

**GAO**

Report to the Ranking Member,  
Committee on Environment and Public  
Works, U.S. Senate

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July 2007

# SURFACE TRANSPORTATION

Strategies Are  
Available for Making  
Existing Road  
Infrastructure  
Perform Better





Highlights of [GAO-07-920](#), a report to the Ranking Member, Committee on Environment and Public Works, U.S. Senate

### Why GAO Did This Study

For the past several decades, the capacity of the nation’s road network has not grown fast enough to keep pace with demand. The increasing congestion is apparent to millions of commuters and freight operators. Although road building is perhaps the most familiar antidote, Congress, the Department of Transportation (DOT), and transportation research have emphasized the need to more efficiently use the existing infrastructure as a means to control congestion.

GAO was asked to examine various issues associated with increasing the efficient use of existing infrastructure. This report examines the following questions: (1) What factors inhibit the efficient use of the existing infrastructure of roads and highways? (2) What techniques have been developed for making the current infrastructure more efficient and what is known about the results? (3) How have local decision makers implemented these techniques? (4) What strategies exist for increasing the use of such techniques? To address these questions, GAO reviewed existing studies, examined efforts in five states, and sought transportation officials’ views, among other things.

GAO is not making recommendations in this report. In commenting on a draft of this report, DOT provided technical clarifications, which we incorporated as appropriate.

[www.gao.gov/cgi-bin/getrpt?GAO-07-920](http://www.gao.gov/cgi-bin/getrpt?GAO-07-920).

To view the full product, including the scope and methodology, click on the link above. For more information, contact JayEtta Z. Hecker at (202) 512-2834 or [heckerj@gao.gov](mailto:heckerj@gao.gov).

## SURFACE TRANSPORTATION

# Strategies Are Available for Making Existing Road Infrastructure Perform Better

### What GAO Found

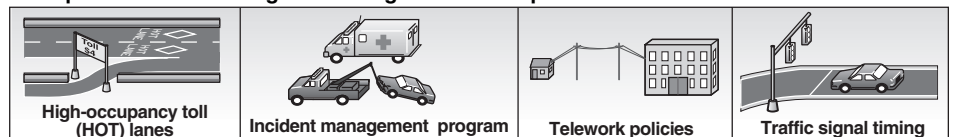
Three broad factors inhibit efficient use of existing roads. First, many were not designed and built to meet today’s traffic volumes, and their operation has not changed sufficiently to better meet current volumes. Second, the federal and state revenue-raising structure does not provide incentives for drivers to use roads efficiently because it does not capture all the costs involved in using roads at time of peak demand. Third, information about which investments produce the highest estimated social benefits is limited when decisions are made about how to address congestion.

Two types of techniques have been developed for making current roads more efficient. One *enhances capacity* through better operations and use of technology, such as timing traffic signals to improve traffic flow. The other *influences behavior* about when and where to drive, through such specific means as flexible work schedules, and charging drivers tolls to use roads during peak hours. Research suggests that these techniques are most effective when tailored to the particular situation and used in combination.

In the states GAO reviewed, officials chose varying techniques but tended to implement them with a similar three-pronged approach: (1) changing planning and related processes to give these techniques more priority, (2) developing creative mechanisms to fund them, and (3) collaborating with multiple stakeholders to put them in place. Officials said many of the techniques, while helpful, provided only marginal benefits, because several persistent challenges prevented greater use. These challenges ranged from resolving jurisdictional authority to finding alternative funding sources.

Although many strategies exist for making greater use of these techniques, they vary depending on the level of government involved. Three strategies cut across all levels of government: (1) considering how the private sector can be used in managing existing road infrastructure, (2) expanding the user-pay concept for managing demand and generating revenue for transportation investments, and (3) measuring results and managing with them in mind. Several other strategies, such as applying techniques on a regional basis and integrating transportation planning more fully with land-use planning, relate primarily to state and local governments. Strategies at the federal level, where participation in transportation projects relates primarily to financial assistance and policies affecting system performance and safety, includes linking federal funding to performance, increasing flexibility for states and localities, and placing additional focus on projects with national benefits.

#### Examples of Various Congestion Mitigation Techniques



Source: GAO.

