largely highway-oriented, but very few, if any, satisfy the process requirements noted above. None of the plans we reviewed contained measureable performance statements about congestion, none evaluated the effect of proposed strategies on congestion, most did not identify potential projects and most provided no implementation schedule for projects. Instead, the CMP sections of plans focused on *measures for monitoring*, particularly the use of real-time monitoring such as on-road cameras or ITS technologies. Recent requirements for performance reporting may help to improve this situation.

7. Inflation

The metropolitan planning regulations also require that, after December 2007, plans use "year of expenditure" estimates of cost and inflation-based estimates of revenue sources. This new requirement introduces a new twist into transportation cost and revenue estimating, which had prior to 2008 been almost exclusively in "current dollar" (nominal) terms. It adds an element of realism but also significant uncertainty about the plans' financial requirements.

At the time of this review, very few long range plans considered inflation. Of the 26 plans reviewed, only four specifically considered inflation in their predictions. Three regions used inflated numbers but did not report the inflation rate; 16 did not address inflation at all and three mentioned it using current dollars for their forecasts. Without a prediction of the future inflation, both costs and revenues will fall short of the forecast.

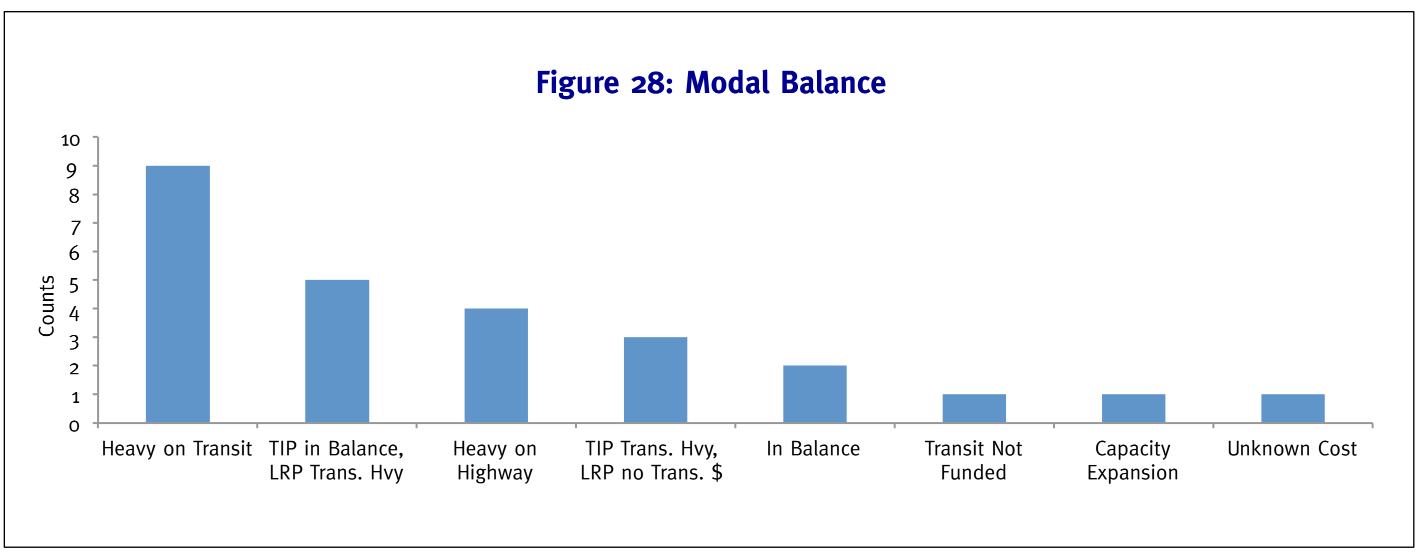
The four regions that considered inflation used different calculation methods. One region took the anticipated 2030-dollar amount and inflated it by 33%, and the remaining three inflated the amount on a yearly basis, but each by a different percentage (ranging from 2.5% to 4.5%). Construction costs have been shown to increase over time; a 2008 study of price trends concluded that overall construction costs increased 22% over one year, 75% over five years and 94% over 10 years.[36] While the recession has reduced inflation over the short-term, when robust economic growth returns, inflation will likely follow. Plans prepared after 2008 can be expected to treat inflation explicitly.



8. Modal Balance

The term “balanced” implies a funding share for alternate modes that is significantly higher than demand shares. Although not defined in the planning regulations, the term generally means that transportation plans should place considerable weight on modes other than drive-alone. The assumption is that these alternatives have been neglected in the past and that this needs to be corrected in future investments.

This is clearly the implication for the plans we reviewed. The following figure indicates that most regions’ plans lean heavily toward the transit side, particularly focusing on the region’s core and not the surrounding suburban area. It is very possible to build a cost-effective transit system that serves both the core and suburban areas; unfortunately the majority of these plans are both extremely costly and ineffective in moving people from home to work. Nine of the 26 regions have a plan that is heavy on the transit side for both the TIP and LRP. Five are balanced in the TIP but heavy on transit for the LRP and three are heavy on transit in the TIP and balanced or limited for the LRP.



9. Air Quality

Transportation plans are also required to address various air quality regulations, as part of the Environmental Protection Agency's "transportation conformity program." The plans must demonstrate, usually by reference to regulations, that the transportation plan will not degrade air quality. In practice this means that the projects in the TIP, taken as a whole, will not worsen air quality below what would occur if the projects were not built.

Of the 26 plans we reviewed, only one (Ft. Myers, in attainment) does not discuss air quality; all the others mention it in some detail. All but one (Baton Rouge) had submitted air quality plans. Virtually all of the regions expect air quality to significantly improve over the next several decades, due almost exclusively to fleet turnover and the automobile emissions reductions, not from reduced driving. But only six regions (Louisville, Dayton, Bakersfield, Albany, Columbia and Lancaster) state this reason. Several plans imply, wrongly, that improvements to the transportation system are the basis for the predicted improvement. (We did not review the air quality (AQ) plans for climate change, but do not recall that any regions mentioned fleet turnover as the primary factor in reduced emissions.) These documents may have been updated for the next round of LRP submissions.

Table 5: Air Quality Forecasts

	Air Quality Treatment	Expected Change to Future Year
Austin TX	Air quality is expected to improve.	Improvement
Louisville KY	Air quality will sharply improve, due to fleet turnover.	Sharp improvement
Richmond VA	Moderate non-attainment for ozone, in conformity. But will improve sharply.	Sharp improvement
Dayton OH	Plan finds that air quality will improve sharply, even if the plan is not implemented.	Sharp improvement
Raleigh NC	Plan has nitrogen oxides (NOX) declining from 36,200 kilograms/day to 9,143, about -75%, from 2007 to 2030. Volatile organic compounds (VOC) decline from 16,273 to 10,378, about -36%.	Improvement
Bakersfield CA	A significant improvement is foreseen, due to fleet turnover.	No forecast
Albuquerque NM	Region is in conformance and is in attainment.	In attainment
Rochester NY	Plan shows large reductions in air pollution, about 80%. This is not attributed to plan, but the implication is there.	Sharp improvement
Jacksonville FL	Region will improve sharply.	Sharp improvement
McAllen TX	In compliance.	In compliance
Baton Rouge LA	Region has defaulted on air quality documents and has been cited.	Defaulted
Knoxville TN	Region is expected to improve sharply in air quality.	Sharp improvement
Boise ID	Region is predicting sharp improvements for NOX and VOC, flat for CO, and worsening for Particulate Matters between 2.5 and 10 microns (PM10) (road dust).	Sharp improvement
Tulsa OK	Region is in conformity, and is predicted to improve sharply.	Sharp improvement
Grand Rapids MI	Region is in "basic" non-attainment for ozone, but will improve sharply.	Sharp improvement
Ft Myers FL	Not discussed.	No mention
Albany-Schenectady-Troy NY	Major improvements foreseen, due to fleet turnover: VOC: 41.8 tons/day declining to 9.6 tons/day with No build, 7.8 Build. NOX: 53.3 tons/day declining to 6.4 No build, 5.7 Build. These are reductions of about 82-90%.	Sharp improvement
Ft Collins CO	Air quality is predicted to slowly improve. Region is in attainment.	Slow improvement
Columbia SC	Attributes recent reductions to technology. Does not make a future forecast.	No forecast
Ogden UT	(part of Salt Lake City region).	(part of Salt Lake City region)
Lancaster PA	Region is marginal non-attainment for ozone, but sharp improvements are likely due to fleet turnover.	Sharp improvement
Des Moines IA	In attainment.	In attainment
Spokane WA	Region is in attainment (acknowledges effect of improved vehicle emissions).	In attainment
Madison WI	Sharp improvement predicted.	Sharp improvement
Bridgeport CT	Air quality will improve sharply.	Sharp improvement
Salem OR	Region predicts sharp improvement.	Sharp improvement

10. Fundamental weaknesses

We also reviewed the 26 plans for fundamental weaknesses such as significant omissions, insufficient funding and lax treatment of expected growth. Only five of the 26 plans appear to deal realistically with their circumstances.[37] The others suffer significant defects in that they do not contain sufficient *known* sources of funds to accomplish the plan, do not consider inflation and do not contain actions that would address problems. They also have major needs unmet after plan implementation.

Table 6: Fundamental Weaknesses

Major Problems	Count
Insufficient funds	7
Fails to consider congestion relief	6
Generally realistic	5
Transit funding needs not met	4
Fails to consider inflation	4
Depends on uncertain funding	3
Not clearly written	1
Fails to consider maintenance needs	1
Total	31*

*multiple deficiencies

Many of these plans fail as planning documents; they are instead "advocacy" studies whose primary purpose is to satisfy the legal requirements for long range planning and push for more funding. These plans are not traditional transportation planning documents, but instead focus on other objectives that seem designed to forcibly shape the urban landscape. And in this shift, the goals of solving transportation problems such as congestion, accessibility and mobility have been pushed aside.

F. Impacts of Plans on Congestion

One frustrating element of most transportation plans is that they do not *quantitatively* document how they will meet their intended goals. One example is congestion relief. In order to assess a plan's impacts on congestion, information is needed on the present magnitude of congestion, which actions in the plan reduce congestion and by how much, what those actions cost, how much congestion remains after the actions are implemented and the likelihood of timely implementation. All of these steps are missing in most plans. Given that they are required in the performance regulations of congestion management processes, their omission is doubly disappointing. Where this information is available, it lies deep within appendix tables or is implied by maps showing general effects.

To determine the impact of these plans on congestion, we followed a straightforward approach. We first quantified how much congestion there is at present in each region, and how much there will be in the future if the region grows as predicted. We then determined the "increase" that would have to be addressed by a variety of transportation actions to hold congestion at current levels. Next, we listed all actions in each TIP and LRP that might have a measurable effect on congestion, and then computed their probable effect given typical traffic volumes and travel time savings.

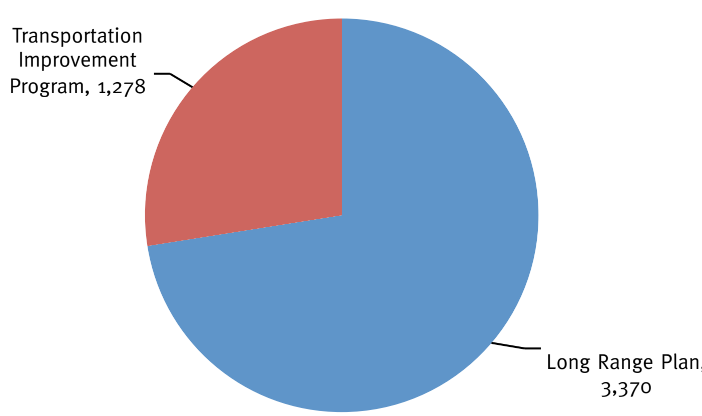
Generally, these types of projects add lanes, build new roads, or widen or improve intersection flow. Estimates of the amount of capacity added, or delay reduced, are based on calculations using the Highway Capacity Manual (2000 version) and other similar references. Other projects, such as transit improvements or pedestrian-bike projects, generally do not affect congestion or delay, since their primary purpose is to provide choices.[38] Of the mid-sized cities only Bridgeport in close proximity to New York City has a transit share above 3.0%. In the rest of the mid-sized cities transit plays a minor, almost insignificant, role. Finally, we summed the impacts of the planned actions and compared them to the predicted growth. The appendices to this report describes the process in more detail.

1. Projects Affecting Congestion

The following table and figures summarize the projects in each LRP and TIP that are likely to affect road capacity or delay. All regions listed at least a few projects. Projects duplicated between the TIP and the LRP were corrected by removing the project from either the TIP or the LRP.

In total, 4,648 projects in the 26 regions were found to likely affect road capacity or delay. About 72%, 3,370 projects, are listed in the LRPs and 28%, 1,278 projects, are listed in the TIPs.

Figure 29: Congestion-Affecting Projects in 26 Mid-Sized Regions

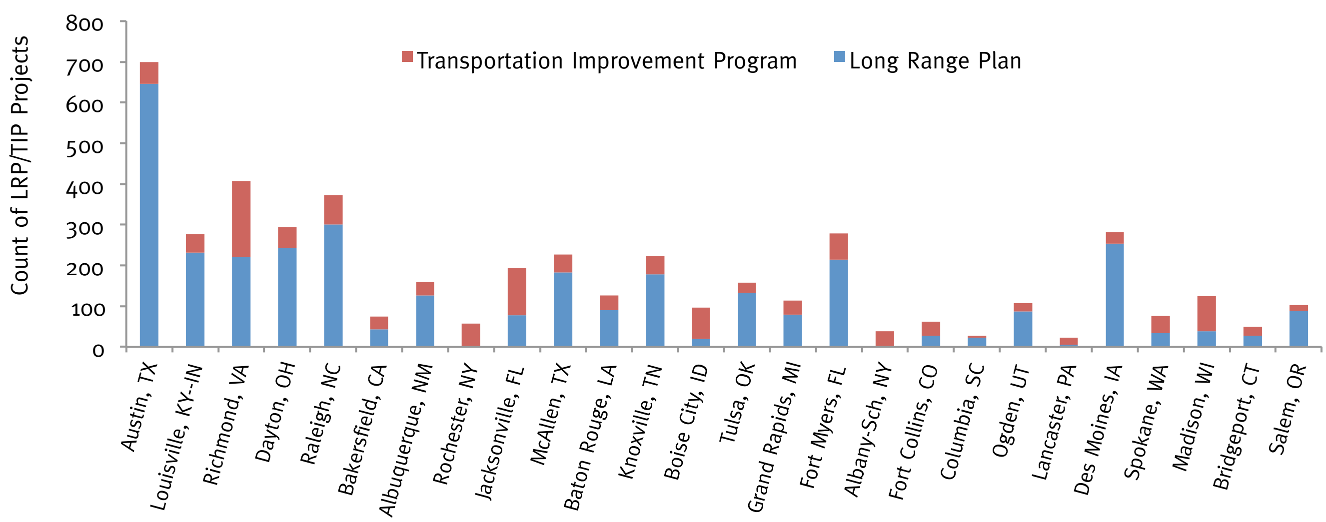


The number of projects affecting congestion varies widely, but generally declines with region size. This ranges from a high of 700 projects for Austin to a low of 22 projects for Lancaster. Two regions (Rochester, Albany) did not list specific projects in the LRP.

Table 7: Projects Affecting Congestion, by Region

Regions (in order of urbanized area population)	Long Range Plan	Transportation Improvement Program	Total
Austin, TX	646	54	700
Louisville, KY--IN	231	46	277
Richmond, VA	220	187	407
Dayton, OH	243	52	295
Raleigh, NC	301	71	372
Bakersfield, CA	43	32	75
Albuquerque, NM	126	33	159
Rochester, NY	NA	57	57
Jacksonville, FL	77	117	194
McAllen, TX	183	44	227
Baton Rouge, LA	90	36	126
Knoxville, TN	178	45	223
Boise City, ID	19	77	96
Tulsa, OK	133	24	157
Grand Rapids, MI	80	33	113
Fort Myers, FL	215	63	278
Albany-Schenectady, NY	NA	38	38
Fort Collins, CO	27	35	62
Columbia, SC	23	5	28
Ogden, UT	87	20	107
Lancaster, PA	6	16	22
Des Moines, IA	254	27	281
Spokane, WA	33	43	76
Madison, WI	39	86	125
Bridgeport, CT	27	23	50
Salem, OR	89	14	103
Grand Total	3,370	1,278	4,648

Figure 30: Congestion-Affecting Projects by Region



To determine the impacts on congestion of project length, traffic and peak-hour speeds before and after construction, other factors are needed. Most of the projects had basic descriptive information; for those that did not, we obtained the information from maps, unit costs or regional officials.

2. Project Length

To quantify congestion relief we need to know the length of the proposed projects. The following table and figures show the total estimated length, in miles. This includes actual lengths as well as lengths estimated by average cost per lane-mile added and similar methods. In total, the proposed work would affect about 8,814 miles, of which about 87% are LRP projects.

Figure 31: Project Length Totals

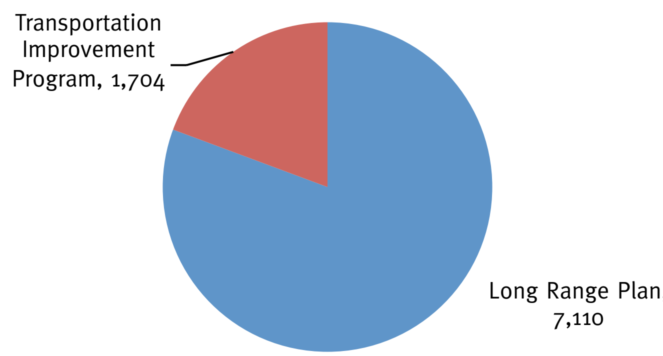
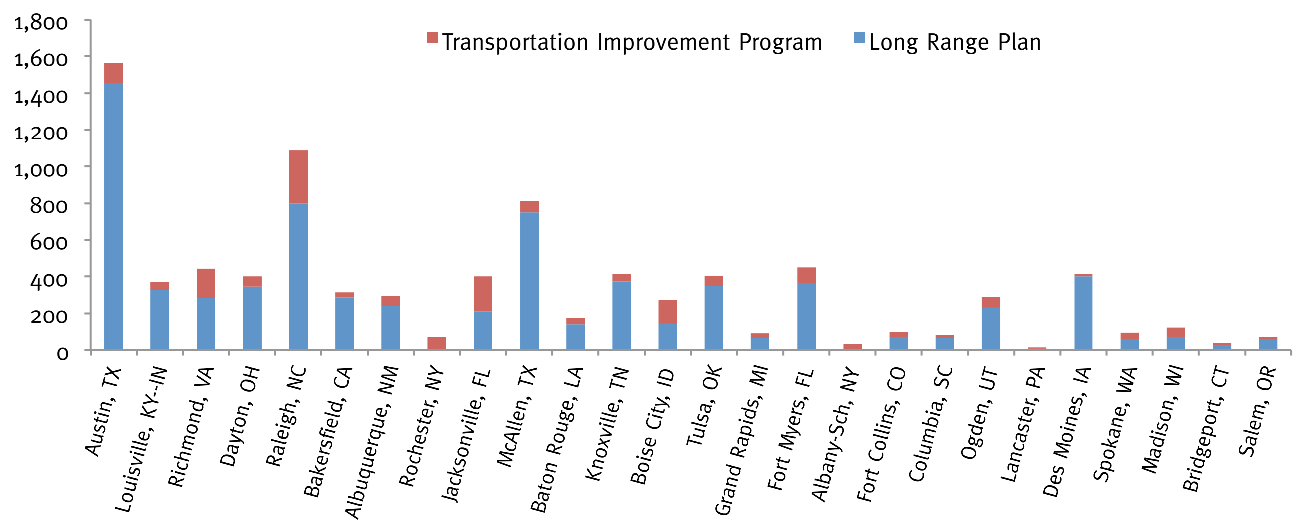


Table 8: Project Lengths by Region

Region (in Size Order)	LRP	TIP	Grand Total
Austin, TX	1,453.58	110.25	1,563.83
Louisville, KY--IN	328.71	42.17	370.88
Richmond, VA	281.62	159.58	441.20
Dayton, OH	345.43	56.68	402.11
Raleigh, NC	797.91	291.52	1,089.43
Bakersfield, CA	285.26	27.85	313.11
Albuquerque, NM	240.32	52.17	292.48
Rochester, NY	0.00	68.76	68.76
Jacksonville, FL	209.23	191.84	401.07
McAllen--Edinburg--Mission, TX	750.24	62.79	813.03
Baton Rouge, LA	140.84	34.54	175.38
Knoxville, TN	371.88	43.96	415.84
Boise City, ID	142.41	128.12	270.53
Tulsa, OK	347.37	57.55	404.93
Grand Rapids, MI	64.69	25.82	90.51
Fort Myers--Cape Coral, FL	365.71	85.23	450.94
Albany--Schenectady--Troy, NY	0.00	29.65	29.65
Fort Collins, CO	69.45	29.44	98.89
Columbia, SC	65.88	13.00	78.88
Ogden, UT	230.40	59.86	290.26
Lancaster, PA	5.26	9.17	14.43
Des Moines, IA	401.70	13.17	414.87
Spokane, WA	58.02	36.95	94.97
Madison, WI	68.18	53.75	121.93
Bridgeport--Milford, CT	26.18	10.43	36.61
Salem, OR	59.29	9.71	69.00
Grand Total	7,109.55	1,703.95	8,813.50

The number of miles affected also generally declines with region size. Austin and Raleigh listed the most mileage affecting congestion, each over 1,000 miles.

Figure 32: Project by Length Estimates, by Region



3. Lane-Miles Added

To determine capacity added to the road system by the TIP and LRP, we must first summarize projects by type. The following table shows lane-miles added, by type of work, for each region. This table sums lane-miles added (including estimated-length projects) by work type code (broad improvement categories) for each region.