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### Abbreviations

DOT	Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HOT	high-occupancy toll lane
HOV	high-occupancy vehicle
ICM	Integrated Corridor Management
ITS	intelligent transportation system
NCHRP	National Cooperative Highway Research Program
NTOC	National Transportation Operations Coalition
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
TIP	Transportation Improvement Program
VII	Vehicle Integration Initiative
VMT	vehicle miles traveled

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United States Government Accountability Office  
Washington, DC 20548

July 26, 2007

The Honorable James M. Inhofe  
Ranking Member  
Committee on Environment and Public Works  
United States Senate

Dear Senator Inhofe:

Mobility—that is, the movement of passengers and goods through the transportation system—is critical to the nation’s economic vitality and its citizens’ quality of life. Mobility gives people access to goods, services, recreation, and jobs; gives businesses access to materials, markets, and people; and promotes the movement of personnel and material to meet national defense needs. While the transportation system that provides this mobility is made up of air, marine, and various modes of surface transportation, the nation’s road network is the transportation system that most citizens use daily. It is also the critical pathway for the movement of freight.

For the past several decades, the capacity of the national road network has not grown fast enough to keep pace with the growing demand. Population, income levels, and economic activity have risen considerably and with them have come significant increases in travel demand and freight movement on the surface transportation system. The result is apparent to millions of commuters and freight operators: increasing number of hours spent inching along clogged roads and highways, especially at rush hours and other times of peak demands. The economic implications are significant, ranging from wasted fuel and time as cars idle in traffic to increased logistics costs for business as the unreliability of the systems grows. While building additional roads is perhaps the most familiar way for addressing congestion, Congress, the Department of Transportation (DOT), and transportation research have emphasized the need to more efficiently use the existing infrastructure as a means to help control congestion. This could be done both by managing the existing network to enable it to handle more traffic and by managing the demands placed upon it. However, transportation stakeholders and experts have generally acknowledged that we are not using the existing infrastructure as efficiently as possible. For example, in its National Strategy to Reduce Congestion on America’s Transportation Network, DOT notes that “at its most fundamental level, highway congestion is caused by the failure to

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develop mechanisms to efficiently manage use of existing capacity and expand capacity at locations where the benefits are the greatest. Although more efficiently using existing infrastructure is intended to help manage congestion, the goal of such efforts is not to completely eliminate or prevent congestion.

Given the importance of the nation's road network, the federal government has partnered with states in developing and maintaining it. In recent years, the Federal Highway Administration (FHWA) has provided nearly \$34 billion each year to states to build and improve roads and bridges and meet other transportation needs. Since transportation research and our work has indicated that the current system will not be able to meet future demand, you asked us to provide information on several key questions related to what is being done—and what else might be needed—in adjusting to this changing environment and ensuring our nation's mobility. More specifically, this report addresses the following questions:

1. What factors inhibit the efficient use of the existing infrastructure of roads and highways?
2. What techniques have been developed for making the current infrastructure more efficient and what is known about the results of these techniques?
3. How have local decision makers implemented these techniques?
4. What strategies exist for increasing the efficient use of existing infrastructure?

To address these questions, we conducted a review of relevant literature, reports, studies, and our prior research and interviewed federal, state, and local transportation officials, as well as representatives from various industry associations with experience in developing, implementing, or analyzing these techniques. We also conducted site visits or interviews with state and local transportation officials in California, Colorado, Florida, Virginia,<sup>1</sup> and Washington. We selected this nongeneralizable sample of states based on the level of congestion of selected metropolitan areas within these states, including Denver; Northern Virginia; Orlando; San Diego; San Francisco/San Jose/Oakland; and Seattle; and additionally

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<sup>1</sup>These interviews were conducted by telephone.

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on the states' experience with using congestion mitigation techniques to achieve geographical diversity. We also visited Aurora and Boulder, Colo.; Altamonte Springs, Fla.; Hampton Roads, Va.; and Bellevue and Issaquah, Wash., to gain some insight into the implementation of congestion management techniques in smaller jurisdictions. During these site visits, we interviewed federal, state, and local transportation officials and toured operations centers. In addition, we reviewed studies and documentation on how these and other metropolitan areas and states have implemented congestion management techniques and their results. We conducted our work from September 2006 through July 2007 in accordance with generally accepted government auditing standards. (See app. 1 for more information about our objectives, scope and methodology.)

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## Results in Brief

Three broad factors inhibit efficient use of roads and highways: design and operation factors; the revenue-raising structure; and a limited focus on selecting projects that produce the highest net social benefits in the current decision-making process. First, many roads were not designed and built to meet current traffic volumes, and operational changes—such as the timing of traffic signals—have not changed sufficiently to cope with the increased use. Second, the federal and state transportation revenue-raising structure, which collects the majority of revenues through motor fuel taxes and other user fees, does not provide incentives for drivers to take into account the external costs, such as increased travel time for other drivers, they impose in deciding when, where, and how to drive. For example, the tax rate on gasoline is the same regardless of whether drivers drive in congested or uncongested periods. Third, there is a limited focus in the current decision-making process on selecting projects that will produce the highest net social benefits. Decision makers also are limited in their ability to identify and put in place infrastructure investments that would produce the highest estimated social benefits because the current decision-making process is compartmentalized by mode and is not driven by economic analysis.

Two categories of congestion mitigation techniques have been developed to improve the efficiency and better optimize the performance of the existing infrastructure. The first category includes techniques that enhance road capacity through better operations, such as incident response vehicles that quickly restore traffic flow after vehicle crashes, or the deployment of transportation technology, such as optimizing the timing of traffic signals to improve traffic flow. The second category includes techniques designed to better acknowledge the impact of using the road system during times of peak demand; these techniques influence

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drivers to make alternative choices, such as car pooling or shifting trips to less congested times. Studies and evaluations of projects indicate that these congestion mitigation techniques have the potential to provide benefits such as reduced congestion delays and improved traffic flows that maximize existing capacity. These studies and evaluations also indicate such techniques are most effective when tailored to the particular situation and used in combination.

At locations we reviewed, officials chose varying congestion mitigation techniques but tended to implement them with a similar three-pronged approach: (1) changing planning and related processes to give them higher priority, (2) developing creative mechanisms to fund them, and (3) collaborating with multiple stakeholders to put them in place. For example, in considering which projects to select for funding, the metropolitan planning organization for the Denver region now awards points to projects that use certain congestion mitigation techniques, such as installing left-turn lanes, coordinating traffic lights, or managing incidents. Officials for the Denver region said they hope awarding points will provide incentives for local planners to include such techniques in their projects. Transportation officials said the mode-specific, “stove-piped” funding structure for transportation projects, together with a general lack of resources for transportation projects, constrained their ability to use these techniques. As a result, they said, they often have had to find alternative methods to supplement traditional funding sources. Officials also reported working with multiple partners to implement congestion mitigation techniques. They said the success of these techniques depends on coordination among many partners. While officials said the techniques produced benefits, these officials also called attention to various challenges that tended to preclude wider use. These challenges ranged from resolving jurisdictional authority to identifying sufficient funding to allow implementation on a broader scale. As a result, they said, the approach they used to implement these techniques could provide only marginal improvement to the efficiency of the road network.

Various strategies exist for increasing the efficient use of infrastructure. We grouped the strategies by the level of government best suited to consider and implement them, given their current authorities, roles, and responsibilities. In some cases, all levels of government would need to be involved in implementing the strategy; in other cases, the federal government or a state government would be most appropriate to implement the strategy. We identified three strategies that cut across all levels of government, including (1) considering how the private sector can be used in managing existing road infrastructure, (2) expanding use of the



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user-pay concept for managing demand and generating revenue for transportation investments, and (3) developing a systematic performance-based management approach to increase the accountability of public expenditures and to link performance to investment decisions. We also identified strategies that would be most appropriate for state and local governments to consider, including applying congestion mitigation techniques on a regional basis and fully integrating transportation and land-use planning. For example, traffic signal timing is one technique that can provide significant benefits to drivers by providing for the smooth flow of traffic along streets and highways. To fully enhance mobility, jurisdictions need to coordinate the timing along an entire corridor, which often crosses multiple jurisdictions. Finally, we identified strategies that the federal government could consider to help increase the efficient use of infrastructure. These strategies include (1) linking funding more directly to performance, (2) increasing the flexibility provided to state and local governments to promote innovative solutions, and (3) focusing on projects (or transportation corridors) of national interest. For example, the federal government could also use incentives to link funding to particular outcomes, such as encouraging state and local governments to increase the efficient use and performance of existing infrastructure. According to transportation research and transportation officials and experts we interviewed, the strategies are not mutually exclusive and ideally would be implemented in a comprehensive manner.