Table 9: Lane-Miles Added, by Project Type and Region, TIP and LRP

Region (In size order)	New Freeway	New Urban Arterial	Widen Urban Arterial	Widen Freeway	Widen Rural Arterial	Freeway Inter-changes or Exits	Signals	Managed Lanes	Bridge Work	Upgrade Urban Arterial to Freeway	Improve but not widen	Reduce Capacity	Grand Total
(Work Type Code)	1	2	3	4*	6*	7	8	9	10	11	12	13	
Austin, TX	424.8	819.5	1,992.1	93.7	16.1	0.0	0.0	177.8	0.4	0.0	0.0	-19.3	3,505.0
Louisville, KY--IN	0.0	71.7	374.7	126.9	0.0	7.3	0.0	0.0	1.3	0.0	0.0	-1.1	580.8
Richmond, VA	25.3	345.5	446.8	48.3	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	866.1
Dayton, OH	0.0	96.7	295.1	102.6	0.0	4.4	0.0	0.0	2.0	0.0	0.0	0.0	500.8
Raleigh, NC	316.2	510.6	1,523.2	133.8	0.0	0.1	0.0	53.0	0.0	0.0	0.0	-2.8	2,534.1
Bakersfield, CA	742.1	10.8	309.2	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	1,066.1
Albuquerque, NM	0.0	314.2	210.1	61.5	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	586.0
Rochester, NY	0.0	4.6	109.3	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	114.0
Jacksonville, FL	0.0	469.0	319.2	79.1	0.0	0.0	0.0	19.8	0.6	0.0	0.0	0.0	887.7
McAllen, TX	700.0	335.3	948.7	6.2	96.2	1.0	0.0	6.6	2.3	0.0	0.0	0.0	2,096.3
Baton Rouge, LA	0.0	63.0	225.2	19.4	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	307.8
Knoxville, TN	17.6	286.8	557.6	36.4	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.1	898.8
Boise City, ID	50.6	33.7	255.6	156.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	497.7
Tulsa, OK	71.7	82.4	495.8	131.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	781.5
Grand Rapids, MI	0.0	0.0	100.2	18.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	118.7

Table 9: Lane-Miles Added, by Project Type and Region, TIP and LRP

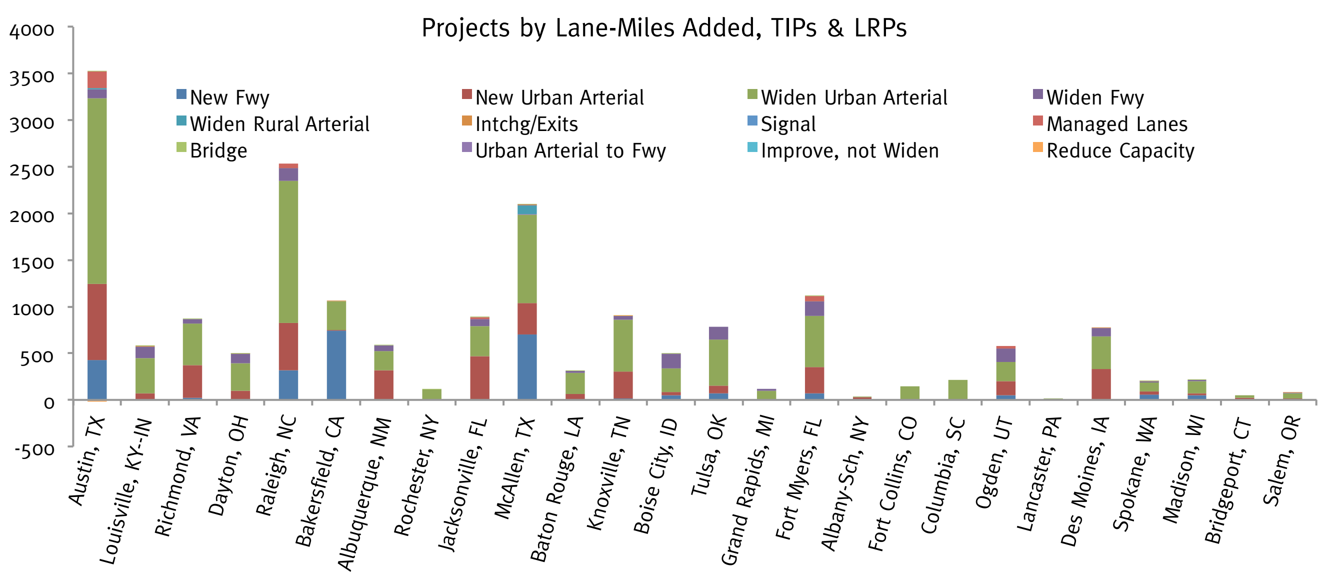
Region (In size order)	New Freeway	New Urban Arterial	Widen Urban Arterial	Widen Freeway	Widen Rural Arterial	Freeway Inter-changes or Exits	Signals	Managed Lanes	Bridge Work	Upgrade Urban Arterial to Freeway	Improve but not widen	Reduce Capacity	Grand Total
Fort Myers, FL	73.4	280.9	547.9	159.7	0.0	0.2	0.0	54.9	6.8	0.0	0.0	0.0	1,123.7
Albany S-T, NY	0.0	29.9	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.3
Fort Collins, CO	0.0	7.0	137.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.6
Columbia, SC	0.0	10.4	204.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	215.1
Ogden, UT	48.0	153.7	203.9	145.6	0.0	0.0	0.0	27.2	0.0	0.0	0.0	0.0	578.4
Lancaster, PA	0.0	6.1	10.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9
Des Moines, IA	8.1	321.0	350.9	92.9	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	773.2
Spokane, WA	60.0	28.0	95.7	15.3	0.0	2.0	0.0	0.0	0.2	0.0	0.0	-0.4	200.8
Madison, WI	48.1	21.4	129.6	17.6	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	217.9
Bridgeport CT	0.0	19.6	28.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.2
Salem, OR	0.0	12.6	57.1	5.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	75.5
Grand Total	2,586	4334.4	9,938.7	1,451	112.3	19.6	0.0	339.3	17.2	0.0	0.0	-23.5	18,775

*Work Type 5 was later removed.

Overall, the projects would add about 18,750 lane-miles. However, the projects will have a disproportionate impact since some remove highway bottlenecks. Highway bottlenecks are specific physical locations on highways that routinely experience recurring congestion and traffic backups because traffic volumes exceed highway capacity.[39]

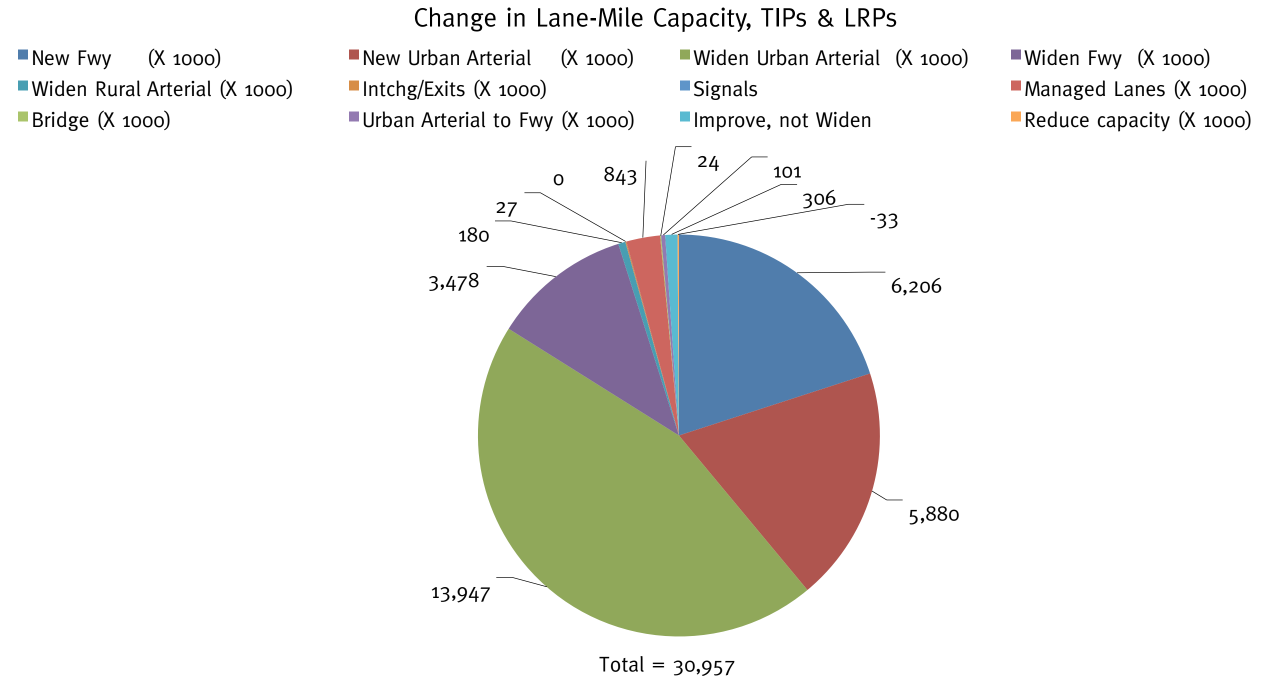
Such projects add few lane-miles but greatly reduce congestion. More than half of the improvements are for arterial widenings, with another 45% for new arterials and freeways. Over 97% of the lane-miles added come from new freeways, new arterials, arterial widenings and freeway widenings. The largest increases are for Austin and Raleigh, and generally the increased lane-miles decline with region size.

Figure 33: Lane-Miles Added, by Region and Work Type, in the Long Range Plan and Transportation Improvement Plan



To convert these lane-mile improvements into increased capacity, we used standard capacity estimates for typical improvements, ranging from about 2,400 vehicles per hour for modern freeway lanes to about 1,400 vehicles per hour for arterial lanes. The following table and figures show the results. In total, the improvements would add about 30,900,000 hourly lane-miles of capacity to the road system of our 26 regions. On average, about 1,667 hourly lane-miles of capacity are added for each lane-mile of length.

Figure 34: Changes in Hourly Lane-Miles of Capacity by Project Type



However, the regions vary only slightly in the ratio of capacity added to lane-miles added. On average, the regions add about 1,400–1,700 hourly vehicle-miles of capacity for each lane-mile of road added. A few regions have project mixes that produce higher or lower estimates.

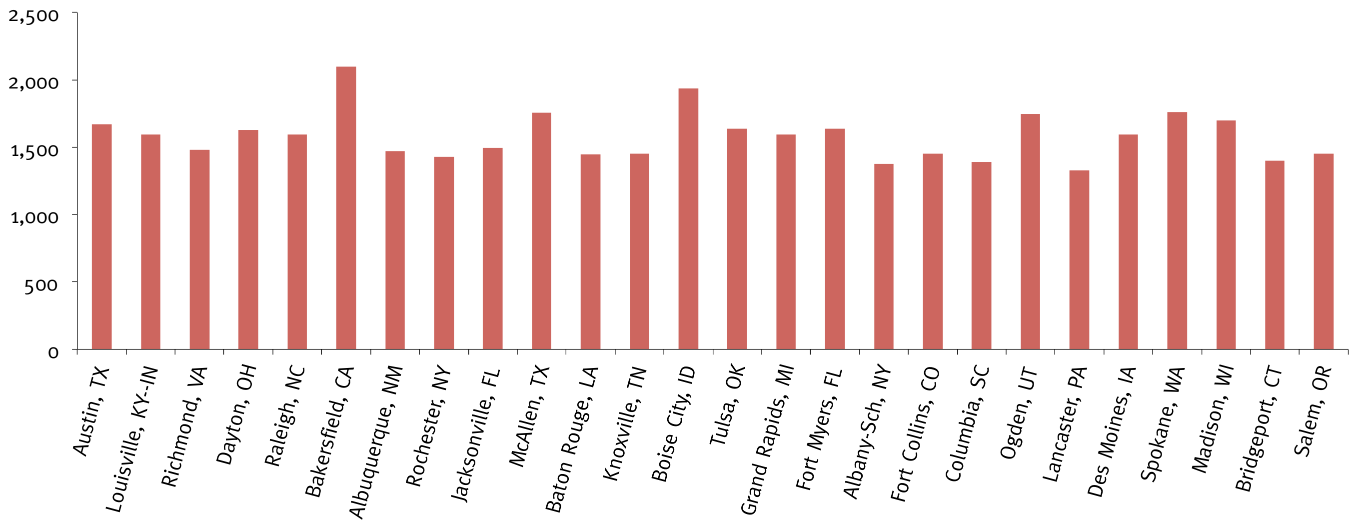
Table 10: Average Capacity Change

Region (In size order)	Lane-Miles Added	Change in Hourly Lane-Miles of Capacity (X 1000)	Ratio (Change in Hourly Lane-Miles of Capacity / Lane-Mile Added)
Austin, TX	3,505.0	5,859	1,671.6
Louisville, KY--IN	580.8	926	1,595.0
Richmond, VA	866.1	1,282	1,479.9
Dayton, OH	500.8	814	1,625.6
Raleigh, NC	2,534.1	4,043	1,595.5
Bakersfield, CA	1,066.1	2,236	2,097.5
Albuquerque, NM	586.0	863	1,473.0
Rochester, NY	114.0	163	1,428.8
Jacksonville, FL	887.7	1,328	1,496.6
McAllen--Edinburg--Mission, TX	2,096.3	3,685	1,758.1
Baton Rouge, LA	307.8	445	1,445.4
Knoxville, TN	898.8	1,307	1,453.7
Boise City, ID	497.7	964	1,936.5
Tulsa, OK	781.5	1,281	1,639.0
Grand Rapids, MI	118.7	189	1,592.8

Table 10: Average Capacity Change

Region (In size order)	Lane-Miles Added	Change in Hourly Lane-Miles of Capacity (X 1000)	Ratio (Change in Hourly Lane-Miles of Capacity / Lane-Mile Added)
Fort Myers--Cape Coral, FL	1,123.7	1,842	1,638.9
Albany--Schenectady--Troy, NY	39.3	54	1,377.7
Fort Collins, CO	144.6	210	1,451.7
Columbia, SC	215.1	299	1,390.4
Ogden, UT	578.4	1,010	1,746.4
Lancaster, PA	16.9	22	1,327.4
Des Moines, IA	773.2	1,233	1,594.5
Spokane, WA	200.8	354	1,763.0
Madison, WI	217.9	371	1,700.9
Bridgeport--Milford, CT	48.2	67	1,400.0
Salem, OR	75.5	110	1,450.0
Grand Total	18,564.7	30,958	1,667.6

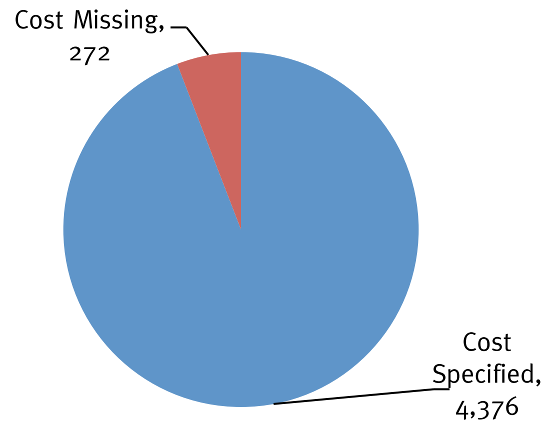
Figure 35: Ratio of Change in Lane-Miles of Capacity to Lane-Miles Added



4. Project Costs

Project costs are drawn directly from the LRP and TIP documents. As noted above, these costs are typically in current year dollars, and have *not* been converted to year of expenditure dollars, reflecting when the work will actually be completed. Therefore they are low, perhaps including only half of the total expenditure in nominal terms. Another problem is that some projects, particularly those in the long range plan, do not have cost estimates. The following table and figures show, for each region, how many capacity-affecting projects have a specified cost estimate, and how many projects have missing cost estimates.

Figure 36: Summary of Projects by Cost Available



Although relatively few projects have missing costs, the most significant problems were with Bridgeport-Milford and Tulsa, which have long range plans that do not include individual project costs.

Table 11: Projects with Specified Costs

Missing Cost Summary	Cost is Specified	Cost is Missing	Percent Missing Cost
Austin, TX	673	27	3.86%
Louisville, KY--IN	276	1	0.36%
Richmond, VA	393	14	3.44%
Dayton, OH	295	0	0.00%
Raleigh, NC	365	7	1.88%
Bakersfield, CA	69	6	8.00%
Albuquerque, NM	159	0	0.00%
Rochester, NY	56	1	1.75%
Jacksonville, FL	194	0	0.00%
McAllen--Edinburg--Mission, TX	226	1	0.44%
Baton Rouge, LA	125	1	0.79%
Knoxville, TN	215	8	3.59%
Boise City, ID	96	0	0.00%
Tulsa, OK	24	133	84.71%
Grand Rapids, MI	113	0	0.00%
Fort Myers--Cape Coral, FL	271	7	2.52%
Albany--Schenectady--Troy, NY	37	1	2.63%
Fort Collins, CO	56	6	9.68%
Columbia, SC	26	2	7.14%
Ogden, UT	101	6	5.61%
Lancaster, PA	21	1	4.55%
Des Moines, IA	272	9	3.20%
Spokane, WA	76	0	0.00%
Madison, WI	113	12	9.60%
Bridgeport--Milford, CT	23	27	54.00%
Salem, OR	101	2	1.94%
Grand Total	4,376	272	5.85%

Total project costs are shown in the following table and figures. Overall, these 26 plans estimate about $85 B, in current dollars, in capacity-increasing projects. (We do not have LRP project lists for Albany or Rochester). While this is obviously a significant sum, in perspective it is about 53% of the total estimated cost ($158.2 B) of the LRPs and TIPs.

Figure 37: Estimated Capacity Expansion Project Costs by Plan Type, $B

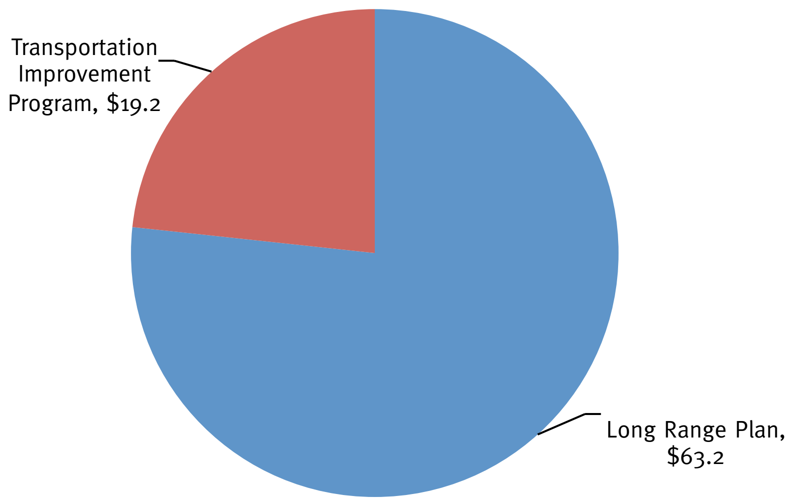
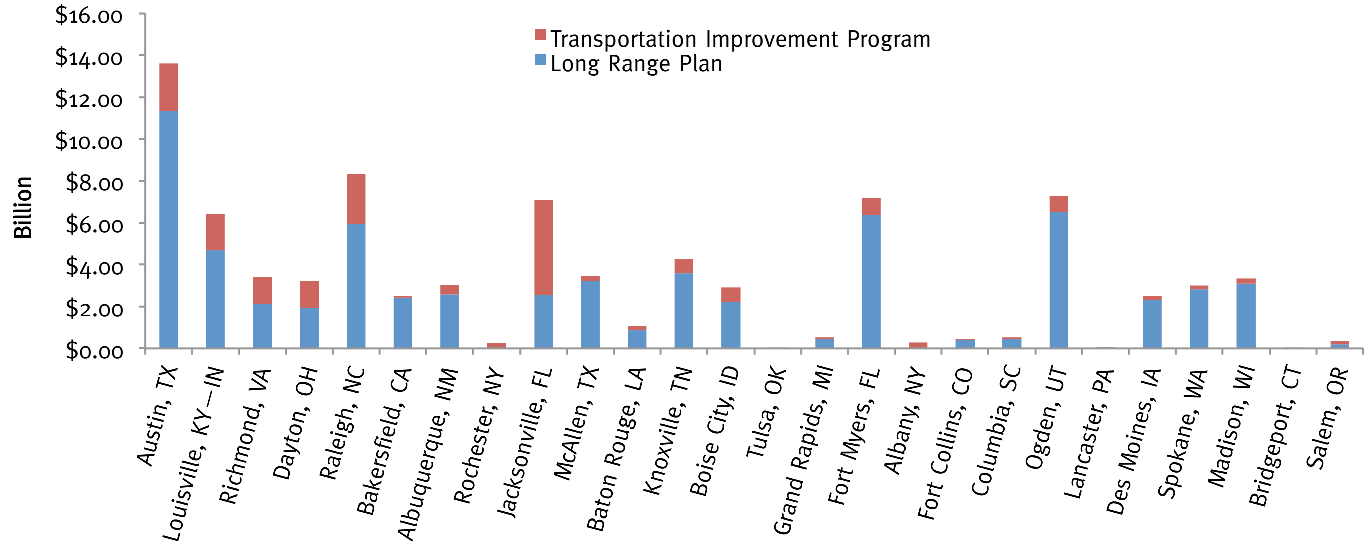