DOT, including FHWA, reviewed a draft of this report. DOT officials provided technical clarifications, which we incorporated as appropriate.

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## Background

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### Pressure on Road System Continues to Build

Road usage, as measured by vehicle miles traveled (VMT), has grown over the last 25 years. From 1980 through 2005, the most recent years for which data are available, road usage grew at an average annual rate of 2.7 percent from 1980 through 2005. A number of demographic and economic trends contribute to this increase in road usage, including the shift from urban to suburban areas by businesses and households, rising household incomes, and a greater reliance on trucks to move freight. For example, research shows that car ownership and VMT rise with income. The average U.S. household income (in 2005 dollars) grew from \$47,263 in 1980 to \$63,344 in 2005, according to U.S. Census Bureau data, fueling the number of cars on the road and the number of miles traveled.

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Increasing road usage has led to growing congestion in the nation's transportation system. In 2006, FHWA reported that congestion on U.S. highways between 1982 and 2003 had increased in extent, duration, and intensity. For example, in the largest U.S. cities, 67 percent of travel was impacted by congestion—up from 33 percent in 1982. As a result, drivers in urban areas are increasingly experiencing what FHWA calls recurring congestion, which is congestion that occurs day-in and day-out, such as slowdowns that occur during morning and afternoon commutes, even when road and weather conditions are ideal. This type of congestion occurs simply because so many cars and trucks are trying to use the road at the same time; the network as currently designed and operated simply cannot handle the volume. The imbalance between demand and supply also affects the network's ability to recover from what FHWA refers to as nonrecurring congestion, which is caused by crashes, weather, construction, or other event-driven variability. The increased volume of traffic often exacerbates the effects of such slowdowns and roadblocks in traffic flow. Both categories of congestion can lead to significant loss of productivity with real economic impacts. For example, the Texas Transportation Institute estimates that U.S. drivers experienced 3.7 billion hours of travel delay and wasted 2.3 billion gallons of fuel in 2003 due to congestion in the top 83 urban areas. The Texas Transportation Institute projected the total cost at \$63 billion (in 2003 dollars). In addition to the economic effects, congestion can also lead to negative environmental impacts. For example, studies have shown potential negative health effects from living near busy roads, with one recent study showing that children in neighborhoods with higher levels of traffic pollutants have shown an increased prevalence of asthma and bronchitis symptoms.<sup>2</sup>

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### Capacity Has Not Kept Pace with Demand, and Is Not Likely to Do So

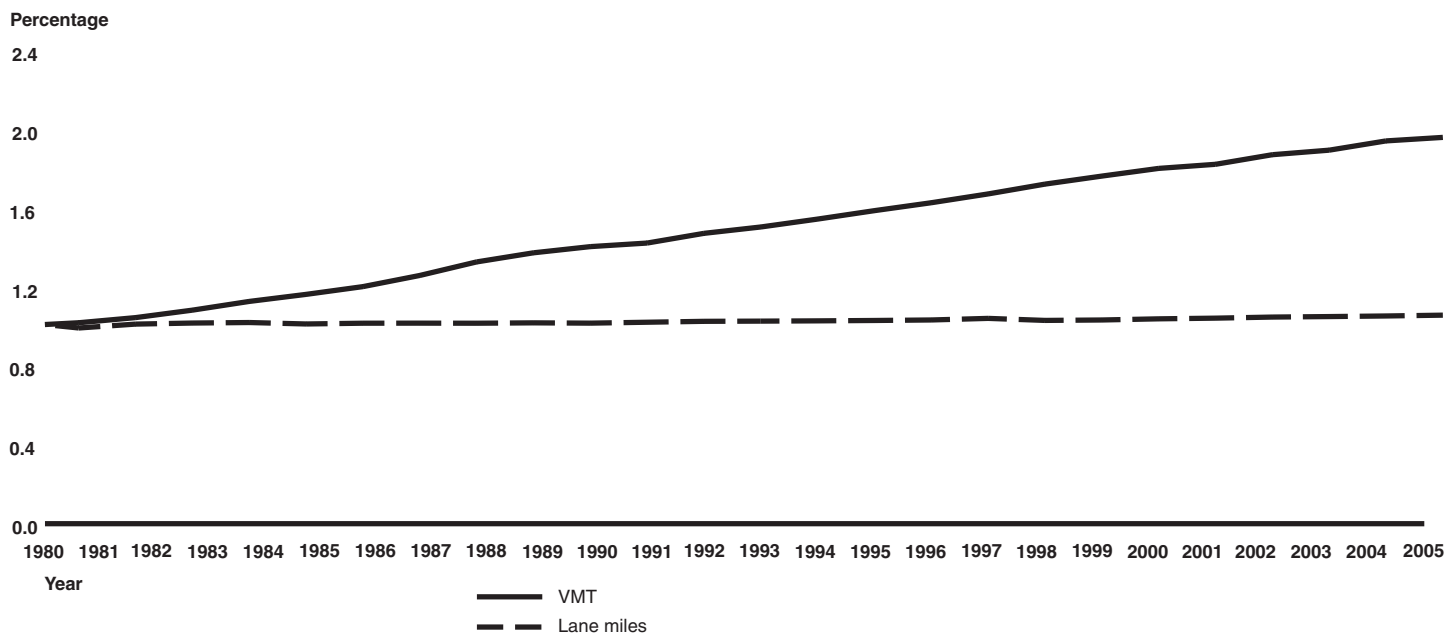
Several strategies exist for addressing the growing congestion on roads, including constructing new infrastructure to add capacity, improving maintenance on existing capacity, and managing existing capacity through operational methods. While building new capacity is still a viable strategy in certain situations, such as in areas where there is available space to accommodate new roads or to add more lanes to existing roads, overall, the construction of new capacity is not keeping pace with the growing demand. For example, while VMT has almost doubled from 1980 to 2005,

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<sup>2</sup>Janice J. Kim, et al., "Traffic-related Air Pollution near Busy Roads: The East Bay Children's Respiratory Health Study," *American Journal of Respiratory and Critical Care Medicine* 170 (2004); 520-526.

growing at an average annual rate of 2.7 percent, during the same time, new construction of lane miles increased capacity at an average annual rate of 0.2 percent, so that by 2005 total capacity was only 6 percent greater than in 1980. (See fig. 1.)

**Figure 1: Percentage Change of Vehicle Miles Traveled and New Construction of Lane Miles between 1980 and 2005**



Source: GAO analysis of highway statistics from FHWA.  
 Note: Index = 1 for 1980.

Many factors appear to have contributed to the slow increase in supply relative to demand, with the several listed below often cited as most critical.

- *The purchasing power of available funding for highway construction and maintenance is declining.* Although transportation revenues have continued to increase in nominal terms, with total highway revenues for states growing an average of 3.6 percent per year between 1995 and 2004, the federal and state motor fuel tax rates—the mainstay of state highway revenue—have not kept up with inflation. According to DOT and FHWA data, this has resulted in a decline in the purchasing power in real terms of revenues generated by federal and state motor fuel tax rates since 1990.
- *An increasing proportion of available funds is being spent to preserve existing infrastructure.* State and regional transportation decision makers are devoting more funding to highway investments that preserve, enhance,

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and maintain existing infrastructure than to investments that add capacity. Existing infrastructure is aging and keeping it functional is becoming more expensive. According to FHWA data, of the \$70.3 billion spent nationally in 2004 on highway capital spending, 52 percent (\$36.4 billion) was spent on system preservation, compared with 39 percent (\$27.5 billion) for new construction.<sup>3</sup> In 1993, 45 percent of the total was spent on system preservation.

- *The recent growth of road construction costs exceeds the overall rate of inflation.* The cost of building new capacity and maintaining existing capacity has increased steadily over the last few years, at a rate that exceeds inflation. The composite bid price index<sup>4</sup> for highway construction has almost doubled since 1987, according to FHWA. In particular, the price of construction materials has increased significantly in the last few years because of rising diesel and asphalt prices.
- *Road-building solutions are becoming less popular.* In many locations, the public has grown increasingly resistant to carving out additional space for roads, both for environmental and for social reasons. As a result, state and local governments have increasingly identified quality of life and environmental sustainability as key principles in their long-term regional plans for managing growth and investing in transportation infrastructure. Transportation planners will have to make trade-offs between facilitating increased mobility—through adding new road capacity—and giving due regard to environmental and other social goals.