Table 12: Estimated Project Costs for Capacity Expansion

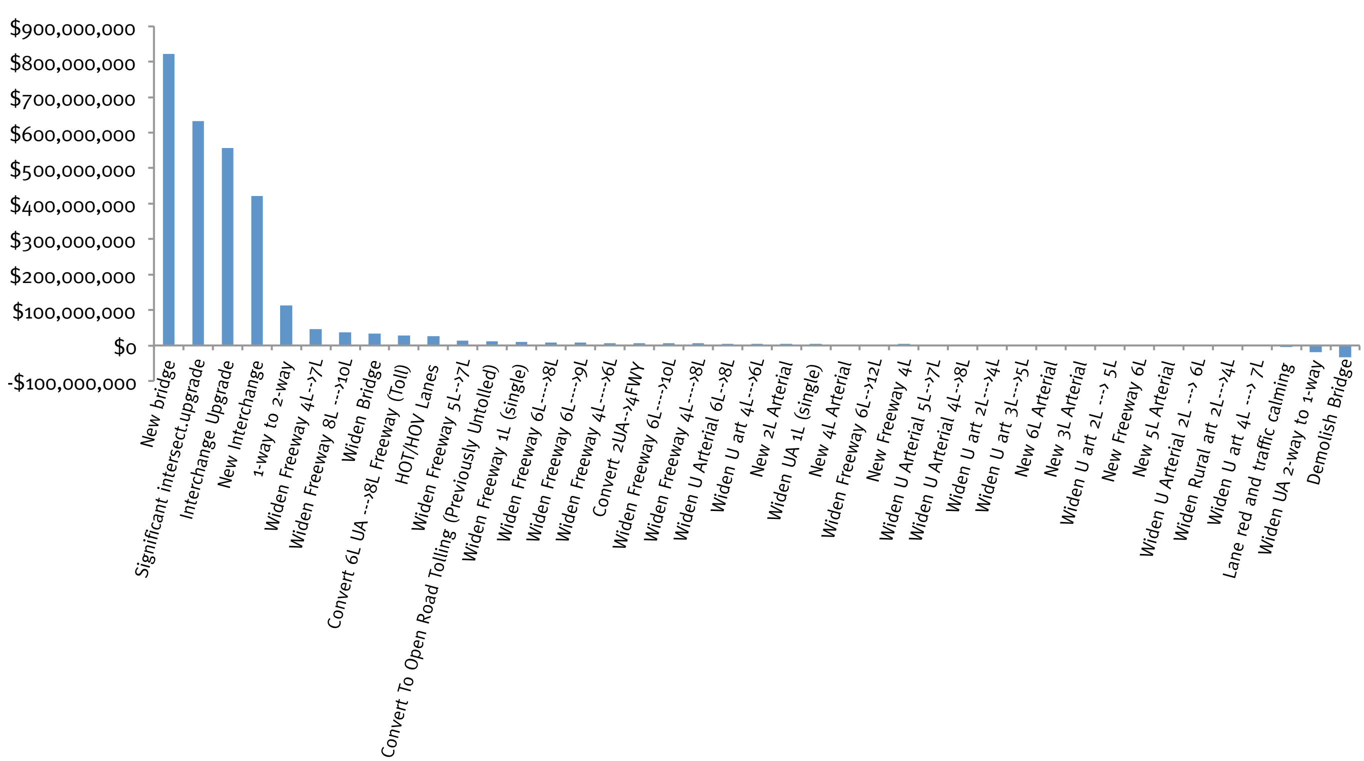
	LRP ($ B)	TIP ($ B)	Total ($ B)
Austin, TX	$11.33	$2.27	$13.60
Louisville, KY--IN	$4.69	$1.73	$6.42
Richmond, VA	$2.11	$1.29	$3.40
Dayton, OH	$1.93	$1.28	$3.21
Raleigh, NC	$5.94	$2.38	$8.32
Bakersfield, CA	$2.43	$0.10	$2.53
Albuquerque, NM	$2.58	$0.45	$3.03
Rochester, NY	$0.00	$0.25	$0.25
Jacksonville, FL	$2.54	$4.57	$7.11
McAllen--Edinburg--Mission, TX	$3.23	$0.23	$3.46
Baton Rouge, LA	$0.85	$0.23	$1.08
Knoxville, TN	$3.58	$0.66	$4.25
Boise City, ID	$2.20	$0.71	$2.91
Tulsa, OK	$0.00	$0.02	$0.02
Grand Rapids, MI	$0.44	$0.10	$0.54
Fort Myers--Cape Coral, FL	$6.36	$0.82	$7.18
Albany--Schenectady--Troy, NY	$0.00	$0.27	$0.27
Fort Collins, CO	$0.40	$0.00	$0.40
Columbia, SC	$0.45	$0.08	$0.53
Ogden, UT	$6.52	$0.75	$7.27
Lancaster, PA	$0.03	$0.03	$0.06
Des Moines, IA	$2.31	$0.19	$2.50
Spokane, WA	$2.81	$0.18	$2.99
Madison, WI	$3.10	$0.23	$3.33
Bridgeport--Milford, CT	$0.00	$0.04	$0.04
Salem, OR	$0.20	$0.14	$0.34
Total	$66.04	$19.00	$85.04

Figure 38: Estimated Project Costs for Expanded Capacity, by Region



The chart below shows the average cost per lane-mile added, by project type. The top four most expensive project types per lane-mile added (new bridges, intersection upgrades, interchange upgrades and new interchanges) far exceed the expense of other project types.

Figure 39: Average Cost per Lane-Mile Added

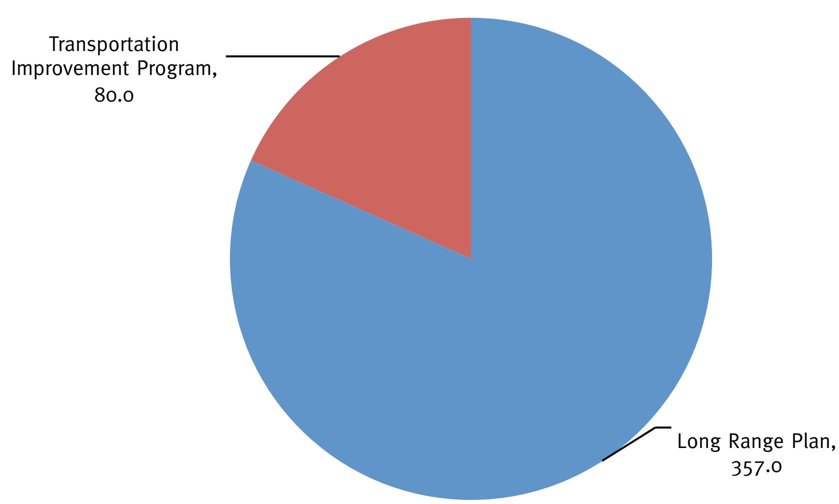


5. Impact on Congestion

To determine the impact of these planned expenditures on congestion in each region, we estimated the reduction in delay that could be expected from each action, *if implemented in a timely fashion.* This was determined by computing the reduction in travel time, which is the reduction in delay traveling through the project, multiplied by the affected traffic; more details for each project type are provided in Appendix 1.[40]

The following table and figure summarize the findings. Overall, about 437,700 vehicle-hours of daily delay would be saved across our 26 regions. About 81% of delay reduction comes from projects scheduled in the long range plan, and about 19% from TIP projects.

Figure 40: Savings in Delay (Daily Savings in Hours x 1000)



Savings in delay are generally proportional to region size and program size. The largest savings, about 75,500 hours daily, are in the Austin region, followed by about 53,900 hours in the Raleigh region and 36,300 hours in the McAllen region. Generally, the savings decline with region size, although Raleigh, McAllen, Ft. Myers and Des Moines appear to be exceptions, all showing larger potential savings relative to size.

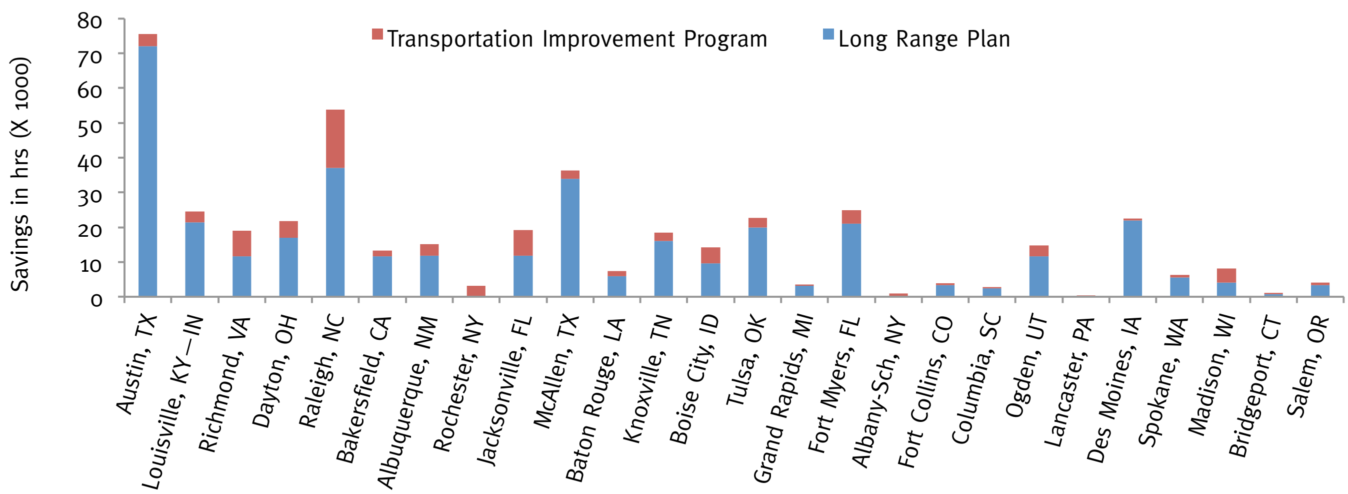
Table 13: Savings in Delay, Vehicle-Hours, by Region

Region (in size Order)	LRP (X 1000)	TIP (X 1000)	Total
Austin, TX	72.1	3.4	75.5
Louisville, KY--IN	21.5	3.1	24.6
Richmond, VA	11.7	7.2	18.9
Dayton, OH	17.0	4.8	21.8
Raleigh, NC	37.0	16.8	53.8
Bakersfield, CA	11.6	1.6	13.2
Albuquerque, NM	11.9	3.2	15.1

Table 13: Savings in Delay, Vehicle-Hours, by Region

Rochester, NY	0.0	3.1	3.1
Jacksonville, FL	11.8	7.4	19.2
McAllen--Edinburg--Mission, TX	33.9	2.4	36.3
Baton Rouge, LA	5.9	1.5	7.4
Knoxville, TN	16.1	2.4	18.5
Boise City, ID	9.7	4.5	14.2
Tulsa, OK	19.9	2.8	22.7
Grand Rapids, MI	3.1	0.5	3.6
Fort Myers--Cape Coral, FL	21.1	3.8	24.9
Albany--Schenectady--Troy, NY	0.0	1.0	1.0
Fort Collins, CO	3.3	0.5	3.8
Columbia, SC	2.4	0.5	2.9
Ogden, UT	11.6	3.2	14.8
Lancaster, PA	0.2	0.3	0.5
Des Moines, IA	22.0	0.5	22.5
Spokane, WA	5.6	0.7	6.3
Madison, WI	4.1	3.9	8.0
Bridgeport--Milford, CT	0.7	0.4	1.1
Salem, OR	3.4	0.7	4.1
Total	357.5	80.2	437.7

Figure 41: Savings in Delay, Daily Vehicle-Hours, by Region



More details on the nature of the potential savings are shown in the following table. The great majority (over 91%) of delay savings come from work types 1, 2, 3 and 4 (new freeways, new arterials, arterial widening and freeway widening), and about 75% of the savings are in widening urban arterials, building new urban arterials and upgrading arterials to freeways.

Figure 42: Daily Savings by Project Type (Sum of Daily Savings in Hours)

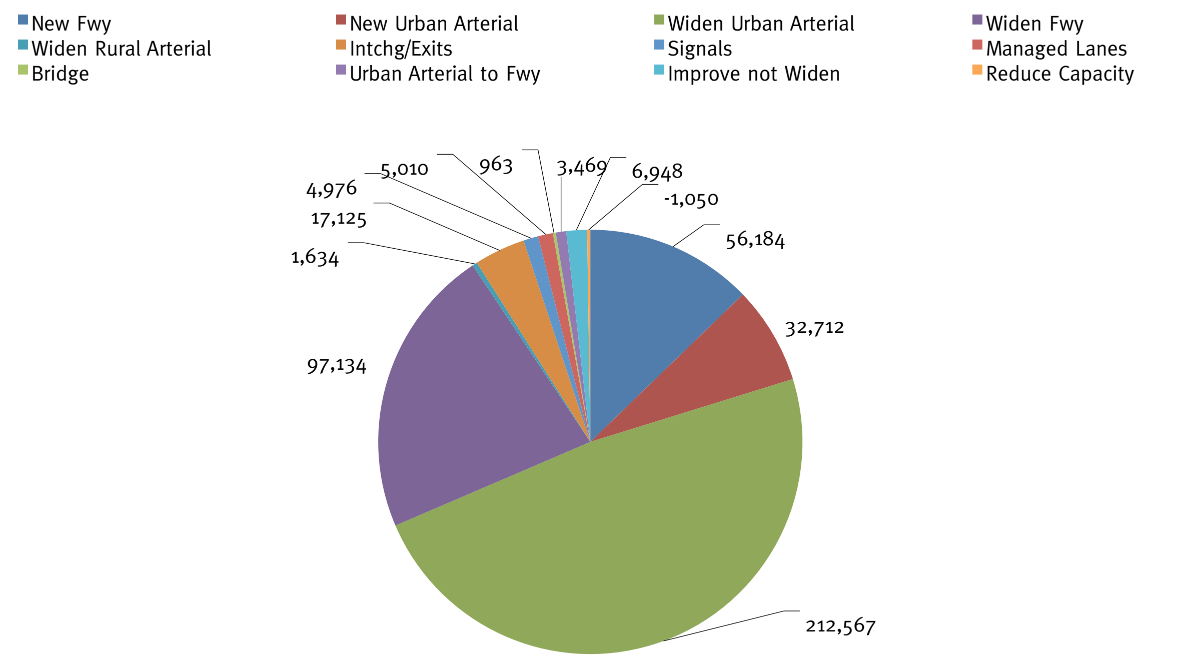
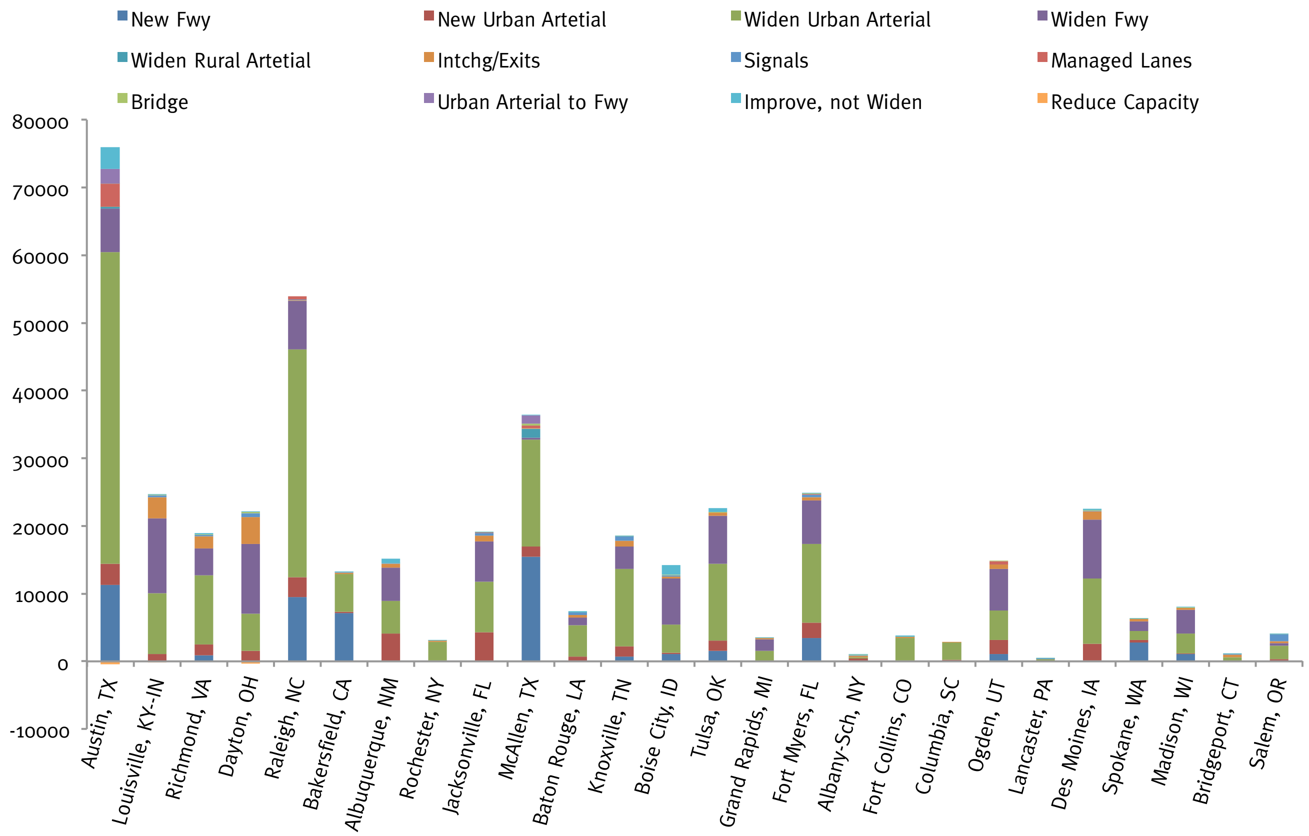


Table 14: Details of Potential Daily Savings in Delay, Hours/Day

Region	New Frwy	New Urban Arterial	Widen Urban Arterial	Widen Freeway *	Widen Rural Arterial*	Freeway Interchanges or Exits	Signals	Managed Lanes	Bridge Work	Upgrade Urban Arterial to Frwy	Improve but do not widen	Reduce Capacity	Total
(Work Type)	1	2	3	4	6	7	8	9	10	11	12	13	
Austin, TX	11,315	3,070	46,047	6,458	235	75	0	3,353	3	2,236	3,131	-402	75,520
Louisville, KY	0	1,061	8,978	11,086	0	3,153	253	0	93	0	101	-149	24,574
Richmond, VA	874	1,602	10,228	4,000	0	1,731	249	0	114	0	127	0	18,925
Dayton, OH	0	1,528	5,488	10,372	0	3,936	579	0	146	0	74	-353	21,771
Raleigh, NC	9,482	2,909	33,653	7,213	0	108	61	489	0	0	0	-55	53,862
Bakersfield, CA	7,099	242	5,575	0	0	154	123	0	2	0	7	0	13,201
Albuquerque, NM	0	4,148	4,781	4,948	0	523	125	0	2	0	649	-74	15,102
Rochester, NY	0	140	2,770	0	0	166	0	0	2	0	52	0	3,130
Jacksonville, FL	0	4,317	7,418	5,998	0	857	336	86	38	0	105	0	19,156
McAllen, TX	15,483	1,440	15,794	274	1399	67		417	220	1,233	5		36,331
Baton Rouge, LA	0	707	4,601	1,174	0	337	439	0	3	0	108	0	7,369
Knoxville, TN	680	1,494	11,459	3,348	0	882	615	0	15	0	10	-3	18,499
Boise, ID	1,118	113	4,239	6,752	0	323	184	0	42	0	1,407	0	14,177
Tulsa, OK	1,586	1,512	11,299	7,107	0	495	0	0	49	0	605	-6	22,647
Gr. Rapids, MI	0	0	1,543	1,736	0	198	0	0	12	0	50	0	3,538
Fort Myers, FL	3,443	2,239	11,670	6,418		442	377	162	104		13	-2	24,866
Albany-Sc-T, NY		448	164			141	184		6		44		988
Fort Collins, CO	0	133	3,290	0	0	225	0	0	2	0	152	0	3,802
Columbia, SC	0	196	2,570	0	0	94	0	0	0	0	0	0	2,860
Ogden, UT	1,062	2,057	4,403	6,176	0	623	12	502	3	0	0	0	14,839
Lancaster, PA	0	75	224	0	0	33	123	0	2	0	1	0	457
Des Moines, IA	163	2,467	9,627	8,658	0	1,258	123	0	15	0	194	0	22,505
Spokane, WA	2,814	338	1,307	1,436	0	403	0	0	15	0	3	-3	6,315
Madison, WI	1,064	120	2,895	3,547	0	289	0	0	72	0	83	-5	8,067
Bridgeport, CT		41	580			381	125	0	2		18		1,147
Salem, OR	0	315	1,965	433	0	231	1,070	0	3	0	7	0	4,023
Total	56,183	32,712	212,567	97,134	1,634	17,125	4,976	5,010	963	3,469	6,948	-1,050	437,672

*Work Type 5 was previously deleted. Missing data indicate no projects

Figure 43: Potential Delay Savings by Region and Project Type (Daily Savings in Hours)



6. Cost-Effectiveness

It is important to consider the construction costs for each project and contrast this with the minutes or dollars saved. There are several different ways to calculate cost-effectiveness. The chart below shows the *average* congestion delay savings in hours for each detailed project type. On average, major actions such as new freeways and freeway widenings are likely to save the most delay. For instance, a new four-lane freeway, by our calculations, is likely to save, on average, about 1,700 hours of delay per day. But few regions are planning new freeways. Freeway widenings are also big delay savers, but are also uncommon.

Another equally important metric is the *relative savings potential per dollar expended*. The following table shows this calculation, along with average traffic data, for each region. Note that average cost per hour saved is the weighted average (sum of cost estimate divided by sum of 20-year savings).[41] On average, the projects proposed in these TIPs and LRPs would cost about $18.84 per vehicle-hour saved.