Building new infrastructure to keep pace with demand may continue to be problematic in the future, because revenues from the Highway Trust Fund—the major source of federal highway and transit funding—are projected to continue to erode in real terms due to inflation. Additionally, funding authorized in the most recent highway and transit program legislation is expected to outstrip the growth in trust fund receipts. According to recent estimates from the Congressional Budget Office and the President’s budget, the trust fund balance will steadily decline and

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<sup>3</sup>The remaining 9 percent was spent for system enhancements such as safety, operational, or environmental enhancements.

<sup>4</sup>The composite bid price index is composed of six indicator items: common excavation, to indicate the price trend for all roadway excavation; Portland cement concrete pavement and bituminous concrete pavement, to indicate the price trend for all surfacing types; and reinforcing steel, structural steel, and structural concrete, to indicate the price trend for structures. The index is adjusted to account for inflation, so a doubling represents a substantial loss in purchasing power.

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reach a negative balance of more than \$14 billion by the end of fiscal year 2012.<sup>5</sup> The overall fiscal imbalance the nation faces makes it difficult to find an easy fix for this problem by seeking to significantly expand federal contributions. As a result, in 2007, we placed financing of the nation’s transportation infrastructure on our list of high-risk issues facing federal decision makers.<sup>6</sup>

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### With Capacity Constrained, Other Approaches Are Receiving More Attention

Given these trends, state and local governments are turning to the other tools to manage congestion, including improving the efficiency of the existing road network. When considering how to better manage existing road infrastructure, two key concepts are important and will be referred to often in this report: maximizing the flow of vehicles and promoting efficient use of the road through users’ choices.

- *Maximizing the flow of vehicles.* This concept deals with achieving maximum flow of vehicles through a stretch of highway. Once a road reaches a certain capacity level, drivers’ ability to travel at or near the posted speed limit begins to decrease, because traffic flow is increasingly affected by such things as an inability to change lanes to pass slower vehicles or a need to slow down to allow merging vehicles to enter. Transportation research uses “level of service”<sup>7</sup> to measure the speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience for a road. As figure 2 shows, level of service ranges from “free flow,” where the amount of traffic is small enough to allow travel at the posted speed limit, to “stop and go flow,” where a road has become so packed with vehicles that drivers’ speeds can fall to far lower than the speed limit. When the number of vehicles approaches maximum capacity, speeds are slowed to the point that a road can accommodate fewer total vehicles in a given period of time. As the figure shows, a road is considered to have a “stable flow” when the number of vehicles represents between roughly 50 to 85 percent of the road’s maximum carrying capacity.