Figure 44: Average Daily Savings in Delay by Project Type (in Hours)

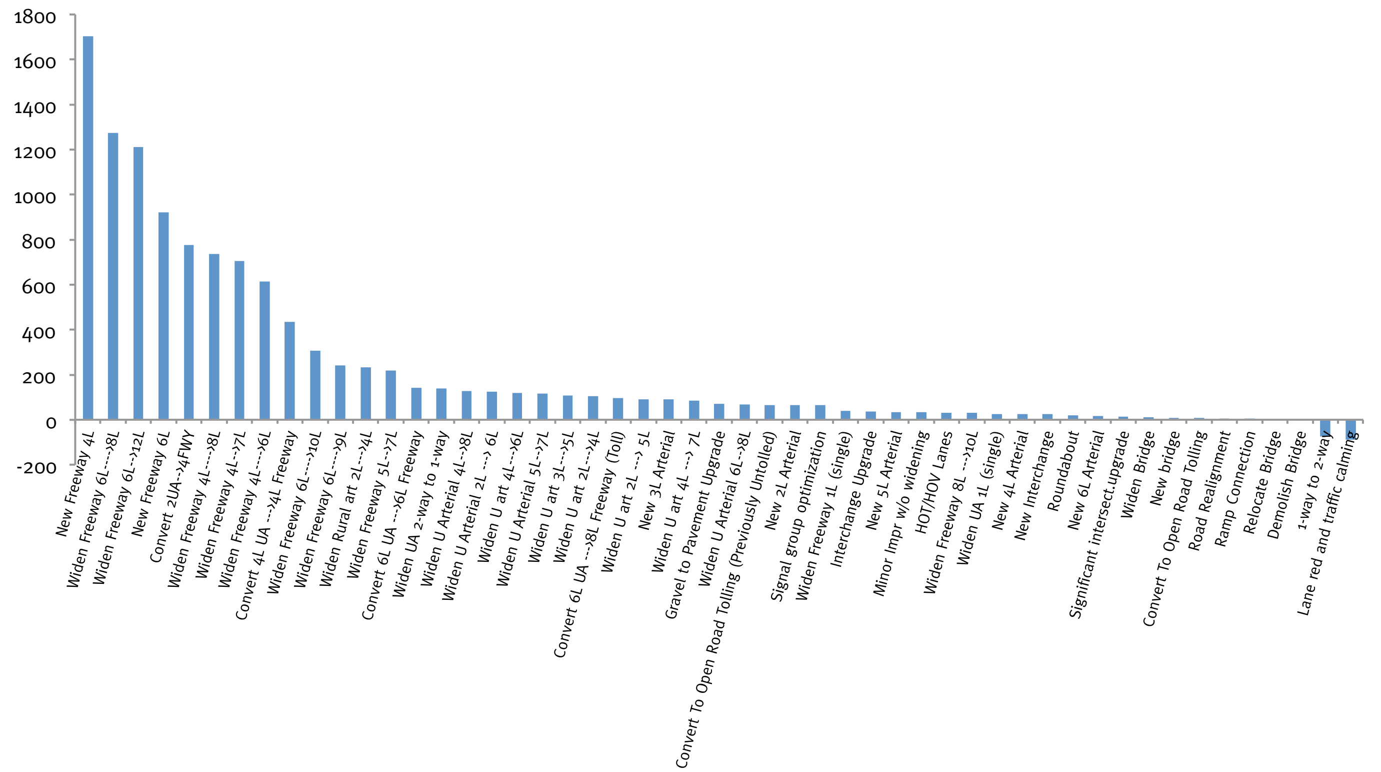


Table 15: Cost-Effectiveness of Savings, by Region

Region (in Size Order)	Project Count	Average Daily Traffic/Mile, (Thousands), 1995	Average Daily Traffic/Mile, (Thousands), 2005	Average Daily Traffic/Mile, (Thousands), 2030	Daily Savings in hours, Thousands	20-Year Savings (Millions)	Cost Estimate, (Billions)	Average Cost per Hour of Congestion Delay Savings
Austin, TX	700	21.2	22.0	26.7	75.5	755.2	$13.60	$18.01
Louisville, KY	277	26.6	29.2	38.0	24.6	245.7	$6.42	$26.12
Richmond, VA	407	19.3	19.9	24.0	18.9	189.3	$3.40	$17.98
Dayton, OH	295	21.2	22.3	27.7	21.8	217.7	$3.21	$14.73
Raleigh, NC	372	17.4	17.4	21.9	53.9	538.6	$8.32	$15.44
Bakersfield, CA	75	19.9	19.8	23.5	13.2	132.0	$2.53	$19.15
Albuquerque, NM	159	22.1	23.5	29.5	15.1	151.0	$3.03	$20.06
Rochester, NY	57	17.8	17.9	21.4	3.1	31.3	$0.25	$8.02
Jacksonville, FL	194	21.0	22.1	27.4	19.2	191.6	$7.11	$37.14
McAllen, TX	227	12.2	12.0	13.3	36.3	363.3	$3.46	$9.53
Baton Rouge, LA	126	18.6	19.0	22.8	7.4	73.7	$1.08	$14.63
Knoxville, TN	223	19.6	20.3	24.8	18.5	185.0	$4.25	$22.96
Boise City, ID	96	40.1	46.1	63.1	14.2	141.8	$2.91	$20.55
Tulsa, OK	157	24.7	26.2	33.4	22.6	226.5	$0.24	$1.05
Grand Rapids, MI	113	20.8	21.8	27.0	3.5	35.4	$0.54	$15.25
Fort Myers FL	278	19.9	20.7	25.1	24.9	248.7	$7.18	$28.87
Albany-Schenectady NY	38	16.9	16.9	19.8	1.0	9.9	$0.27	$27.71
Fort Collins, CO	62	23.2	24.8	31.3	3.8	38.0	$0.40	$10.40
Columbia, SC	28	17.6	17.8	21.3	2.9	28.6	$0.53	$18.66
Ogden, UT	107	30.3	33.4	44.1	14.8	148.4	$7.27	$48.99
Lancaster, PA	22	13.3	12.3	13.0	0.5	4.6	$0.05	$11.24
Des Moines, IA	281	23.0	24.6	30.9	22.5	225.1	$2.50	$11.11
Spokane, WA	76	16.7	16.6	19.5	6.3	63.1	$2.99	$47.35
Madison, WI	125	17.2	17.2	20.2	8.1	80.7	$0.54	$6.68
Bridgeport, CT	50	19.9	20.6	25.4	1.1	11.5	$0.04	$3.59
Salem, OR	103	15.3	14.8	16.8	4.0	40.2	$0.34	$8.55
Grand Total	4,648	20.8	21.7	26.9	437.7	4,376.7	$82.46	$18.84

A third approach is to review average costs per hour of delay saved. The following table computes these relative cost-effectiveness indices for detailed project types. Some project types (bridge demolitions, lane reductions, traffic calming and one-way to two-way conversions) actually *increase* delay. But of those that reduce delays, *the most cost-effective projects are typically those that increase throughput at relatively low cost: converting arterial pairs from two-way to one-way, widening high-volume arterials, implementing signal group optimization and widening urban and rural arterials from two lanes to four lanes.* On the other hand, new interchanges and arterials and HOV lanes are typically the least cost-effective. In medium-sized regions the cross-street traffic volumes of new interchanges do not typically justify the expense, and new arterials and HOV lanes are relatively expensive to construct considering the low traffic volumes.

Table 16: Cost-Effectiveness of Savings, by Project Type

Congestion Delay Savings Summary by Project Type	Project Type Code	Project Count	Average of 1995 Thousand vehicle-miles traveled /Mile	Average of 2005 Thousand VMT /Mile	Average of 2030 Thousand Vehicle-Miles Traveled /Mile	Average of Daily Savings in K hours	Sum of 20-Year Savings ($M)	Sum of Cost Estimate ($B)	Sum of Lane-Miles Added (Including Estimated Length Projects)	Avg. Cost per Hour of Congestion Delay Savings	Average Cost per Lane-Mile Added (Including Estimated Length Projects) ($M)
Demolish Bridge	38.0	4.0	13.3	12.3	13.0	-2.1	-0.1	$0.0	-0.4	-$156.75	-$32.965
Lane Red Traffic Calming	35.0	8.0	19.2	19.9	23.4	-87.5	-5.3	$0.1	-23.2	-$23.56	-$5.342
1-way to 2-way	36.0	7.0	15.0	14.5	16.0	-73.7	-5.2	$0.0	0.1	-$2.18	$112.573
Relocate Bridge	53.0	1.0	13.3	12.3	13.0	1.6	0.0	$0.0	0.0	$0.00	-
Widen Urban Arterial 2-way to 1-way	37.0	12.0	27.8	30.8	39.8	137.9	16.5	$0.0	-1.4	$1.63	-$19.375
Widen Urban Arterial 4 lane ---› 7 lane	29.0	1.0	25.1	27.6	33.8	84.3	0.8	$0.0	4.8	$2.97	$0.521
Signal Group Optimization	12.0	95.0	13.3	12.3	13.0	63.8	49.8	$0.2	0.0	$3.02	-
Gravel-to Pavement Upgrade	45.0	25.0	13.3	12.3	13.0	70.9	17.7	$0.1	0.0	$3.89	-
Widen Rural Arterial 2 lane ---›4 lanes	7.0	7.0	12.2	11.4	12.0	233.4	16.3	$0.1	112.3	$4.70	$0.685
Widen Urban Arterial 3 lane---›5 lane	31.0	13.0	25.1	27.6	33.8	108.6	14.1	$0.1	26.8	$4.81	$2.540
Convert 2 lane Urban Arterial--›4 lane Freeway	52.0	2.0	44.4	46.2	60.0	777.3	15.5	$0.1	12.6	$5.02	$6.190
Convert to Tolling	54.0	3.0	13.3	12.3	13.0	7.1	0.2	$0.0	0.0	$6.60	-
Widen Freeway 6 lane---›8 lane	3.0	11.0	77.0	92.8	132.4	1273.4	140.1	$1.1	129.4	$7.51	$8.133
Widen Freeway 4 lane---›6 lane	4.0	111.0	73.1	87.3	125.1	612.6	680.0	$6.4	942.0	$9.38	$6.771
Widen Urban Arterial 5 lane--›7 lane	46.0	5.0	29.0	31.3	39.1	117.1	5.9	$0.1	21.5	$10.02	$2.731
Roundabout	15.0	21.0	13.3	12.3	13.0	18.3	3.9	$0.0	0.0	$10.36	-
Widen Urban Arterial 2 lane---›4 lane	6.0	1314.0	12.9	11.9	12.9	105.9	1391.9	$14.8	6465.0	$10.61	$2.284
New 3 lane Arterial	25.0	55.0	13.0	12.0	12.7	90.3	49.7	$0.6	277.1	$11.67	$2.092
Widen Freeway 4 lane---›8 lane	5.0	12.0	68.0	81.4	115.5	735.8	88.3	$1.1	193.6	$11.99	$5.467
New Freeway 6 lane	30.0	18.0	55.4	63.1	90.9	920.9	165.8	$2.1	1144.7	$12.84	$1.860
Widen Urban Arterial 2 lane ---› 5 lane	27.0	158.0	13.2	12.2	13.0	90.7	143.3	$2.0	937.4	$13.67	$2.089
Widen Urban Arterial 2 lane ---› 6 lane	33.0	49.0	13.3	12.3	13.0	124.7	61.1	$0.8	482.0	$13.69	$1.735
Widen Urban Arterial 4 lane--›8 lane	50.0	4.0	25.1	27.6	33.8	126.7	5.1	$0.1	28.9	$15.38	$2.698
New Freeway 4 lane	2.0	23.0	57.1	64.4	88.3	1722.0	396.1	$6.1	1441.2	$15.39	$4.231
Widen Urban Arterial 4 lane---›6 lane	17.0	309.0	25.0	27.4	33.7	120.6	372.5	$5.8	1393.5	$15.45	$4.131
Convert 4 lane Urban Arterial ---›4 lane Freeway	22.0	7.0	49.1	52.8	70.3	434.3	30.4	$0.5	0.0	$16.32	-

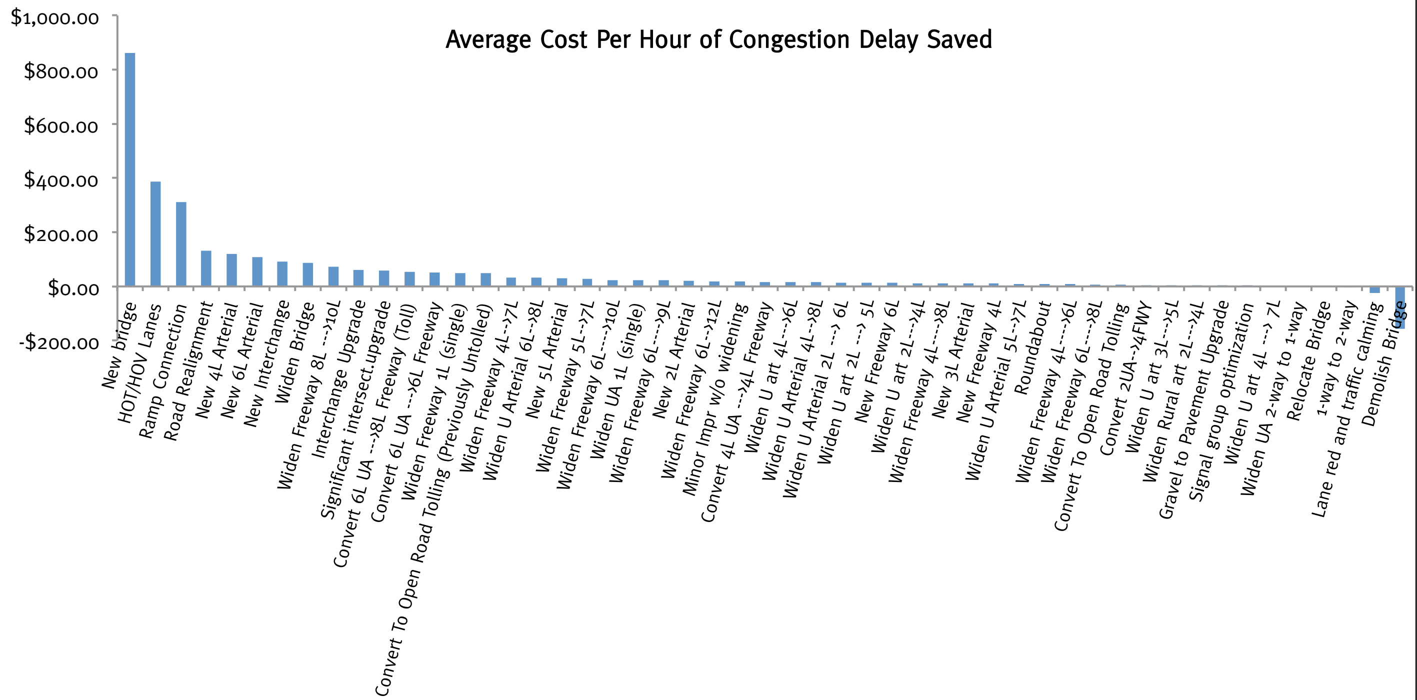
Table 16: Cost-Effectiveness of Savings, by Project Type

Congestion Delay Savings Summary by Project Type	Project Type Code	Project Count	Average of 1995 Thousand vehicle-miles traveled /Mile	Average of 2005 Thousand VMT /Mile	Average of 2030 Thousand Vehicle-Miles Traveled /Mile	Average of Daily Savings in K hours	Sum of 20-Year Savings ($M)	Sum of Cost Estimate ($B)	Sum of Lane-Miles Added (Including Estimated Length Projects)	Avg. Cost per Hour of Congestion Delay Savings	Average Cost per Lane-Mile Added (Including Estimated Length Projects) ($M)
Minor Improvement without Widening	34.0	219.0	20.7	21.7	26.6	31.9	69.5	$1.2	0.0	$17.38	-
Widen Freeway 6 Lane-->12 Lane	49.0	1.0	77.0	92.8	132.4	1210.6	12.1	$0.2	69.9	$18.31	$3.172
New 2 Lane Arterial	10.0	282.0	12.9	11.9	12.5	64.2	181.2	$3.9	943.1	$21.62	$4.152
Widen Freeway 6 Lane--->9 Lane	44.0	5.0	77.0	92.8	132.4	241.1	12.1	$0.3	34.8	$22.69	$7.859
Widen Urban Arterial by One Lane (single)	1.0	352.0	15.0	14.4	16.0	25.8	90.6	$2.1	540.3	$23.70	$3.974
Widen Freeway from 6 Lane---->10 Lane	42.0	4.0	77.0	92.8	132.4	307.8	12.3	$0.3	47.4	$23.74	$6.168
Widen Freeway 5 Lane-->7 Lane	51.0	1.0	77.0	92.8	132.4	218.2	2.2	$0.1	4.2	$27.83	$14.459
New 5 Lane Arterial	26.0	9.0	13.3	12.3	13.0	33.1	3.0	$0.1	49.8	$30.47	$1.821
Widen Urban Arterial 6 Lane-->8 Lane	47.0	9.0	25.1	27.6	33.8	66.9	6.0	$0.2	40.0	$31.75	$4.786
Widen Freeway 4 Lane-->7 Lane	48.0	3.0	77.0	92.8	132.4	705.0	21.1	$0.7	15.0	$32.77	$46.211
Convert To Toll Previously Untolled)	55.0	21.0	38.5	39.7	51.0	66.3	13.9	$0.7	57.7	$49.80	$12.021
Widen Freeway by 1 Lane (single)	41.0	7.0	77.0	92.8	132.4	40.3	2.8	$0.1	14.1	$49.92	$9.962
Convert 6 Lane Urban Arterial --->6 Lane Freeway	21.0	3.0	44.4	46.2	60.0	142.9	4.3	$0.2	0.0	$52.01	-
Convert 6 Lane Urban Arterial--->8 Lane Freeway (Toll)	56.0	3.0	44.4	46.2	60.0	97.0	2.9	$0.2	5.7	$54.93	$28.035
Significant Intersection Upgrade	11.0	546.0	13.4	12.4	13.1	12.7	69.4	$4.0	6.3	$57.47	$632.635
Interchange Upgrade	23.0	179.0	65.4	78.1	109.3	37.5	67.2	$4.1	7.3	$60.51	$556.817
Widen Freeway 8 Lane --->10 Lane	24.0	1.0	77.0	92.8	132.4	31.2	0.3	$0.0	0.6	$72.17	$37.500
New 4 Lane Arterial	9.0	341.0	13.1	12.1	13.0	26.0	88.6	$7.0	2842.4	$79.01	$2.464
Widen Bridge	28.0	48.0	32.5	36.6	48.9	9.6	4.6	$0.4	11.9	$87.24	$33.733
New Interchange	18.0	109.0	42.7	49.0	67.4	24.8	27.0	$2.5	6.0	$93.69	$421.689
New 6 Lane Arterial	40.0	27.0	13.3	12.3	13.0	17.3	4.7	$0.5	222.1	$107.86	$2.267
Road Realignment	32.0	63.0	13.7	12.8	13.7	5.0	3.1	$0.4	0.0	$131.95	-
Ramp Connection	16.0	18.0	64.5	76.1	107.0	4.2	0.8	$0.2	0.0	$310.98	-
HOT/HOV Lanes	13.0	57.0	45.1	51.2	69.3	31.3	17.5	$6.8	263.3	$387.01	$25.745
New Bridge	14.0	65.0	20.5	21.4	26.5	7.7	5.0	$4.3	5.3	$862.39	$821.625
	Grand Total	4648.0	20.8	21.7	26.9	94.6	4376.7	$82.5	18775.0	$18.84	$4.392

7. How Much Will Congestion Increase?

Having estimated the amount of congestion relief that the 26 regional plans are likely to contain, we turn to determining the congestion growth in each region. First, we estimate the amount of current congestion (vehicle-hours of delay) in each region, and then we estimate how much congestion will increase in the future. Essentially, we apply the predicted growth in TTI (an index of congestion growth) to the entire population growth of each region. Appendix 1 provides more details on the procedure.

Figure 45: Cost-Effectiveness, by Project Type



The following table shows the projected growth in peak-period travel time and delay in each region. Overall, the regions are expected to experience a 67% increase in peak-period travel time, but delay is expected to increase much more rapidly, about 186%. The regions with the largest percent increases are those that are growing the most rapidly.

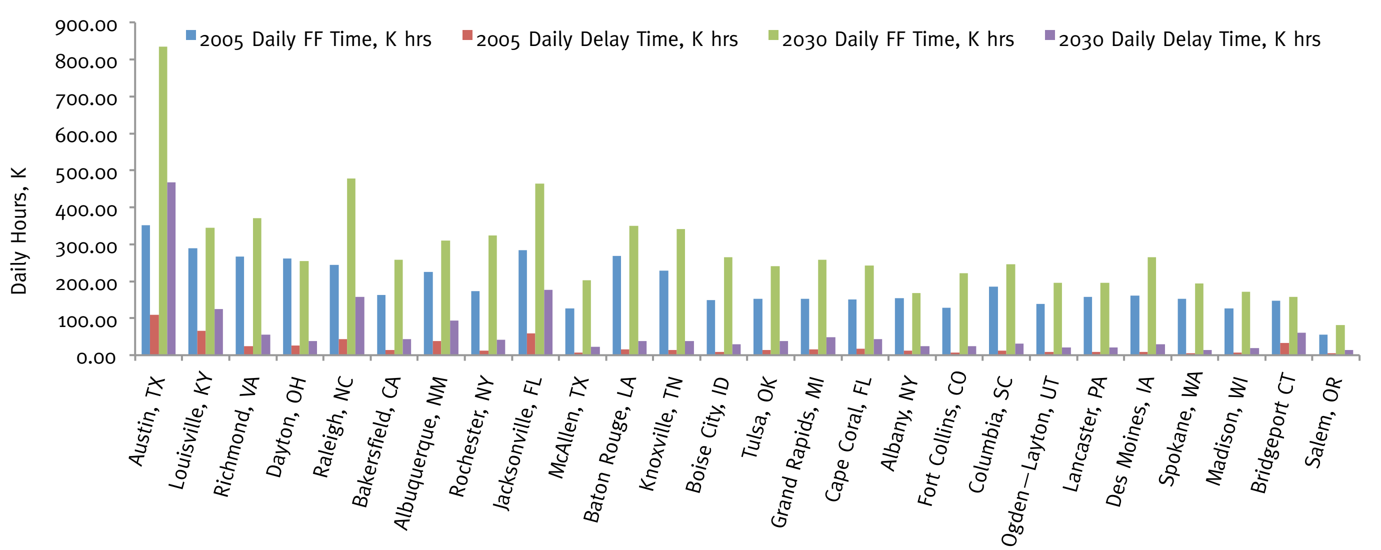
Table 17: Growth in Congestion Delay, 2005–30

Region (in order of percent increase in delay)	2005 Daily Free-Flow Travel Time, Thousands Hours	2005 Daily Delay Time, Thousands Hours	2005 Total Daily Commuter Time, Thousands Hours	2005 Annual Delay Hours Per Commuter	2030 Daily Free Flow Time, Thousands Hours	2030 Daily Delay Time, Thousands Hours	2030 Total Daily Commuter Time, Thousands Hours	2030 Annual Delay Hours per Commuter	Percent Increase in Delay
Austin, TX	352.0	109.1	461.1	45.95	834.5	467.3	1301.7	83.00	328.3
Raleigh, NC	244.6	44.0	288.7	29.24	477.1	157.5	634.6	53.60	257.6
Rochester, NY	172.8	12.1	184.9	10.41	324.7	42.2	367.0	19.34	249.1
Boise City, ID	149.7	9.0	158.7	9.15	264.2	29.1	293.3	16.78	223.6
Grand Rapids, MI	152.2	15.2	167.4	15.08	258.5	49.1	307.6	28.64	222.7
Fort Collins, CO	128.4	7.7	136.1	9.95	222.1	24.4	246.5	18.25	217.2
Des Moines, IA	161.1	9.7	170.7	8.73	265.3	29.2	294.4	16.00	201.9
Bakersfield, CA	163.2	14.7	177.9	14.79	258.4	43.9	302.3	27.94	199.1
Jacksonville, FL	284.3	59.7	344.0	36.01	463.5	176.1	639.6	65.17	195.0
McAllen, TX	126.9	7.6	134.5	10.09	201.9	22.2	224.1	18.51	191.8
Tulsa, OK	152.7	13.7	166.5	12.45	240.0	38.4	278.5	22.14	179.4
Salem, OR	55.5	5.0	60.5	15.00	82.0	13.9	95.9	28.33	179.1
Knoxville, TN	228.6	13.7	242.3	9.95	342.1	37.6	379.7	18.25	174.4
Ogden--Layton, UT	139.2	8.3	147.5	10.05	195.5	21.5	217.0	18.42	157.5
Madison, WI	125.9	7.6	133.5	9.01	171.0	18.8	189.8	16.52	149.0
Columbia, SC	185.2	13.0	198.2	11.83	245.2	31.9	277.1	21.97	145.9
Albuquerque, NM	225.2	38.3	263.5	26.76	310.8	93.3	404.1	47.22	143.5
Cape Coral, FL	151.1	18.1	169.2	20.80	242.9	43.7	286.6	31.21	141.1

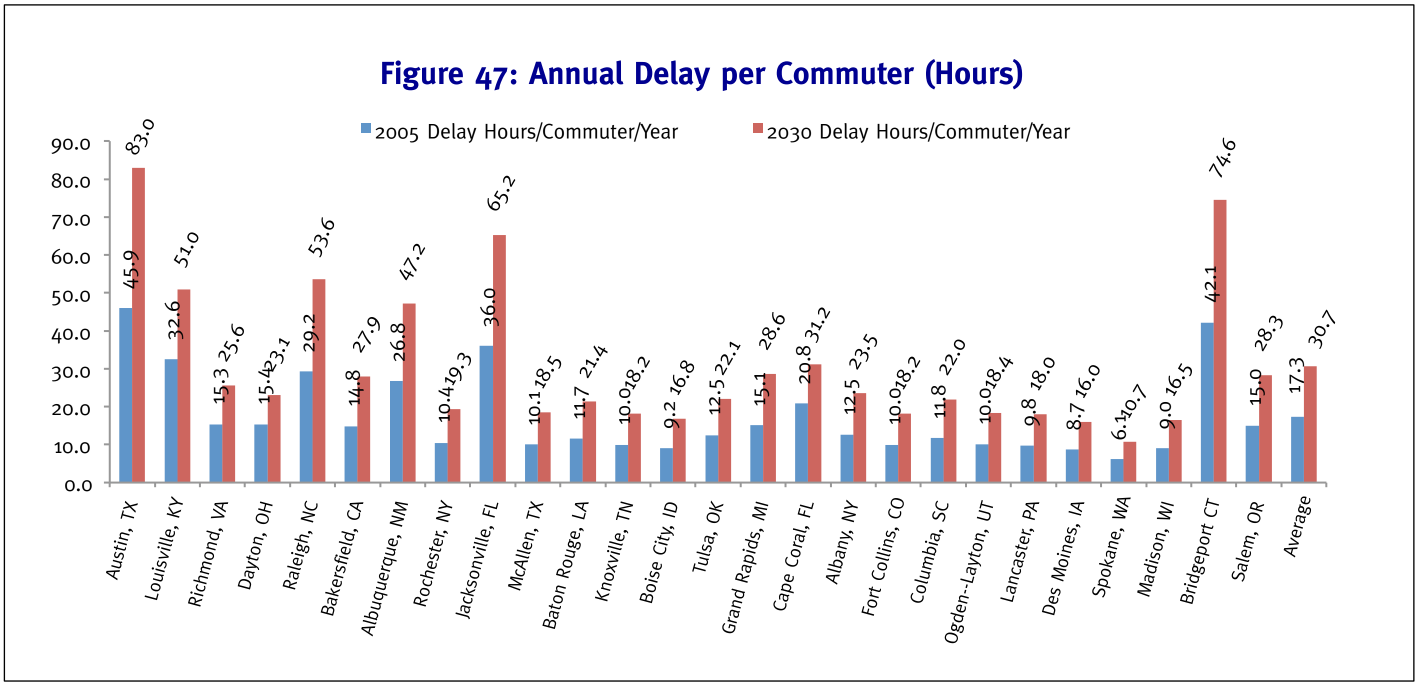
Table 17: Growth in Congestion Delay, 2005–30

Region (in order of percent increase in delay)	2005 Daily Free-Flow Travel Time, Thousands Hours	2005 Daily Delay Time, Thousands Hours	2005 Total Daily Commuter Time, Thousands Hours	2005 Annual Delay Hours Per Commuter	2030 Daily Free Flow Time, Thousands Hours	2030 Daily Delay Time, Thousands Hours	2030 Total Daily Commuter Time, Thousands Hours	2030 Annual Delay Hours per Commuter	Percent Increase in Delay
Baton Rouge, LA	269.1	16.1	285.3	11.65	349.7	38.5	388.2	21.36	138.2
Richmond, VA	267.4	24.1	291.4	15.34	371.5	55.7	427.2	25.57	131.6
Lancaster, PA	157.9	9.5	167.4	9.81	196.4	21.6	218.0	17.99	128.1
Spokane, WA	151.8	6.1	157.9	6.12	193.8	13.6	207.3	10.71	123.3
Albany, NY	154.0	12.3	166.3	12.53	168.2	25.2	193.4	23.50	104.7
Bridgeport CT	148.2	32.6	180.8	42.08	157.8	61.5	219.3	74.59	88.7
Louisville, KY	288.9	66.5	355.4	32.57	345.4	124.3	469.7	50.98	87.1
Dayton, OH	261.9	26.2	288.1	15.38	254.8	38.2	293.1	23.07	45.9
Average	188.4	23.1	211.4	8.67	286.1	66.1	352.2	15.37	186.5
Sum	4897.7	599.9	5497.6		7437.3	1718.8	9156.1		

Figure 46: Components of Change in Peak-Period Travel, 2005–2030



Annual delay per commuter will increase, on average, about 85%, from 17.3 hours per year to about 31 hours per year. However, annual delay in the more congested regions will approach 80 hours per year, or about two work weeks per year.



8. Difference between Plan Savings and Congestion Growth

Having reviewed what the regional plans contain and how growth will increase delay in each region, we are now able to evaluate the plans according to their effectiveness. The following table and figures summarize the findings. The key findings are:

- ***In 22 of the 26 regions, the expected growth in congestion delay is larger, often considerably, than the delay savings contained in the plans*** *(Dayton, McAllen, Ogden and Des Moines are exceptions). This means that unless further actions are taken or projects are expedited, most regions will have worse congestion in the future, after planned projects are built, than now.*
- ***However, a number of regions have "deficits" that are relatively small, suggesting that modest changes to the plans would allow these regions to hold the line on congestion.*** *Similarly, in those regions that have estimated "surpluses" in their plans, actions should be taken to shore up the plan and implement projects on schedule. This is particularly the case since growth rates have recently slowed, increasing the chances that regions can mitigate congestion.*
- *Some regions have a "systemic" deficit in their plan: it is highly unlikely that the present plans, even if implemented on schedule, would have any measurable effect on congestion.* ***For these regions, a substantial review and revision of plans is in order.***

Looking at the pattern of savings, the plans can be grouped into four general categories:

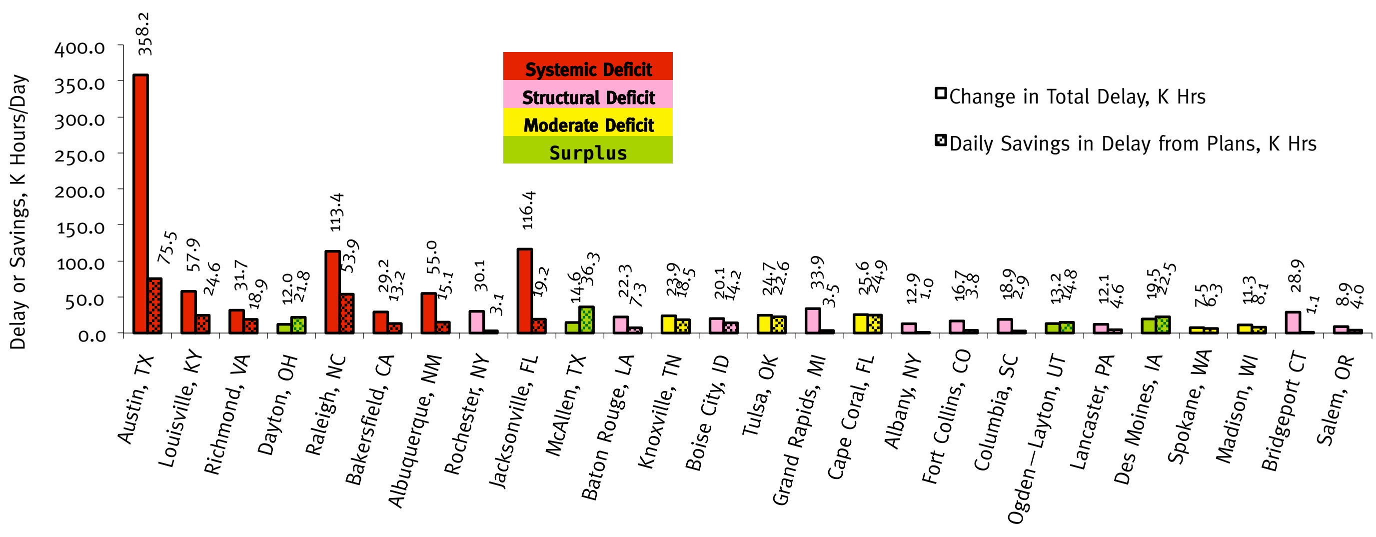
- (Green) Generally smaller regions that actually have a "surplus" between plan savings and congestion growth. Of the 26 regions we reviewed, four fall into this category: Dayton, McAllen, Ogden and Des Moines.

- (Yellow) Mid-sized regions of 500–600,000 population that have modest "deficits" between their plans and congestion growth. Of the 26 regions, five are in this category: Knoxville, Tulsa, Cape Coral, Spokane and Madison.
- (Red) Generally larger regions that have "systemic deficits" between plan content and congestion growth. These are regions that have growth rates so high or costs so low, that their plans are unlikely to significantly reduce congestion, even if substantially modified. Of our 26 regions, seven are in this category: Austin, Louisville, Richmond, Raleigh, Bakersfield, Albuquerque and Jacksonville. However, the recent slowdown in traffic growth suggests that some of these regions are still small enough to be able reduce congestion through concerted actions—essentially putting them in the "yellow" category.
- (Pink) Other medium or smaller size regions, which seem to have "structural deficits" between their plans and congestion growth. These are regions whose plans are so tilted toward ineffective actions that they are highly unlikely to provide congestion relief. The regions in this category are Rochester, Baton Rouge, Grand Rapids, Albany, Ft. Collins, Columbia, Lancaster, Bridgeport and Salem. In these regions, a serious, objective re-thinking of the purpose and content of the plans, and the specifics of the proposed projects, is in order. Ironically, most of these places are smaller regions that could probably significantly reduce congestion. If the citizens of these regions indicate that congestion is an important issue then the plans should reflect that concern, not ignore it.

Table 18: Increase in Delay vs. Plan Savings, 2005–30

Region (in order of size)	Base Population, Long Range Plan, Thousands	Percent Population Growth, 2005-30	Increase in Daily Delay, Thousands Hours, 2005-30	Savings in Daily Delay from Plans, Thousands Hours	Difference, Thousands Hours	Percent Difference	Deficit or Surplus
Austin, TX	1,160	137	358.2	75.5	-282.7	-78.9	Systemic
Louisville, KY	947	20	57.9	24.6	-33.3	-57.5	Systemic
Richmond, VA	827	39	31.7	18.9	-12.8	-40.3	Systemic
Dayton, OH	822	-3	12.0	21.8	9.8	81.1	Surplus
Raleigh, NC	729	95	113.4	53.9	-59.5	-52.5	Systemic
Bakersfield, CA	694	58	29.2	13.2	-16.0	-54.9	Systemic
Albuquerque, NM	692	38	55.0	15.1	-39.9	-72.5	Systemic
Rochester, NY	665	11	30.1	3.1	-27.0	-89.7	Systemic
Jacksonville, FL	644	63	116.4	19.2	-97.2	-83.5	Systemic
McAllen, TX	627	59	14.6	36.3	21.7	148.6	Surplus
Baton Rouge, LA	611	30	22.3	7.3	-15.0	-67.3	Systemic
Knoxville, TN	598	50	23.9	18.5	-5.4	-22.6	Modest
Boise City, ID	554	77	20.1	14.2	-5.9	-29.3	Modest
Tulsa, OK	551	57	24.7	22.6	-2.1	-8.4	Modest
Grand Rapids, MI	544	43	33.9	3.5	-30.4	-89.7	Structural
Cape Coral, FL	530	61	25.6	24.9	-0.7	-2.7	Modest
Albany, NY	511	9	12.9	1.0	-11.9	-92.4	Structural
Fort Collins, CO	500	73	16.7	3.8	-12.9	-77.3	Structural
Columbia, SC	497	32	18.9	2.9	-16.0	-84.7	Structural
Ogden--Layton, UT	482	40	13.2	14.8	1.6	12.5	Surplus
Lancaster, PA	471	24	12.1	4.6	-7.5	-62.1	Structural
Des Moines, IA	456	65	19.5	22.5	3.0	15.3	Surplus
Spokane, WA	442	28	7.5	6.3	-1.2	-15.9	Modest
Madison, WI	427	36	11.3	8.1	-3.2	-28.0	Modest
Bridgeport CT	309	6	28.9	1.1	-27.8	-96.2	Structural
Salem, OR	203	48	8.9	4.0	-4.9	-55.3	Structural
Unweighted Average	595.9	44	43.0	17.0	-26.0	-38.6	
Sum			1,119.0	441.7	-677.3		

Figure 48: Delay Increases vs. Plan Savings (2005–2030)



In the recommendations section below, we suggest further what each region should do**.**

G. Benefits of Congestion Relief

The benefits of congestion improvement traditionally include direct user benefits, primarily decreased travel time and savings in vehicle operating costs. But in addition to these benefits, individuals can get to more distant locations more easily, increasing their "opportunity circle." In this way, society also gains through better access to jobs, shopping and recreation. Other benefits include increased travel time reliability, increased economic activity and lower vehicle emissions. The following table is intended to summarize these benefits for the regions as a whole.

The largest direct benefit from most transportation projects is decreased travel time, compared with pre-project circumstances. Indeed, that is the primary reason why transportation projects are built. As noted above, in total these projects would save about 437,000 hours of travel time daily. At an average value of time of $13.00 per hour (about ½ the average wage rate), the value of these time savings over 20 years is about $56.9 B.[42] The value of improved travel time *reliability* (the certainty of being able to arrive when planned), is about 70% of the value of travel time, or about $39.82 B, over 20 years.[43] The value of fuel saved, at $3.50/gallon, adds another $22.98 B. Together these direct benefits to users total $119.7 B, over 20 years, in current dollars.

Table 19: Benefits vs. Costs of Congestion Relief, 26 Mid-Sized Regions			
Class of Benefit			
User Benefits	Basis	Calculation	Benefit over 20 Years
Savings in Travel Time	Value of Saved Time	437,000 hours daily *250 days/year *20 years *2 directions *$13/hour	$56.88 B
Improved Reliability of Travel	Value of Reliability	0.7 * value of time	$39.82 B
Fuel Savings	Value of Fuel	4.376 B hours saved *30 miles per hour/ 20 miles per gallon * $ 2/gallon	$13.13 B
Subtotal			$109.83 B
Regional Economic Impact	"Multiplier" on construction costs	$82.46 B * 0.3 (assumes ½ of multiplier stays local)	$24.74 B
	"Multiplier" on user savings	$109.83 B * 0.6 (assumes all user savings are local)	$65.89 B
Subtotal			$90.63B
Total			$200.45 B
Project Costs			$82.46 B
Employment Impacts	Construction	10,000 jobs per $ 1 Billion (short term)	824,600 equivalent jobs
	Productivity gains	10,000 jobs per $ 1 Billion (over 20 years)	2,004,500 equivalent jobs
Carbon Dioxide Emissions	Tons of CO_2 emissions saved	Savings of 3,011 tons/day from congestion relief, x 250 days/year (about 1% of 2005 Carbon Dioxide emissions), * 250 work days/year	753,000 tons/year

In addition to these benefits, the regions also gain in terms of improved access, which translates into better choices for shopping, jobs and recreation. One method of expressing this impact is through the use of "multipliers," which are economic expansion factors that account for how expenditures ripple through economies. A typical value of a multiplier is 0.6, indicating a 60% increase in economic activity.[44] Using this incremental multiplier, the value of the incremental benefit (beyond construction jobs, which are a transfer) and the value of the user savings, is about $90.63 B.[45] So, the overall benefit of these projects totals $200 B over 20 years, compared with a cost of about $82.4 B.

A second method for analyzing these benefits is through the prism of "equivalent jobs."[46] This is not an additional benefit but another way to express the benefits. The equivalent jobs related to project construction are about 824,000, but this is spread out over 20 years and several thousand projects. And since these jobs are supported by taxpayers through fuel taxes and other fees, these are not "new" positions. Improvements in productivity, however, do produce additional wealth, with the equivalent jobs value of about 2,004,600 jobs, spread out over 20 years and several thousand projects. The real gain from transportation investments is not the short-term construction jobs but the longer-term savings in travel time and improved accessibility, which pays benefits over the long term.

Finally, emissions impacts should not be neglected. The emissions impacts of improved capacity related to removing severe congestion from these regions is about 753,000 tons of carbon dioxide per year, or about 1% of the 2005 transportation-related carbon dioxide emissions from these 26 regions.[47]

The following table details the benefits and costs for each region. Overall benefit-cost ratios are positive for all regions. They range from a high of 11.50 for Bridgeport (Tulsa's costs are incomplete and low) to a low of 1.15 for Spokane.

Table 20: Benefits and Costs, by Region

Region (in Size Order)	Value of Time Saved, $ Billions*	Value of Reliability, $ Billions**	Value of Fuel Saved, $Billions***	Total User Saving, $Billions	Regional Economic Impact of Construction $Billions****	Regional Economic Impact of User Benefits, $Billions****	Total Regional Economic Benefits	Total User and Regional Benefits, $ Billions	Project Costs, $Billions	Region's Benefit/ C Ratio
Austin, TX	9.818	6.872	2.266	18.956	4.081	11.373	15.454	34.410	13.602	2.53
Louisville, KY-IN	3.195	2.236	0.737	6.168	1.926	3.701	5.627	11.795	6.419	1.84
Richmond, VA	2.460	1.722	0.568	4.750	1.021	2.850	3.871	8.622	3.404	2.53
Dayton, OH	2.830	1.981	0.653	5.465	0.962	3.279	4.241	9.705	3.206	3.03
Raleigh, NC	7.002	4.901	1.616	13.519	2.495	8.112	10.606	24.125	8.315	2.90
Bakersfield, CA	1.716	1.201	0.396	3.314	0.758	1.988	2.746	6.060	2.528	2.40
Albuquerque, NM	1.963	1.374	0.453	3.790	0.909	2.274	3.183	6.974	3.030	2.30
Rochester, NY	0.407	0.285	0.094	0.786	0.075	0.471	0.547	1.332	0.251	5.31
Jacksonville, FL	2.490	1.743	0.575	4.808	2.134	2.885	5.019	9.827	7.114	1.38
McAllen, TX	4.723	3.306	1.090	9.119	1.039	5.472	6.511	15.630	3.464	4.51
Baton Rouge, LA	0.958	0.671	0.221	1.850	0.323	1.110	1.433	3.283	1.078	3.05
Knoxville, TN	2.405	1.683	0.555	4.643	1.274	2.786	4.060	8.704	4.247	2.05
Boise City, ID	1.843	1.290	0.425	3.558	0.874	2.135	3.009	6.567	2.913	2.25
Tulsa, OK	2.944	2.061	0.679	5.684	0.071	3.411	3.482	9.166	0.237	38.70
Grand Rapids, MI	0.460	0.322	0.106	0.888	0.162	0.533	0.695	1.583	0.540	2.93
Fort Myers, FL	3.233	2.263	0.746	6.241	2.154	3.745	5.899	12.140	7.180	1.69
Albany-Schenectady, NY	0.128	0.090	0.030	0.248	0.082	0.149	0.231	0.479	0.274	1.75
Fort Collins, CO	0.494	0.346	0.114	0.954	0.119	0.573	0.691	1.645	0.395	4.16
Columbia, SC	0.372	0.260	0.086	0.718	0.160	0.431	0.591	1.309	0.534	2.45
Ogden, UT	1.929	1.350	0.445	3.725	2.181	2.235	4.415	8.140	7.269	1.12
Lancaster, PA	0.059	0.042	0.014	0.115	0.015	0.069	0.084	0.199	0.051	3.87
Des Moines, IA	2.926	2.048	0.675	5.649	0.750	3.389	4.139	9.788	2.500	3.91
Spokane, WA	0.821	0.575	0.189	1.585	0.897	0.951	1.848	3.433	2.990	1.15
Madison, WI	1.049	0.734	0.242	2.025	0.162	1.215	1.377	3.401	0.539	6.31
Bridgeport, CT	0.149	0.104	0.034	0.288	0.012	0.173	0.185	0.473	0.041	11.50
Salem, OR	0.523	0.366	0.121	1.010	0.103	0.606	0.709	1.719	0.344	5.00
Grand Total	56.897	39.828	13.130	109.856	24.739	65.913	90.653	200.508	82.464	2.43

*Valued at $ 13/hour, 250 days/year, 2 directions, 20 years

**Value = 0.70* value of time

***Value = time saved*30 mph/20 mpg * $ 2/gallon

****Value = 0.30*construction costs (assumes 30% of constr. costs stay local)

*****Value = 0.60*user savings (Assumes all user savings are invested locally)

Part 3

Conclusions and Recommendations

A. Conclusions

The key findings of this assessment are:

- Congestion is measured in a wide variety of ways, making comparisons difficult. The best present regional comparison is the Travel Time Index.
- The transportation plans of 26 mid-sized regions generally predict, on average, about a 44% increase in population and a 56% increase in traffic over the next several decades. For most regions, this means a doubling of average commuter delay, and a 200–300% increase in total regional commuting delay. This is caused more by regional growth than unnecessary trips, in conjunction with limited capacity expansion. Most growth will be in the suburbs of regions. Transit shares average about 2% for commuting. Although growth rates have slowed, virtually all regions will experience substantial growth over the next 20 years.
- On average, the regions plan to spend about $927 million in short range (TIP) improvements. Of this, transit spending will average about $119 million, or about 13%. The most common major initiatives are Interstate maintenance and arterial resurfacings. Few mid-sized regions have major transit initiatives.
- Long range plans recommend a wide variety of non-transportation goals for their systems. Congestion reduction is generally a minor goal.
- On average, long range plans would spend about $5.157 B, of which about 20% is transit-focused. But these costs do not include inflation and are likely low. Most major initiatives are highway expansions.
- The per-commuter expenditure for transit is about nine times higher than the per-commuter expenditure for solo drivers in the TIP and 12 times higher in the LRP. Most plans are unbalanced modally, and most are fiscally unrealistic.
- Even with these expenditures, virtually all regions report that congestion will be *worse* after the expenditures. But in spite of increased congestion, air quality will improve due to fleet turnover.