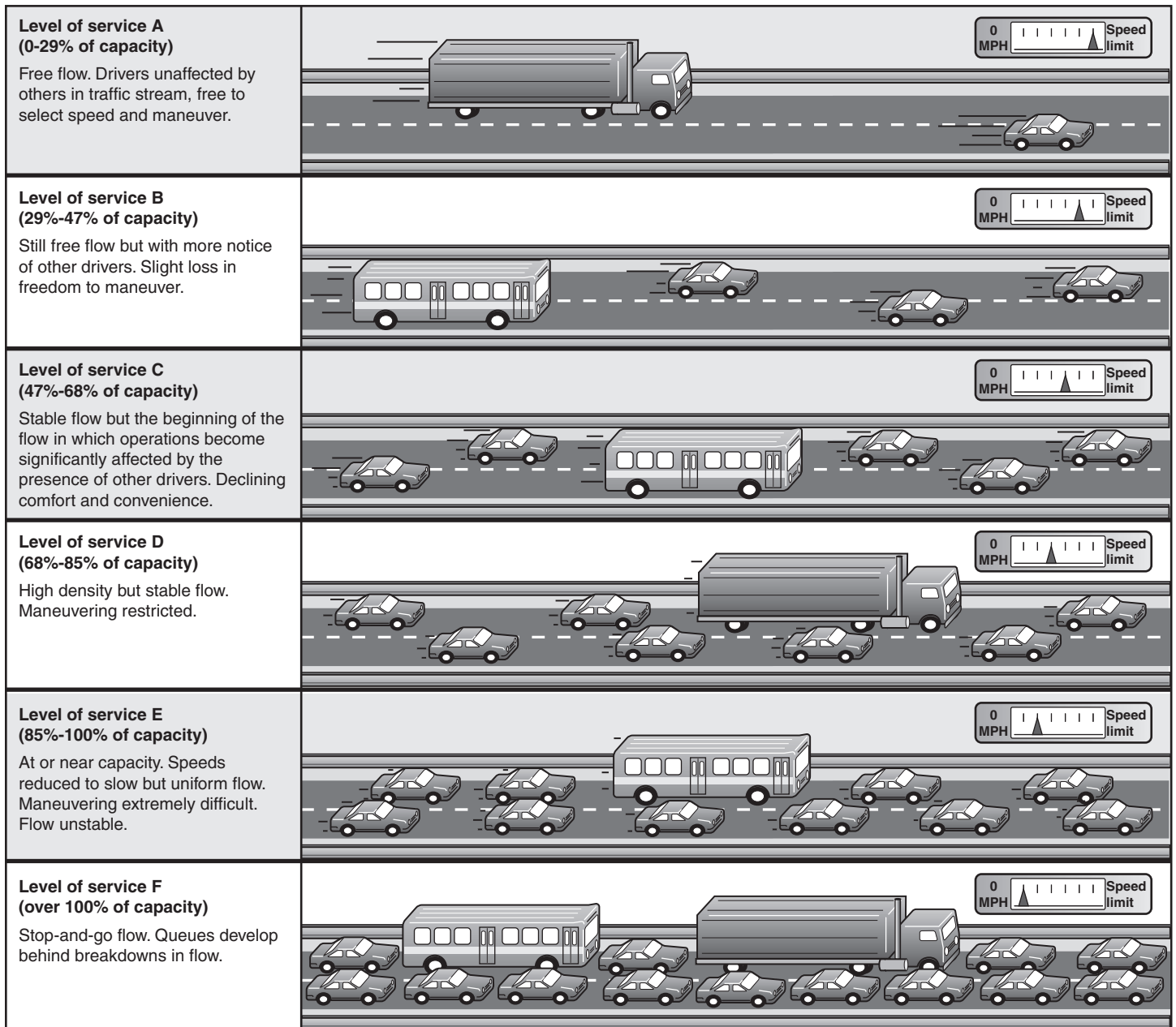
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<sup>5</sup>GAO, *Performance and Accountability: Transportation Challenges Facing Congress and the Department of Transportation*, [GAO-07-545T](#) (Washington, D.C.: Mar. 6, 2007); and GAO, *Highway Trust Fund: Overview of Highway Trust Fund Estimates*, [GAO-06-572T](#) (Washington, D.C.: Apr. 4, 2006).

<sup>6</sup>GAO, *High Risk Series: An Update*, [GAO-07-310](#) (Washington, D.C.: January 2007).

<sup>7</sup>Definitions of level of service are dependent on the specific road type, such as multilane highways or urban streets. There are other measures that are used such as travel time reliability.

**Figure 2: Representation of Levels of Service on a Two-Lane Highway**



Source: GAO analysis of the Transportation Research Board of the National Academies *Highway Capacity Manual*.

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- *Promoting efficient use through users' choices.* This concept deals with ensuring that road users make choices about when to drive based on the full costs of using the road. Economists see congestion as a byproduct of drivers' decisions to use a specific road based only on the benefits they receive and the costs that they incur (for example, the gasoline they use and the time they spend) and not on the external costs they impose on others, such as increased travel time for others and increased pollution.<sup>8</sup> From an economic perspective, a road is not efficiently "priced" when this condition occurs. To achieve more efficient use, some type of pricing mechanism, such as a toll or surcharge, would need to be implemented to take into account the cost that a driver imposes on others when using a congested road. Efficient road pricing is basically seen as a way to ration limited resources—for example, the use of a highway during times of peak demand, such as rush hour. A toll or surcharge, under such conditions, would create incentives for drivers to shift their travel to periods of lower demand, use other roads, or make other adjustments, when the costs of their decision to drive during congested periods exceed the benefits they receive.

Although more efficiently using existing infrastructure is intended to help manage congestion, the goal of such efforts is not to completely eliminate or prevent congestion. For example, an exorbitantly priced toll on a road that discourages drivers from using it would create an inefficient use of the infrastructure—even though there would be no congestion on the road. Similarly, a road network that could disperse a crowd of 90,000 from a football game and create no congestion would require many lanes that would likely be underused at all other times of the year. Economic efficiency is thus a balancing act.