- Regional congestion management plans concentrate on congestion *measurement* rather than congestion reduction. Few plans report the impact of actions on congestion.
- The 26 regions together contain about 4,648 projects that affect congestion, in total costing about $85.4 B, slightly more than half of their budgets.
- If implemented, these projects would save about 438,000 hours of travel time daily, 90% of which are due to new freeways and arterials and freeway/arterial widenings. However, the most cost-effective projects, in terms of cost per hour of time saved, are one-way pairs, widening urban arterials and signal optimization, all costing less than $5–6 per hour saved.
- Most plans do not adequately address projected increases in congestion. Of the 26 regions studied, only four have enough delay reduction in their plans to hold congestion at current levels. They are typically smaller regions with fewer than 300,000 people.
- Seven other regions, typically between 300,000 and 600,000 people, have plans that show *modest deficits* in holding congestion to current levels. These regions can reduce congestion if they make minor changes in their plans. However the recent slowdown of growth suggests that regions below a higher cutoff, such as a population of 800,000 that take focused actions, could hold congestion at current levels.
- However, most regions above 600,000 persons (possibly now, about 800,000 persons) will not sufficiently reduce delays to hold congestion at current levels. Many regions of more than about 600,000 people seem to have "*systemic deficits*" between the contents of their plans and projected congestion increases. They typically do not have enough fiscal resources, or are directing them in such a way as to make increased congestion highly likely, *in spite of plans*.
- Finally, a few regions have "*structurally deficit"* plans that contain such a distorted view of trends and reality that, regardless of size, they are likely to experience sharp increases in congestion even though better planning could prevent it. Ironically, most of these regions are quite small, making congestion reduction likely if targeted.
- The overall benefits of these congestion-relieving projects, in user savings and regional productivity, are about two times their costs.

It is no coincidence that region size is strongly correlated with this grouping. With just two exceptions (Dayton and McAllen), regions with above 600,000 people seem to have a present magnitude of congestion that makes it less likely that they can hold congestion at current levels. While these regions can slow the congestion growth rate, they need to be realistic about significantly reducing it without major initiatives. On the other hand, regions with fewer than 600,000 people have considerably more opportunity to hold congestion at current levels, especially the smallest of these regions. Some of these regions have deliberately chosen investment paths that fail to address rising congestion, an unfortunate circumstance for the vast majority of their commuters.

Our review of the plans of these 26 mid-sized regions finds that most are seriously deficient in basic ways. *Perhaps most critically, the plans largely understate the implications about growth, downplaying its magnitude and impact on congestion*. The "facts of growth" are hidden in most plans:

- Population growth will result in much higher congestion levels, *in spite of the plans*;
- The region will continue to spread out and decline in density as incomes rise;
- Increasing traffic is a key indicator of economic health, not of past planning failures.
- Private auto travel will continue to increase, both as a share of travel and in absolute terms.
- Transit shares, already low in most mid-sized regions, are unlikely to grow (because of rising wealth, increasing preferences for private mobility, and urban spatial structure). In mid-sized regions transit shares are generally unrelated to congestion, air pollution or sprawl.
- Economic growth typically increases traffic. For most mid-sized regions, increasing economic activity will mean either increasing congestion or increasing highway capacity.
- In spite of growth, air pollution will continue to improve (through fleet turnover).

However, the weaknesses are larger than just misrepresentations. Most plans also suffer from numerous substantive weaknesses, specifically:

- *"Shotgun" goals*: most plans contain too many ill-defined goals, which are not tied to specific measures of progress or attainment, and are only marginally related to transportation.
- *Technical weaknesses*, particularly regarding forecasts of trends and their impacts on performance indicators.
- *Missing cost-effectiveness,* particularly the link between proposed actions and changes in performance.
- *Fiscally simplistic,* embracing unrealistic assumptions about the likelihood of additional revenues, increasing costs of work, likely inflation or the present worth of both project costs and benefits.
- *Modal imbalance*, reflected in per-commuter expenditures for transit modes that are 9–15 times higher than per-commuter expenditures for road improvements.
- *Geographic imbalance*, reflected in over-attention to density increases and inner-core issues when most growth is admittedly in suburbs and rural fringes.
- *Anti-auto tone*, reflected in both philosophy and wording that prefers transit, carpooling, walking, biking and pedestrian travel over solo driver travel.

Many plans seem to contain a naïve localism. They rarely discuss the region's role in the state or national picture, or that even a large region is buffeted by large state or national trends, particularly demographics, economic changes and technology. Most plans do not adequately assess the likelihood of funding or discuss state funding formulas for fund allocation, suggesting by absence and sometimes direct mention that major changes are essential to achieving the plan.

In short, some of these are not really *transportation* plans but rather *urban design* plans. In the absence of national or even local requirements for such direct documents, transportation plans have become convenient vehicles for using the threat of federal action (withholding funds) to coerce modal behavior and living choices that could not otherwise occur. The result, of course, has been even more congestion and loss of economic activity in these regions.

Because of these failures, most plans inadequately deal with congestion increases. They falsely claim that they cannot shape regional trends. They paint unrealistic and overly optimistic pictures of their circumstances, making it sound as if they can manage external factors that are out of their control.

B. Recommendations

However, despite these findings mid-sized regions have an excellent opportunity to relieve congestion because they have many advantages over larger regions:

- They often have slower population growth rates, which allow them to deal with emerging problems. The recent economic slowdown provides an opportunity to get ahead of congestion problems.
- They generally have lower levels of present congestion, even though congestion may be growing faster than in larger regions.
- With a few exceptions they have low or modest transit costs and few plans for major transit expansions.
- They typically have lower unit costs of construction and can therefore achieve much on even relatively thin budgets.[48]
- They are typically located some distance from larger regions and hence have less inter-region long-distance commuting.

These circumstances provide opportunities to create high-quality transportation systems that serve the entire region at a modest price. Therefore, we offer a number of suggestions at the local, state and federal levels aimed at improving the relevance of mid-sized region's transportation plans and increasing the likelihood that they will be able to hold congestion at current levels.

Local Governments:

- **Review plan realism**. Review local plans for realism and straightforward treatment of problems. Obtain objective data, not just "advocate" views, on citizen priorities. Recognize the reality of rising congestion and its implications for economic health. Eliminate unrealistic expectations and "Pollyanna" talk. Have practical expectations, particularly regarding alternate modes.

- **Focus plans.** Limit transportation plans to deal with transportation problems, not “feel good” goals that only marginally relate to transportation. Limit sharply the use of transportation plans to achieve other objectives.
- **Limit goals:** Limit goals to achievable actions. Set specific standards for a limited set of goals, and a time frame for achieving them.
- **Fund cost-effective projects.** Evaluate all projects for the actual effect on goals. Reduce “drag” from projects that “feel good” but are ineffective.
- **Determine plan impacts.** Determine specifically how the plan (essentially a group of projects, with a funding source) would affect the goal achievement.
- **Increase attention to congestion.** Congestion should be given more attention in most plans. Congestion should be more than just a “sky is falling” forecast; it also needs to be a primary element of project selection and goal achievement.
- **Develop practical plans to reduce, not just monitor, congestion.** Most of the congestion management plans we reviewed were inadequate statements of how the region actually planned to reduce congestion or slow its growth.
- **Implement plans on schedule.** Most plans lacked follow-through. Generally, project implementation is the responsibility of individual modal agencies, not planning agencies, but the status of plan schedules and in particular whether they are ahead of or behind schedule should be determined and reported.
- **Reduce attention to large “legacy” projects.** Most plans have too much focus on a few major projects, implying wrongly that these are the key to the region’s future. In truth, the continuous, steady implementation of minor projects over time produces greater change**.** Large “legacy” projects sometimes have their place but are rarely game-changers and can be controversial. Since Congress has sharply reduced “earmarks” they are also less likely to be justifiable. A sound realistic mix of projects is more likely to reduce congestion over time.
- **Place more attention on intersections, left turns, bottleneck removal and signal timing.** While these actions are often included in plans, they should make up a larger portion of most plans that we reviewed. Particularly in mid-sized regions where freeway congestion is often modest, they are effective ways of reducing overall congestion and smoothing flow.
- **Review modal balance.** Most plans place too much emphasis on the assumed ability of transit or non-motorized projects to change travel behavior. In reality few, if any, of them actually shift behavior by measurable amounts, particularly in smaller regions. These projects should be funded based on their objective benefits and roughly in proportion to their modal shares, not because politicians or planners favor one mode over another or because non-local funding might be available.
- **Increase attention to flex-time and work-at-home policies.** These overlooked policies hold considerable potential for reducing commuter travel, yet they are all but ignored in most plans. In

mid-sized regions these modes are 5–10 times the share of transit, and could be significantly increased at relatively low cost.

These suggestions are generally appropriate to all mid-sized regions. In addition, regions in each of the four categories below should consider other actions:

- **(Green) Regions with "surpluses"** are uniquely positioned to take advantage of the flexibility their plans provide to reduce congestion below current levels. They should move deliberately to ensure that TIP and LPR projects are implemented on schedule, that other projects are considered as needed, and that additional items, such as those identified above, are reviewed.
- **(Yellow) Regions with "modest deficits"** are likely to be able to hold congestion at current levels, with modest additional attention to the issue and increased priority. They need to move to review the projects in their current plan, move up those that have significant congestion relief, and add others that may have been given less attention or priority.
- **(Red) Regions with "systemic deficits"** are either too large (mostly larger than 600,000–800,000 population), growing too fast, lack available resources or have modal priorities that make them unlikely to hold congestion at current levels, *even if* their transportation plans are fully implemented. Therefore they need to review their plans by reconsidering what transportation goals are appropriate. This may lead to a reconsideration of the role of various modes, their appropriate funding levels and the nature of fiscal needs and funding priorities.
- **(Pink) Regions with "structural deficits"** are those, generally of smaller size, which have chosen to focus on actions that do not relieve congestion. They need to understand the importance of this issue for economic health, competitiveness and commuting realities, and reconsider their decisions.

State Governments:

State governments are also partially responsible for dealing with congestion in urban areas, for several reasons. First, the state may actually own portions of the urban road system that is congested. Also, since the economic health of the state depends on smooth and unfettered exchanges of goods and services within and between regions, if these flows are impeded by congestion the state's economy suffers. States also have a responsibility to all citizens to ensure a high-quality transportation system, to which rising congestion is a serious threat. They are also responsible for ensuring that limited state resources are spent wisely, on cost-effective and worthy transportation projects. Travel time-savings, largely the result of reduced congestion, is a major project benefit and should be considered in cost-effective project selection. State governments should:

- **Compare major projects head-to-head across the state.** To ensure that the best projects, statewide, are funded, states should put a "final filter" on local MPO plans for major projects on the state highway system. Fund the best of these using objective criteria.

- **Limit state funding to an equal share of approved project costs, for those projects that are uniformly evaluated and pass "justification."** If projects are supported differentially this can lead to regional preferences and inequities. State taxpayers should not support weak local projects.
- **Include congestion in statewide funding formulas.** Ensure that congestion relief (value of savings in travel time) is an important criterion in selecting statewide projects.
- **Require uniform plan formats.** Within states, regions should be following a similar format for their plans, each region presenting the same information in essentially the same way. This will permit straightforward assessment of plan effectiveness, without compromising local prerogatives.
- **Provide means for local government funding sources.** Ensure that local governments have the mechanisms they need to fund strictly local projects with their own resources. This might include state infrastructure banks, revolving funds, local bonding flexibility, portions of state fuel taxes, etc.

Federal Government:

The federal government also has a role in ensuring smooth-flowing and efficient transportation systems, to facilitate commerce and economic health. Although the responsibility for congestion relief lies primarily with state and local governments, the federal government also has a role. This includes funding, through the CMAQ program and other programs, and enforcing rules and regulations. However, as noted above, the present regulations tend to focus more on the *monitoring* of congestion, rather than its relief.

- **Get serious about congestion *reduction*, not just plans to monitor it.** If congestion relief or reduction is a serious federal goal then some additional action—prescriptions, incentives or directives—will need to be taken. The slow-but-steady increases in congestion reported annually by the Texas Transportation Institute show that, if congestion *reduction* is the goal, we have failed.
- **Increase the uniformity of plan formats.** Federal rules specify the content of TIPs and LRPs, but not their format. A review of over 60 such plans from across the U.S. suggests that more uniformity of reporting (not content) would be useful. It is currently very difficult to determine or compare the content of plans, because even simple indicators of travel and congestion are not reported uniformly. Something similar to the HPMS reporting requirements, which ensure basic comparability in such measures as congestion, expenditures, revenue sources, unfunded gaps, etc., would help.

In summary, we find that the transportation plans of mid-sized regions have the potential to considerably mitigate, and perhaps even reduce, rising congestion, *if* these regions act boldly to implement the congestion-reducing projects already in their plans. Regions with fewer than about 600,000–800,000 persons are most likely to be able to make significant reductions in congestion, while those with more than 800,000 in population will, generally, find it more difficult to hold congestion at current levels.

Appendix 1

Appendix 1: Detailed Methodology

A. Measuring Congestion and Delay Calculations

There are a wide variety of measures of congestion such as speed, travel time, traffic level, delay, volume versus capacity and vehicle spacing. The most commonly used measures are:

1. Volume/Capacity ratio.

This measure is typically used for individual road sections. Traffic volume is the flow rate, in vehicles per hour, for the peak hour of the facility. Capacity is defined as the maximum amount of traffic a freeway lane can carry based on the traffic mix, highway geometry and environment.[49] Maximum capacities for freeways are about 2,400 vehicles per lane per hour, with lower numbers (1,800–2,200) more typical for common urban freeways; for arterials, typical capacities are in the range of 1,100-1,400 vehicles per lane per hour. The volume-to-capacity ratio, V/C, defines the percentage of capacity at a given point used by traffic. A closely related concept, Level of Service (LOS), is an A–F scale defining the quality of flow, with A the best and F the worst (stop and go traffic). Figure A1, from the *Highway Capacity Manual*, shows a well-known 1960s photograph of freeway congestion at Level of Service (LOS) F, "severely congested."

Figure 1A: Level of Service F, *Highway Capacity Manual*

Illustration 13-10, Los F

2. Intersection delay.

For signalized intersections, the *Highway Capacity Manual* measures congestion in terms of average delay per vehicle, and levels of service are defined based on the average amount of delay at each separate intersection movement. Intersection movements are considered severely congested when the average delay exceeds 80 seconds per vehicle. Since many signals are timed on a two and a half to three minute cycle, this is equivalent to requiring the average vehicle to wait more than one cycle before getting through the light. This definition has also changed in recent years as drivers seem more willing to accept a longer delay; in the 1994 manual the LOS F delay was set at 60 seconds.

3. Flow quality and speed.

For urban arterials, the *Highway Capacity Manual* uses measures of speed and flow quality such as the presence of progression-timed signals (signals coordinated so that drivers don't stop at most lights). Arterials operating at five to 15 mph with low levels of progression timing are considered severely congested.

4. Travel time index.

The above measures are used for analysis of individual roads but cannot be readily applied to cities. The Texas Transportation Institute (Shrank and Lomax, 2005) has developed a delay-related index intended to measure the quality of congestion for an entire city. The index is referred to as the Travel Time Index (TTI), defined as:

$$\text{TTI} = \frac{\text{Weighted average travel time in peak hour}}{\text{Weighted average travel time in off-peak hours}}$$

This index conveniently relates congestion to peak-hour travel times. For instance, a TTI of 1.25 means that travel times in a given city take 25% longer in the peak hours than in the off-peak. Delay is considered severe when the TTI exceeds 1.18. This is because a TTI of 1.18 corresponds closely to travel at peak flow, the top of LOS E, which is about 18% longer travel time than free-flow travel time. The TTI was originally developed for use in larger cities, but recently has been extended to smaller cities.[50] Newer use of cell-phone data to measure on-the-ground delays by actual travelers has substantially increased the usefulness and availability of these data.

5. Data Collection.

Highway capacity project data were collected from transportation improvement plans (TIP) and long range transportation plans (LRP) available on metropolitan planning organization (MPO) websites, usually in PDF form. Most of the plans dated from 2003–08, and therefore have been likely updated since this research was conducted. MPOs were then contacted to request access to the project data in Excel format. In the cases where this was not available, project data were converted manually from PDF to Excel format. The raw project data were then merged together into one master file, which lists common important variables pulled from the raw project data. Based on the project descriptions in these data, projects were assigned project type codes according to the table attached.

6. Missing Data Issues.

Project length. Many projects were initially missing length information. In a few cases, lengths were estimated using plan maps, Mapquest.com and Google Maps. In most other cases, length was estimated based on the total project costs and lane-miles added. Average cost per lane-mile added was calculated for various project types. Then, cost per lane added could be used to estimate the missing lengths. A few project types (e.g., road narrowing, bridge repairs, pedestrian-bike actions) did not add capacity, and thus lane-miles added were zero. In these cases, length was estimated based on the average cost per lane-mile after.

Project costs. In some cases, project costs were missing. In these cases, costs were estimated based on the number of lanes added. Using this information and the average number of lane-miles added for a given project type, we could develop an estimate of length. In these cases, projects type codes were assigned based on what seemed the most likely interpretation of the information given.

Project lists. We were never able to get a list of projects for the long range transportation plan from Albany. Rochester's long range plan does not list specific projects. Similarly, Fort Collins's long range plan lists only a limited number of projects, focusing on general, corridor-based goals. Otherwise project lists were available.

Project type and work type codes. To simplify our calculations we classified each project into 50 Project Types, and then condensed these into 13 Work Types. For each of these, we estimated per-lane capacity and typical peak-period speed before and after work. The following table summarizes these statistics:

Table 1A: Work Type and Project Type Codes

ProjecType of Project	Work Type Code	Project Type Code	Capacity/ Lane Before	Capacity/ Lane After	Speed Before	Speed After	Proportion ADT Affected
New Freeway 4 Lane	1	2	2400	2400	40	60	1
New Freeway 8 Lane	1	20	2400	2400	40	65	1
New Freeway 6 Lane	1	30	2400	2400	40	60	1
New Freeway 2 Lane	1	43	2400	2400	40	50	1
New 4 Lane Arterial	2	9	1400	1400	40	50	1
New 2 Lane Arterial	2	10	1200	1200	25	40	1
New 3 Lane Arterial	2	25	1400	1400	25	50	1
New 5 Lane Arterial	2	26	1400	1400	30	45	1
New 6 Lane Arterial	2	40	1400	1400	40	50	1
Widen Urban Arterial by 1 Lane (single)	3	1	1400	1400	30	45	0.5
Widen Urban Arterial 2 Lane-->4 Lane	3	6	1400	1400	25	45	1
Widen Urban Arterial 4 Lane-->6 Lane	3	17	1400	1400	35	50	1
Widen Urban Arterial 2 Lane-->5 Lane	3	27	1400	1400	25	40	1
Widen Urban Arterial 4 Lane-->7 Lane	3	29	1400	1400	35	50	1
Widen Urban Arterial 3 Lane-->5 Lane	3	31	1400	1400	30	50	1
Widen Urban Arterial 2 Lane--> 6 Lane	3	33	1400	1400	25	50	1
Widen Urban Arterial 2-way to 1-way	3	37	1600	1400	35	45	1
Gravel to Pavement Upgrade	3	45	600	1400	25	50	1

Table 1A: Work Type and Project Type Codes							
ProjecType of Project	Work Type Code	Project Type Code	Capacity/ Lane Before	Capacity/ Lane After	Speed Before	Speed After	Proportion ADT Affected
Widen Urban Arterial 5 Lane-->7 Lane	3	46	1400	1400	35	50	1
Widen Urban Arterial 6 Lane-->8 Lane	3	47	1400	1400	40	50	1
Widen Urban Arterial 4 Lane-->8 Lane	3	50	1400	1400	35	50	1
Widen Freeway 6 Lane-->8 Lane	4	3	2400	2400	40	65	1
Widen Freeway 4 Lane-->6 Lane	4	4	2400	2400	40	60	1
Widen Freeway 4 Lane-->8 Lane	4	5	2400	2400	40	65	1
Widen Freeway 8 Lane -->10 Lane	4	24	2400	2400	50	65	1
Widen Freeway 2 Lane-->4 Lane	4	39	2000	2400	40	55	1
Widen Freeway by 1 Lane (single)	4	41	2400	2400	50	55	0.5
Widen Freeway 6 Lane-->10 Lane	4	42	2400	2400	50	65	1
Widen Freeway 6 Lane-->9 Lane	4	44	2400	2400	50	65	1
Widen Freeway 4 Lane-->7 Lane	4	48	2400	2400	40	65	1
Widen Freeway 6 Lane-->12 Lane	4	49	2400	2400	50	65	1
Widen Freeway 5 Lane-->7 Lane	4	51	1400	1400	50	65	1
Widen Rural Arterial 2 Lane-->4 Lane	6	7	1600	1600	35	60	1
Widen Rural Arterial 4 Lane-->6 Lane	6	19	1600	1600	45	60	1
New Exit on Freeway	7	8	2400	2400	50	60	0.2
Significant Intersection Upgrade	7	11	1400	1400	30	50	1
Roundabout	7	15	1400	1600	15	35	1.3
Ramp Connection	7	16	1000	1200	40	45	0.1
New Interchange	7	18	2000	2000	35	55	0.2
Interchange Upgrade	7	23	2000	2000	35	55	0.2
Road Realignment	7	32	1400	1400	40	45	1
Signal Group Optimization	8	12	1400	1400	20	40	1
HOT/HOV Lanes	9	13	2400	2400	45	65	0.12
Convert To Open Road Tolling	9	54	2400	2400	55	65	1
Convert To Open Road Tolling (from Untolled)	9	55	2400	2400	55	65	1
New Bridge	10	14	1400	1400	35	45	1
Widen Bridge	10	28	1400	1400	35	45	1
Relocate Bridge	10	53	1400	1400	35	45	1
Convert 6 Lane Urban Arterial to 6+ Lane Freeway	11	21	1400	2400	40	65	1
Convert 4 Lane Urban Arterial to 4+ Lane Freeway	11	22	1400	2400	35	60	1
Convert 2 Lane Urban Arterial to 4+ Lane Freeway	11	52	1400	2400	35	60	1
Convert 6 Lane Urban Arterial to 8+ Lane Freeway (Toll)	11	56	1400	2400	40	65	1
Minor Improvement without Widening	12	34	1100	1400	40	45	1
Lane Red and Traffic Calming	13	35	1400	1000	45	35	1
Convert 1-Way Street to 2-Way Street	13	36	1400	1600	45	35	1
Demolish Bridge	13	38	1400	1400	35	25	1

Proportion of ADT affected**:** This determines whether the project affects traffic on the entire road section or just a portion of it. Typically, this is 1.0, but it is less than 1.0 in certain cases such as single-direction improvements, freeway interchanges that affect cross-street traffic, and HOV lanes that affect about 10% of traffic.

7. Calculations to Estimate Delay Savings.

Delay savings. The estimated change in speed for a given project type, combined with the length (or estimated length) of a given project, were used to estimate the change in travel time resulting from the project. In other words:

*Change in travel time through the section = Length * (1/Speed before – 1/Speed after)*

To estimate traffic volume, we used the 2005 VMT/mile for the street's functional class in its urban area (or the average of 2005 and projected 2030 VMT/mile in the case of long range projects), from the Federal Highway Administration's Highway Statistics urbanized area tables. Average daily traffic was then converted to peak-hour traffic using 0.10 as the peak-hour factor (0.20 ADT for the two AM and PM peak periods).

Then, these items are multiplied together to estimate the daily savings in travel time generated by the project. Thus:

*Daily Project Travel Affected = (VMT/mi)*0.2*Length*Pct Affected*(1/spd before – 1/spd after)*

Time savings**:** These daily savings for each project were then totaled for each city and compared to their projected increase in delay over the next 20 years.

Speed assumptions. To determine the effects of our assumptions about speed on segments before and after improvements, we re-ran our analysis using different speed assumptions roughly in line with the default speeds from NCHRP Report 599. This change did increase the amount of savings generated by planned improvements, but the increase appeared overly optimistic. Thus, we returned to the original speed assumptions.

8. City-by-City Data Descriptions and Issues.

Albany. The TIP was copied from an HTML table on the Capital District Transportation Committee MPO website into an Excel spreadsheet. It did not include length data, and included only partial data on lanes before vs. after. Missing values were filled in as described in Section 6 above in most cases. Some lengths were estimated using online maps. We did not find a list of projects in the LRP, and did not receive a response from the MPO to our request for this information.

Albuquerque. The TIP and LRP project lists were manually converted from PDF to Excel format. The TIP included complete length data and most lanes before/after data. The LRP included most lanes before/after data but not length data. Missing values were filled in as described in Section 6 above in most cases. Some lengths were estimated using online maps.

Austin. We received the TIP and LRP project lists respectively from Art Zamorano and Stephanie Greathouse of Capital Area Metropolitan Planning Organization. Neither project list included length data. However, both lists included lanes after, and the LRP also included lanes before. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Bakersfield. The TIP and LRP project lists were manually converted from PDF to Excel format. Length data were missing from the TIP and mostly missing from the LRP project list. The LRP included lanes after but not lanes before, while the TIP included very little lane data. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Baton Rouge. We received TIP and LRP project lists in Excel format from Huey Dugas of the Capital Region Planning Commission. The data did not include project lengths or lanes before, but lanes after were included in many project descriptions for widening projects. "Lanes before" were filled in with estimates. Most lengths were estimated using the methods described previously, though some were found using online maps.

Boise. We received the TIP in Excel format and the LRP project list in Word format from Toni Tisdale of the Community Planning Association of Southwest Idaho. Some length data were missing from the LRP and mostly missing from the TIP. The LRP included most lanes before/after data, while the TIP also included some (but not all) of these data. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Bridgeport. The TIP and LRP project lists were converted manually to Excel format. Neither list included much data on project length or the number of lanes before/after. Furthermore, the LRP project list did not include cost estimates for individual projects, though it did include total costs for project subgroups. Missing lanes before/after and lengths were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Columbia. We received the TIP and LRP project list in one combined Excel file from Roland Bart of the Central Midlands Council of Governments. The data had most major items such as length and costs as well as lanes after (in the description field) but did not include lanes before. This missing item was filled in using best-guess estimates. For example, arterials widened to four lanes were assumed to initially have two lanes.

Dayton. We received the LRP project list in Excel format from Andrew Rodney of the Miami Valley Regional Planning Commission (MVRPC). The TIP projects had to be manually compiled into an Excel list from project profiles on the MVRPC website. The LRP project data were mostly complete, including major items such as length, lanes before and after (in the description) and costs. TIP project data included most lengths and lanes after, but were missing lanes before. These were filled in using best-guess estimates.

Des Moines. We received the TIP and LRP project lists from Adam Noelting of Des Moines Area Metropolitan Planning Organization. The LRP data included lengths and lanes before/after, as well as costs. TIP data were missing lengths and most lanes before/after data. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Fort Collins. We received the TIP in Excel format from Tia Raamot of the North Front Range Metropolitan Planning Organization. The LRP included only a limited project list, which was converted manually from PDF to Excel format. The TIP included very little data on lengths or lanes before/after. The LRP included lanes before/after but did not include lengths. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Fort Myers. We received the LRP project list in Excel format from Don Scott of the Lee County Metropolitan Planning Organization. The TIP had to be manually converted from PDF to Excel. Length data were mostly missing in the TIP, but complete in the LRP project list. Lane data were mostly complete, though some lanes before were missing. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Grand Rapids. We received the LRP project list in Excel format from Andrea Dewey, while the TIP had to be converted manually from PDF to Excel format. Both lists had length data, and the LRP project list had most lanes before/after data, but the lane data were missing from the TIP. Missing values were filled in as described in Section 6 above.

Jacksonville. We received the LRP project list in Excel format and the TIP in Access format (which we then converted to Excel) from Wanda Forrest of the First Coast Metropolitan Planning Organization. The TIP data included partial length data and partial before/after lane data. The LRP data were missing length data, but included most lane data (in project descriptions). These missing lane and length measures were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Knoxville. We received the LRP project list from Katie Habgood of the Knoxville Regional Transportation Planning Organization. The TIP was converted from PDF to Excel manually. Both project lists included most lanes before/after data, but did not include much length data. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Lancaster. We received TIP and LRP project list data in Excel format from Carol Palmoski of the Lancaster County Planning Commission. The data were missing some important information. No lengths were included, lane data were missing from the TIP (although the LRP project list had partial lane data), and project descriptions were unspecific. Missing values were filled in as described in Section 6 above.

Louisville. We received the TIP and LRP project lists in Excel format from David Burton of the Kentuckiana Regional Planning and Development Agency. Project descriptions included most lanes before/after data, but lengths were mostly missing. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Madison. We received the TIP in Excel format from Ronda Statz of the Madison Area Transportation Planning Board. The LRP project list had to be manually converted from PDF to Excel. The LRP project list included most major items including lengths, lanes after, and cost, but was missing lanes before. The TIP had partial lanes after and length data, but was also missing lanes before. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

McAllen (Hidalgo County). The TIP and LRP project lists had to be manually converted from PDF to Excel format. The TIP included lanes after data, but did not include most lanes before or lengths. The LRP project list included complete data on lengths and lanes before/after. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Ogden. We received the TIP and LRP project lists in Excel format respectively from Ben Wuthrich and Jory Johner of the Wasatch Front Regional Council. Both lists included complete data on length. The TIP contained complete cost data, while cost data in the LRP were mostly complete. The LRP lanes before/after data were also complete, while the TIP included most lanes after data, but was missing lanes before data. Missing values were filled in as described in Section 6 above.

Raleigh. We received the TIP and LRP project lists in Excel format from Diane Wilson of the Capital Area Metropolitan Planning Organization. There were several project duplication issues within the TIP as well as between the TIP and LRP which we resolved. The TIP data included major items such as segment name, project limits, lengths, and costs, but lacked some descriptors such as lanes before and lanes after. These were filled in with best-guess estimates. The LRP data did include lanes before and lanes after as well as the other important data items.

Richmond. We received the TIP and LRP project lists in Excel format respectively from Jin Lee and Lee Yoltan of Richmond Regional Planning District Commission. The TIP included partial length data, while the LRP had mostly complete length data. The TIP included most lanes after data, but was missing lanes before data. The LRP had most lanes after data and some lanes before data. Missing values were filled in as described in Section 6 above.

Rochester. We received the TIP project list in Excel format from Jim Stack of the Genesee Transportation Commission (GTC). The data were missing major items such as length, lanes before, and lanes after. Many projects appeared to be rehabilitations without capacity improvement. Lanes before and lanes after were filled in with best-guess estimates. Most lengths were estimated using the TIP map or Mapquest.com. According to Mr. Stack and the LRP document on the GTC website, individual projects are not listed in the LRP, and thus there is no LRP project list to include in the analysis.

Salem. We received the TIP and LRP project lists in Excel format respectively from Mike Jaffe and Ray Jackson of Mid-Valley Council of Governments. Length data were missing in the TIP and mostly missing in the LRP project list. Lanes before/after were partially missing in both lists. Missing values were filled in as described in Section 6 above.

Spokane. We received the TIP in Excel format from Sue Arneson of the Spokane Regional Transportation Council, but the LRP project list had to be manually converted. The TIP included length data, but the LRP did not. The TIP and LRP both included most lanes after data, but lanes before were missing in most cases. Missing values were filled in as described in Section 6 above. Some lengths were estimated using online maps.

Tulsa. The TIP and LRP project lists had to be manually converted from PDF to Excel format. The TIP included most length data, but did not include much lane data. The LRP project list included lanes after, but not lanes before or lengths. The LRP project list was also missing cost data for individual projects, though it did contain information about total costs. Missing lanes before/after and lengths were filled in as described in Section 6 above. Some lengths were estimated using online maps. The following table documents the detailed project coding for the study, so that other practitioners/researchers can revise their work or undertake similar analysis.

Table 2A: Column Heading Explanations for Project Master Spreadsheet

Column Heading	Explanation
Original Sort	Order of original sorting, including projects and city/plan-specific header lines, for the purpose of returning to the original order to reverse a sort
Caleb's ID	Unique ID for each individual project
TransCAD City ID	City ID used in TransCAD GIS data
UA Code	Urban Area Code
TransCAD Name	City name, as in TransCAD GIS data
Standard Federal Region Code	Code for the region where the city is located (see http://en.wikipedia.org/wiki/List_of_regions_of_the_United_States# Standard_Federal_Regions)
MPO's Project ID	Project ID/PIN used by the planning agency
TIP or LRP	Indicates whether the project is in the city's transportation improvement program or their long range plan
Project Name	The name of the project, usually the route being improved
Location	Route of improvement and/or project limits
From	Project starting limit
To	Project ending limit
Length (Mi)	Length of the project in miles
Length B (Mi)	Equals Non-Zero Length, unless length is zero or missing, in which case this variable is set to 1
Work Type Description	Description of the improvement(s) included in the project
Include 1=Yes 2=Likely 3=Unlikely 4=No	Indicates how sure we are that the project creates a capacity and/or speed change and thus should be included in our analysis
Include as Affects DELAY (Binary)	Equals 1 for projects included in analysis, 0 otherwise
Cases within Project	How many distinct improvements are included in the project
Cost per Mi	Total Cost divided by Length B
Project Type Code	Code for specific type of improvement, based primarily on the work type description, lanes before, and lanes after
Work Type Code	Code for broad category of improvement, based primarily on the work type description, lanes before, and lanes after
Dave's Short Functional Class 1=Interstate 2=Other Frwy-Expy 3=Princ Art-Minor Art 4=LOCColl	Shorthand code for functional class of the improved route 1=Interstate 2=Other Freeway-Expressway 3=Principal Arterial-Minor Arterial 4=Local Collector
Lanes Before	Number of lanes on the route before improvement
Lanes After	Number of lanes on the route after improvement
Lanes Added	Change in lanes due to the project (negative if a lane reduction)
Data Entry Error Check	A space used to search for miscodes (e.g. project type 6 with lanes added different from 2). Formula varies depending on specific error check
Non-zero length	Equals length if length is not zero. Otherwise returns a missing value. When length is not specified, a default value is assigned in the following cases: In the case of intersections, a length of 0.1 miles is assigned; in the case of interchanges, signal group optimization, and open-road toll conversions (previously tolled), a length of 1 mile is assigned.
CAPLB	Capacity before improvement (from lookup table, based on project type code)
CAPLA	Capacity after improvement (from lookup table, based on project type code)
SB	Speed before improvement (from lookup table, based on project type code)
SA	Speed after improvement (from lookup table, based on project type code)
Pct ADT Affected	Percentage of average daily traffic (ADT) that should be affected by the improvement (from lookup table, based on project type code)
Class Code B 3.5=MA, 4.5=Col	Modified functional class code to distinguish minor arterials from principal arterials and collectors from local streets. An arterial with no more than 2 initial lanes is taken to be a minor arterial. A Local/ Collector with no more than 2 initial lanes in taken to be a collector.

Table 2A: Column Heading Explanations for Project Master Spreadsheet	
1995 KVMT/Mile	Daily VMT (in thousand) per centerline-mile, in 1995, in thousands (from lookup table, highway performance monitoring system, based on city and functional class code B)
2005 KVMT/Mi	Vehicle miles traveled per centerline mile, in 2005, in thousands (from lookup table, based on city and functional class code B)
2030 KVMT/Mi	Forecasted vehicle-miles traveled per centerline mile, in 2030, in thousands (from lookup table, based on city and functional class code B, except where forecast is provided in project list by MPO). Initial forecasts were created using a simple linear trend with the 1995 and 2005 numbers as data points. The initial forecasts were then modified to be reasonable by Dr. Hartgen.
FHWA Functional Class	Federal Highway Administration functional class designation for the improved route
AADT	Average annual daily traffic for a project route
Completion Year	Year (or range of years) when project should be completed
2005 Pop K	2005 urban area population, in thousands
Lane-Mi Added	Lanes added times non-zero length
Lane-Mi Added (Including Estimated Length Projects)	Lanes added times best length estimate
Cost Estimate ($)	Total project cost estimate
Cost per Lane-Mi After (Types 36, 34, 32)	Total cost divided by lanes after improvement. Used to estimate length for project types 36, 34, and 32
Average Cost per Lane-Mi After for Project Type (Types 36, 34, 32)	The mean of cost per lane-mile after for this project's project type code (lookup from pivot table)
Estimated Length by Ave Cost per Lane-Mi After for Project Type (Types 36, 34, 32)	Cost per mile (cost estimate divided by non-zero length) divided by average cost per lane-mile after for project type
LMCB	Capacity Before (Best Length Estimate * Lanes Before * Capacity Before Improvement)
LMCA	Capacity After (Best Length Estimate * Lanes After * Capacity After Improvement)
Change LMC	Change in Capacity (Capacity After-Capacity Before)
Cost per Lane Added	Cost estimate divided by lanes added
Cost per Lane-Mi Added	Cost estimate divided by lane-miles added
Average Cost per Lane-Mi Added for Project Type	The mean of cost per lane-mile added for this project's project type code (lookup from pivot table, based on project type code)
Average Lane-Mi Added for Project Type	The mean of lane-miles added for this project's project type code (lookup from pivot table, based on project type code)
Estimated Length by Avg Cost per Lane-Mi Added for Project Type	Cost per lane added divided by average cost per lane-mile added for project type. Estimates project length based on project type, lanes added and total cost.
Estimated Length by Avg Lane-Mi Added for Project Type	Average lane-miles added for project type divided by lanes added. Estimates project length based on project type and lanes added.
Change in T Time thru Sect L*(1/sb - 1/sa)	Change in travel time through section. Calculated as travel time before project (i.e. Length divided by speed before project) minus travel time after project (i.e. Length divided by speed after project).
Daily Savings in Hrs	Daily travel time saved by improvement (in hours). Calculated as 1000 times the product of Percent Average Daily Traffic Affected, Change in Travel Time Through Section, 2005 Thousands Vehicle-Miles Traveled/Mi, and the Peak Hour Factor (0.2 for 2 peak hours). In the case on long range projects, the mean of 2005 Thousands Vehicle-Miles Traveled/Mi and 2030 Thousands Vehicle-Miles Traveled/Mi is used in place of 2005 Thousands Vehicle-Miles Traveled/Mi.
20-Year Savings	Travel time saved by improvement over 20-year span (in hours). Calculated as Daily Savings in Hours times 10,000.
Cost-Hr Saved	Project cost per hour of travel time saved by project (in dollars per hour). Calculated as cost estimate divided by 20-year savings.
Best Length Estimate	Length if available. If not, then it takes the mean of the two length estimates. If one of those is not available, it takes the estimate that is available.

9. Table and Graphic Notes.

In the master project list spreadsheet, most summary tables are created using pivot tables. However, because pivot tables have limited sorting and editing options, the “derived” tables are placed to the right of the actual pivot tables. These derived tables display the pivot tables in a format that can be easily sorted by city size and reformatted for clear display.

B. Computation of Growth in Congestion

To estimate the magnitude of congestion growth for each region, we used a variety of information describing population, traffic, present congestion and speeds. The procedure is best described by using **Austin TX** as an example:

1. Background Data

• 2005 Population (Am Comm. Survey)	958,186	Urbanized area
• 2005 Commuters (ACS)	475,769	Urbanized area
• Mean travel time to work (ACS)	23.3	Minutes
• Car-truck-van (CTV) total commuters (ACS)	437,247	Urbanized area
• CTV % (ACS)	91.90%	Pct CTV

2. Calculate 2005 Peak Period Delay, Using LRP Pop and Employment

• 2005 Travel Time Index (from TTI)	1.31
• Base year population, from LRP	1,160,000 (for larger region)
• Base year employment, from LRP	646,000 (for larger region)
• Base year CTV commuters	0.919*646k = 593,700 (use ACS %)
• Mean travel time (from ACS, above)	23.3 minutes
• Mean free flow time	23.3/1.31 = 17.79 min (Free flow portion of commute time)
• Mean delay time	23.3 – 17.8 = 5.51 min (delay part)
• Region's total free flow time	17.8*593.7*2/60 = 352,000 hrs
• Region's total delay time	5.5*593.7*2/60 = 109,100 hrs
• Region's total commute time	23.3*593.7*2/60 = 461,100 hrs
• Delay, hrs/year/commuter	5.5*250*2/60 = 45.9 hrs

3. Calculate 2030 Peak Period Delay, Using LRP Future Pop and Employment

• 2030 population (from LRP)	750,000 (for a larger area than base year)
• Percent increase in pop	(2750-1160)/1160 = 137.1 (very fast)
• 2030 Employment	(646/1160)*2750 = 1,531.000 (use '05 ratio)
• 2030 CTV Commuters	1531*0.910 = 1,407.000 (use '05 ratio)
• 2030 TTI (from Reason Study, 2006)=	1.56
• 2030 Mean free flow time (same as 2005)=	17.79 min
• 2030 Mean total time	1.56*17.8 = 27.75min
• 2030 Mean delay time	27.7-17.8 = 9.96 min
• 2030 Region's total free flow time	17.79*1407000*2/60 = 834,500 hrs
• 2030 Region's total delay time	9.96*1407000*2/60 = 467,300 hrs
• 2030 Region's total commute time	27.75*1407000*2/60 = 1,301,700 hrs
• 2030 Delay, hrs/year/commuter	9.96*250*2/60 = 83.0 hrs

4. Calculate Change in Times and Shortfall

• Change in free flow time	834,500 -351,990 = 482,500 hrs
• Pct increase	137.1 (same as pop %)
• Change in delay time	467,300 – 109,000 = 358,200
• Pct increase	328.2 (very large)
• Change in total commute time	1307000 – 461100 = 977,700 hrs
• Pct increase	212.0
• Daily savings in delay, from LRP and TIP	75,500 hrs
• Difference (-, Plan is short)	75.5 – 358.2 = -282,700 hrs

- **Assumptions**
  - Transit/walk/bike share is constant into the future
  - Workforce/pop ratio is constant into the future
  - TTI will grow steadily even if plan is built
  - Free flow time is constant into the future. Assumes no major shift of land use patterns

Appendix 2

Appendix 2: Supporting Tables

This section provides some additional tables not provided in the text.

A. Project Length

This table/chart represents the sum of the lengths of capacity-affecting projects in the TIP or LRP of each city. These sums do not include lengths estimated based on average cost per lane-mile added or other similar methods, but do include some length estimates based on scale maps of project routes.

Table 3A: Projects by Length

Sum of Length (Mi)	LRP	TIP	Grand Total
Austin, TX	458.44	23.80	482.24
Louisville, KY–IN	143.64	17.45	161.09
Richmond, VA	219.97	72.15	292.12
Dayton, OH	308.68	45.53	354.21
Raleigh, NC	797.81	290.32	1,088.13
Bakersfield, CA	186.80	8.60	195.40
Albuquerque, NM	63.96	45.87	109.83
Rochester, NY	0.00	64.56	64.56
Jacksonville, FL	98.28	102.75	201.03
McAllen–Edinburg–Mission, TX	750.24	18.34	768.58
Baton Rouge, LA	21.16	3.90	25.06
Knoxville, TN	90.19	20.86	111.05
Boise City, ID	105.30	91.82	197.12
Tulsa, OK	31.40	56.41	87.81
Grand Rapids, MI	64.69	22.72	87.41
Fort Myers–Cape Coral, FL	353.73	12.52	366.25
Albany–Schenectady–Troy, NY	0.00	0.00	0.00
Fort Collins, CO	37.34	15.80	53.14
Columbia, SC	61.80	13.00	74.80
Ogden, UT	215.40	57.20	272.60
Lancaster, PA	0.00	0.10	0.10
Des Moines, IA	376.70	4.04	380.74
Spokane, WA	24.50	35.75	60.25
Madison, WI	66.08	34.05	100.13
Bridgeport–Milford, CT	2.90	0.85	3.75
Salem, OR	1.40	2.80	4.20
Grand Total	4,480.40	1,061.20	5,541.60

Figure 2A: Sum of all Projects by Length, 26 Mid-Sized Regions

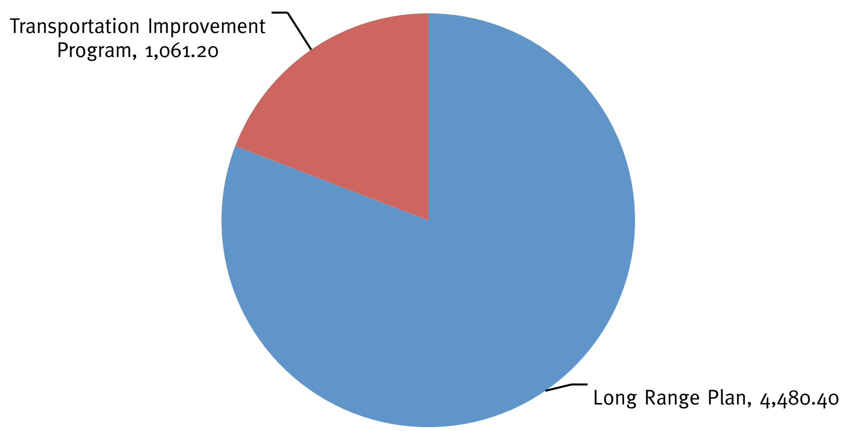
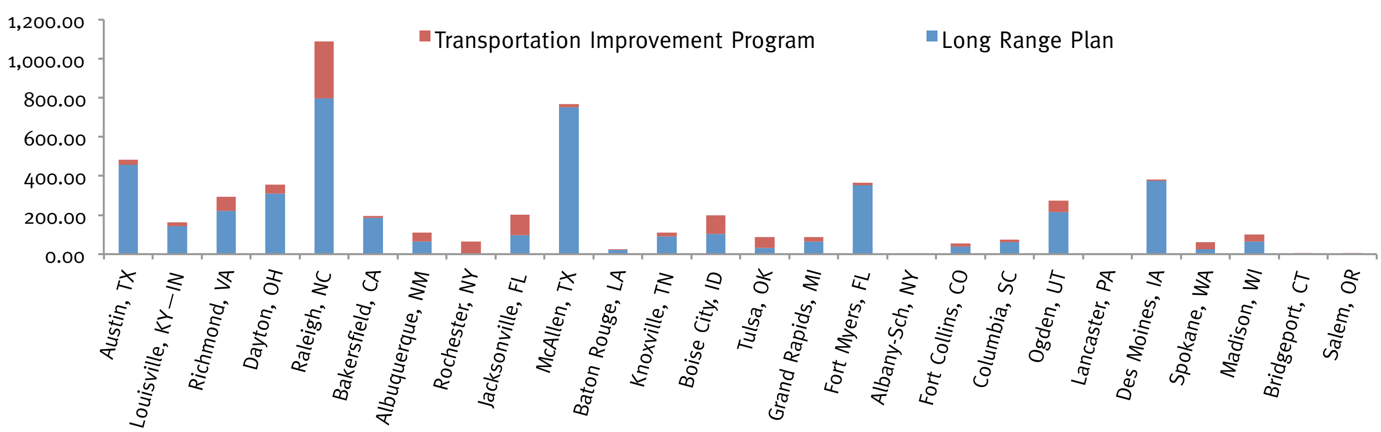


Figure 3A: Projects by Length, 26 Mid-Sized Regions



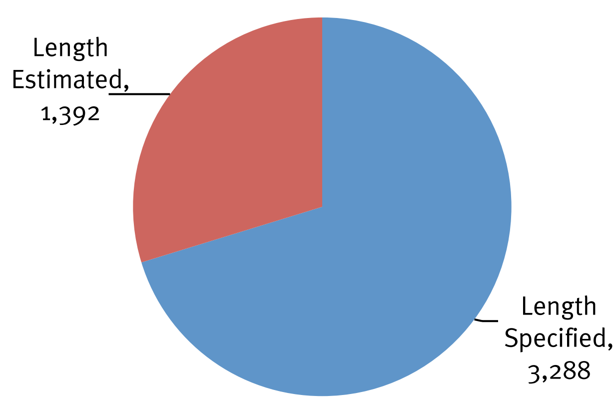
B. Missing Length

The table below shows, for each city, how many capacity-affecting projects have a numeric value specified for a non-zero length (including basic estimates such as 0.10 mile for intersection improvements) and how many projects use lengths estimated based on the average cost per lane-mile added by project type or similar methods.

Table 4A: Missing Length Summary

Missing Length Summary	Length Specified	Length Estimated	Pct Length Estimated
Austin, TX	185	515	73.57%
Louisville, KY--IN	185	92	33.21%
Richmond, VA	346	61	14.99%
Dayton, OH	286	9	3.05%
Raleigh, NC	372	0	0.00%
Bakersfield, CA	46	29	38.67%
Albuquerque, NM	59	100	62.89%
Rochester, NY	56	1	1.75%
Jacksonville, FL	109	85	43.81%
McAllen--Edinburg--Mission, TX	201	26	11.45%
Baton Rouge, LA	53	73	57.94%
Knoxville, TN	104	119	53.36%
Boise City, ID	75	21	21.88%
Tulsa, OK	44	113	71.97%
Grand Rapids, MI	113	0	0.00%
Fort Myers--Cape Coral, FL	242	36	12.95%
Albany--Schenectady--Troy, NY	23	15	39.47%
Fort Collins, CO	46	16	25.81%
Columbia, SC	27	1	3.57%
Ogden, UT	138	1	0.72%
Lancaster, PA	13	9	40.91%
Des Moines, IA	276	5	1.78%
Spokane, WA	60	16	21.05%
Madison, WI	120	5	4.00%
Bridgeport--Milford, CT	36	14	28.00%
Salem, OR	73	30	29.13%
Grand Total	3,288	1,392	29.74%

Figure 4A: Missing Length Summary



C. Capacity Changes

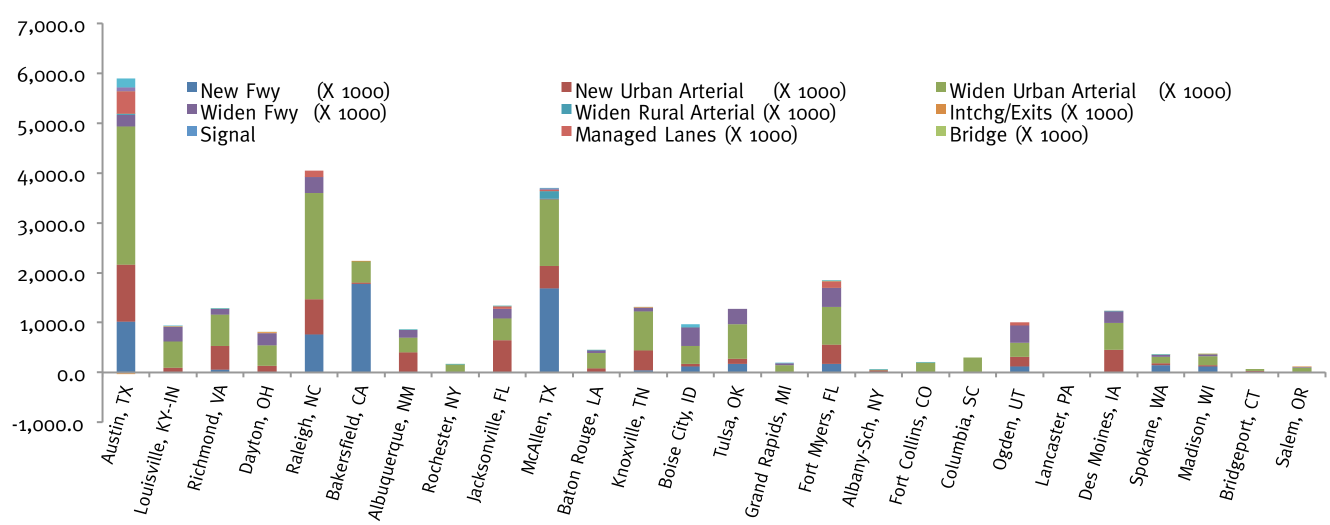
The below table and associated charts (next page) total the change in lane-mile capacity by work type code (broad improvement categories) for each city. Over 95% of the increase in lane-mile capacity comes from work types 1, 2, 3 and 4 (new freeways, new arterials, arterial widening and freeway widening).

Table 5A: Sum of Change Lane-Mile Capacity

Sum of Change Lane-mile Capacity	New Freeway (X 1000)	New Urban Arterial (X 1000)	Widen Urban Arterial (X 1000)	Widen Freeway (X 1000)	Widen Rural Arterial (X 1000)	Interchange/ Exit (X 1000)	Signal	Managed Lanes (X 1000)	Bridge (X 1000)	Urban Arterial to Freeway (X 1000)	Improve no widen (X 1000)	Traffic Calming (X 1000)	(X 1000)
	1	2	3	4*	6*	7	8	9	10	11	12	13	Total
Austin, TX	1,019.4	1,140	2,776	225	26	1.2	0	450	0.6	82	173	-34	5,859
Louisville, KY--IN	0.0	95	525	300	0	4.0	0	0	1.8	0	3	-2	926
Richmond, VA	60.8	476	625	116	0	0.0	0	0	0.3	0	4	0	1,282
Dayton, OH	0.0	132	412	246	0	6.2	0	0	2.8	0	6	9	814
Raleigh, NC	758.9	708	2,132	321	0	0.1	0	127	0.0	0	0	-5	4,043
Bakersfield, CA	1,781.1	14	433	0	0	8.0	0	0	0.0	0	0	0	2,236
Albuquerque, NM	0.0	408	294	148	0	0.0	0	0	0.3	0	14	0	863
Rochester, NY	0.0	6	153	0	0	0.0	0	0	0.1	0	4	0	163
Jacksonville, FL	0.0	640	447	190	0	0.0	0	48	0.8	0	3	0	1,328
McAllen--Edinburg--Mission, TX	1,680.0	460	1,328	15	154	1.4	0	22	3.2	18	3	0	3,685
Baton Rouge, LA	0.0	82	312	47	0	0.0	0	0	0.3	0	3	0	445
Knoxville, TN	42.2	395	781	87	0	0.0	0	0	0.4	0	1	0	1,307
Boise City, ID	121.4	47	358	375	0	0.0	0	0	2.0	0	60	0	964
Tulsa, OK	172.0	99	694	316	0	0.0	0	0	0.0	0	0	0	1,281
Grand Rapids, MI	0.0	0	140	44	0	0.0	0	0	0.0	0	4	0	189
Fort Myers--Cape Coral, FL	176.2	375	766	383	0	0.3	0	131	9.5	0	0	0	1,842
Albany--Schenectady--Troy, NY	0.0	38	13	0	0	0.0	0	0	0.0	0	3	0	54
Fort Collins, CO	0.0	8	193	0	0	0.0	0	0	0.0	0	9	0	210
Columbia, SC	0.0	12	287	0	0	0.0	0	0	0.0	0	0	0	299
Ogden, UT	115.2	195	285	349	0	0.0	0	65	0.0	0	0	0	1,010
Lancaster, PA	0.0	7	15	0	0	0.0	0	0	0.0	0	0	0	22
Des Moines, IA	19.5	433	542	223	0	0.4	0	0	0.0	0	15	0	1,233
Spokane, WA	144.0	35	134	37	0	4.0	0	0	0.3	0	1	-1	354
Madison, WI	115.5	29	181	42	0	0.6	0	0	1.7	0	0	0	371
Bridgeport--Milford, CT	0.0	27	40	0	0	0.0	0	0	0.0	0	0	0	67
Salem, OR	0.0	16	80	13	0	0.4	0	0	0.0	0	0	0	110
Grand Total	6,206.3	5,880	13,947	3,478	180	27	0	843	24	101	306	-33	30,958

* Work Type 5 was previously deleted.

Figure 5A: Change in Lane-Mile Capacity, TIP and LRP



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Prof. David T. Hartgen, professor emeritus of transportation studies at UNC Charlotte and president of The Hartgen Group, is widely known in transportation circles. He established the UNC Charlotte's Center for Interdisciplinary Transportation Studies in 1989 and now conducts research in transportation policy. He is the author of about 355 publications on a wide variety of topics in transportation policy and planning, is the U.S. editor of the international academic journal *Transportation,* and is active in professional organizations. Before coming to Charlotte he directed the statistics and analysis functions of the New York State Department of Transportation and was a policy analyst at the Federal Highway Administration. He holds engineering degrees from Duke University and Northwestern University. His recent national studies of congestion reduction, performance of highway systems, and the transportation performance of the Canadian provinces have attracted wide attention.

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Endnotes

1 David Schrank and Tim Lomax, "The 2012 Urban Mobility Report," Texas Transportation Institute, January 2013, http://mobility.tamu.edu.

2 David T. Hartgen, et al, *Employer Views on Traffic Congestion* (Los Angeles: Reason Foundation, February 20, 2014).

3 USDOT, "National Strategy to Reduce Congestion on America's Transportation Network," May 2006.

4 USDOT, Federal Highway Administration, "An Interim Guidebook on the Congestion Management Process in Metropolitan Transportation Planning," February 6, 2008, http://ops.fhwa.dot.gov/publications/cmpguidebook/index.htm.

5 USDOT, "2013 Report to Congress on the Nations Highways, Bridges and Transit," February 2014. www.fhwa.dot.gov.

6 David T. Hartgen, M. Gregory Fields, and Claire G. Chadwick, "Are They Ready? Mega-Region Growth and Transportation Investment," Report for the Urban Land Institute, April 2008, http://www.hartgengroup.net/project.shtml.

7 David T. Hartgen, "Traffic Congestion in North Carolina Status, Prospects and Solutions," John Locke Foundation, March 7, 2007, http://www.hartgengroup.net/project.shtml.

8 AAA Market Research, Transportation Omnibus "Pocket of Pain" Survey, November 2006.

9 David T. Hartgen and M. Gregory Fields, *Incremental Capacity Needed to Reduce Traffic Congestion* (Los Angeles: Reason Foundation, March 13, 2006).

10 David T. Hartgen, et al, *Employer Views on Traffic Congestion* (Los Angeles: Reason Foundation, February 20, 2014).

11 Cambridge Systematics Inc., "Initial Assessment of Freight Bottlenecks," Federal Highway Administration, 2005.

12 American Highway Users Alliance, "Are We There Yet? Summer Traffic Bottlenecks," 2005.

13 American Highway Users Alliance, "Unclogging America's Arteries: Effective Relief for Highway Bottlenecks," 2005.

14 American Association of State Highway and Transportation Officials, "Combating Congestion Through Leadership, Innovation and Resources," 2007.

[15] U.S. Census Bureau, 2005, American Community Survey, available at: http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=&_lang=en&_ts= ,
Federal Highway Administration, 2005, http://www.fhwa.dot.gov/policy/ohpi/hpms/states.cfm,
David Schrank, and Tim Lomax, "The 2007 Urban Mobility Report, Texas Transportation Institute," Table 5, September 2007.

[16] The Transportation Improvement Program (TIP) is a federally mandated program of projects that each urbanized area expects to build over the short-term, typically four to seven years. The Metropolitan Transportation Plan ("Long Range Plan" or LRP) is a federally mandated plan for the region's transportation needs over the next 20–25 years, along with a fiscally constrained list of projects, with costs needed to get there. These plans are intended to provide a vision and implementation process for the region's transportation needs into the 20+ year horizon. They are revised every three to five years.

[17] David Schrank and Tim Lomax, "The 2007 Urban Mobility Report, Texas Transportation Institute," Table 5, September 2007. A new measure, based on delay on freeways and covering larger regions, has recently been issued by INRIX, but was not used for this study.

[18] By comparison, the Reason report referenced above shows that regions with over three million population average 1.46 TTI, but regions between one million and three million average a TTI of 1.28.

[19] David T. Hartgen and M. Gregory Fields, *Incremental Capacity Needed to Reduce Traffic Congestion* (Los Angeles: Reason Foundation, March 13, 2006).

[20] United States Department of Transportation Federal Highway Administration Office of Operations, *Traffic Congestion and Reliability*, (Washington, D.C.: U.S. DOT, 2005), http://www.ops.fhwa.dot.gov/congestion_report/executive_summary.htm

[21] USDOT, "National Strategy to Reduce Congestion on America's Transportation Networks," May 2006.

[22] So-called "induced demand" is additional travel created by adding capacity. Sometimes referred to as "pent-up" demand, it consists of traffic shifting routes, time, day, or mode of travel. Most careful studies of individual projects show very small (5–15%) effects at most.

[23] Unweighted average. However, none of these forecasts account for slower 2008–09 growth or the current recession, which might slow growth substantially.

[24] U.S. Census Bureau, press release, "New Orleans' Parishes Top Nation in Population Growth Rate," March 20, 2008.

[25] Alan Pisarski, "Commuting in America III," Transportation Research Board, 2006.

[26] USDOT, "National Household Travel Survey, various years." www.fhwa.dot.gov.

[27] Federal Highway Administration, "Highway Statistics," various years. www.fhwa.dot.gov.

28 USDOT, "National Household Travel Survey, various years," FHWA, Highway Statistics, "Table VM1, various years." www.fhwa.dot.gov.

29 The major requirements are a 20+ year horizon, four to five year update cycle, approval by the MPO, demonstrate air quality conformity, forecast demand, integrate modal plans, contain operational and management strategies, consider strategies to preserve the existing systems, discuss environmental mitigation, include pedestrian and bike enhancements, and contain "reasonably available" cost and revenue estimates. (23 CFR Parts 450 and 500, Feb. 14, 2007.)

30 Hartgen, Fields and Chadwick, "Are They Ready?"

31 The Raleigh project was shelved pending review of the region's needs, but was being reconsidered in its revised LRP. In 2012 a more ambitious $4.2 B plan was also proposed.

32 Although the LRP is supposed to be fiscally constrained, some MPOs also include major unfunded projects, usually in a separate category.

33 U.S. Census Bureau, American Fact Finder, Table S0801, "2009 5-year Trends."

34 Transportation Management Areas are urbanized areas over 200,000 population, which include most—if not all—of the 26 regions we reviewed, 23 CFR Part 450.320, "Congestion management process in transportation management areas," USDOT Final Rule, Feb 14, 2007.

35 23 CFR 450.

36 John Semmens, "Price Trends for Major Roadway Inputs," September 2008. Available at: http://www.mtkn.org/products/pt/2008/pt9-08.pdf

37 See Appendices. Plans judged realistic overall are Louisville, McAllen, Ogden, Richmond and Salem. Others near-realistic include Albuquerque, Boise, Des Moines, Ft. Myers, Knoxville and Tulsa.

38 This approach eliminates most transit options, which generally have little effect on congestion unless solo drivers are diverted. An alternate approach would be to use the regional travel demand models to estimate congestion relief for both modal diversions and increased capacity. Some regions used this approach in preparing their forecasts of congestion, but we found little information in the plans documenting the results. For consistency, we used the above procedure for all regions.

39 Cambridge Systematics, *An Initial Assessment of Freight Bottlenecks on Highways*, (Cambridge, MA: Cambridge Systematics, 2005), p. ES-1.

40 Savings in Delay = (Traffic affected)*(Project length)*(1/Speed before - 1/Speed after). A more detailed assessment would undertake a traffic assignment for each project or project group. This was not done here because of time limitations, but we believe that the findings here are reasonably accurate as a first approximation of the impacts.

[41] Costs for Bridgeport-Milford and for Tulsa have been corrected to include the total costs of their long-range projects. The overall relative savings in the long range plans did not include costs for individual projects, but did include totals for project subgroups.

[42] S. Concas, *Synthesis of research on the value of time and reliability*, (Tampa, FL: Center for Urban Transportation Research, Univ. of South Florida, January 2009).

[43] Ibid.

[44] A multiplier of about 1.6 (additional = 0.6) is a common value used for increases in household expenditures.

[45] Government expenditures are not a "benefit" but a transfer from the private sector to the public. Therefore they are treated as an avoidable "cost" that should be compared to the project's real benefits. However, the incremental increase in economic activity caused by the government expenditure is a benefit.

[46] Equivalent jobs is an alternate metric, popular in economic development literature. While cost-benefit analysis is typically preferred, equivalent jobs provides another way of quantifying benefits.

[47] D. T. Hartgen et al, *Impacts of Transportation Policies on Greenhouse Gas Emissions in U.S. Regions* (Los Angeles: Reason Foundation, November 30, 2011).

[48] According to the Federal Highway Administration, unit-costs of road construction in mid-sized regions are one-half to one-third that of larger, denser regions.

[49] Transportation Research Board, *Highway Capacity Manual*, 2000.

[50] David Schrank, and Tim Lomax, "The 2007 Urban Mobility Report, Texas Transportation Institute," September 2007.

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