Congress has recognized the importance of improving the efficient use of the existing road infrastructure through the passage of Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). SAFETEA-LU addresses both current and future challenges facing our nation's transportation system by promoting efficient and effective federal surface transportation programs. In particular, SAFETEA-LU establishes new requirements and programs to

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<sup>8</sup>More specifically, economists consider a road efficiently used when, at the margin, an additional driver using the road perceives his or her personal benefits to exactly offset both his or her personal costs, as well as other social costs, which include such costs as the additional travel time he or she imposes on other drivers, the wear and tear on the road surface, and the pollution to the society. Economists call this point as an equilibrium at which the marginal benefits to the additional user equal the marginal social costs.

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promote the efficient use of existing infrastructure. For example, SAFETEA-LU requires that DOT establish a real-time system management information program to build the capability to monitor, in real time, the traffic and travel conditions of major highways and to share this information with state and local governments to assist in relieving congestion and providing traveler information. According to FHWA officials, a notice of proposed rule making for this program is expected to be published in late 2007.

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### Federal Government Is One of Many Stakeholders in Operating and Managing the Road Infrastructure

Multiple stakeholders are involved in the construction, maintenance, and operation of the nation's road infrastructure. These stakeholders include the federal government, state and local governments, and the private sector.

- The *federal government*, primarily through FHWA and the Federal Transit Administration (FTA), provides funding to state and local governments for road and transit infrastructure, establishes legislation and regulations that influence the performance and safety of the system, and administers transportation programs that cover a range of areas.
- On the front lines of transportation decision making, *state and local governments*, through departments of transportation and metropolitan planning organizations, develop transportation plans and improvement programs, establish transportation funding mechanisms and build, maintain, and operate transportation infrastructure and services.
- The *private sector*, when contracted by federal, state, or local governments, may build new roads, provide maintenance on existing roads, and supply traffic management equipment and, in recent models, design, finance, build, operate, and maintain the roads.

In general, the federal government leaves many of the decisions about specific projects to states and localities, but it partners with these other levels of government in overall planning and administration, as well as funding the projects. The current framework for federal participation is set forth in authorizing statutes, most recently amended by SAFETEA-LU. SAFETEA-LU also amended certain requirements governing the way states and local governments plan and decide upon transportation projects. For example, the requirements describe various planning tasks that states and metropolitan planning organizations must perform to include (1) developing long- and short-range transportation programs and plans, (2) specifying financing for the transportation programs and projects



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identified, and (3) involving a wide range of stakeholders in the process that emphasizes cooperation and coordination. State and local government agencies must operate within the requirements set forth by SAFETEA-LU to receive federal funds.

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## Three Broad Factors Inhibit Efficient Use of Roads

Three broad factors limit efficient use of the road network. First, the design and operation of existing road networks fail to adapt to changing uses. Second, the traditional funding structure does not provide incentives for the efficient use of roads. Third, the current investment decision-making process has a limited focus on selecting projects that may produce the highest net social benefits.

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## Road Network's Design and Operation Fail to Adapt to Changing Uses

It is increasingly apparent that a considerable part of the nation's road network, particularly in urban areas, was neither designed and built to meet today's traffic volumes, nor has its operation changed sufficiently to better meet current usage patterns.

- *Problems with design.* A road's design, which may have been adequate for a lower level of use, can create problems as traffic volumes increase. For example, existing exit and entrance ramps on freeways may be very short, allowing exiting vehicles little distance to move out of a fast-moving lane of traffic and allowing entering vehicles little distance to accelerate to highway speed. When the traffic volume is low, drivers exiting and entering the freeway may have ample time to shift lanes and maintain or increase speed, but as traffic volume increases, they may be unable to do so. As a result, the interchange can become a choke point. Similarly, some older roads do not have separate lanes for left-turning traffic at the intersection and, at peak hours, drivers making left turns can block considerable traffic behind them.
- *Problems with operations.* Growing populations, longer trips, and other demographic and socioeconomic trends have contributed to changes in traffic volume and driving patterns, but operation of the road system has not necessarily changed to deal with these volumes or patterns. For example, because each local jurisdiction generally manages and operates its own streets, it may not have incentives to coordinate the timing of traffic signals on roads that cross many jurisdictions. As a result, the timing of traffic signals on these corridors may not operate in such a way to minimize the number of stops a driver would have to make. At peak hours, as traffic volumes increase, more traffic backs up at each stop, and traffic flow breaks down, creating a significant source of delay for drivers in their daily use of the major street system.

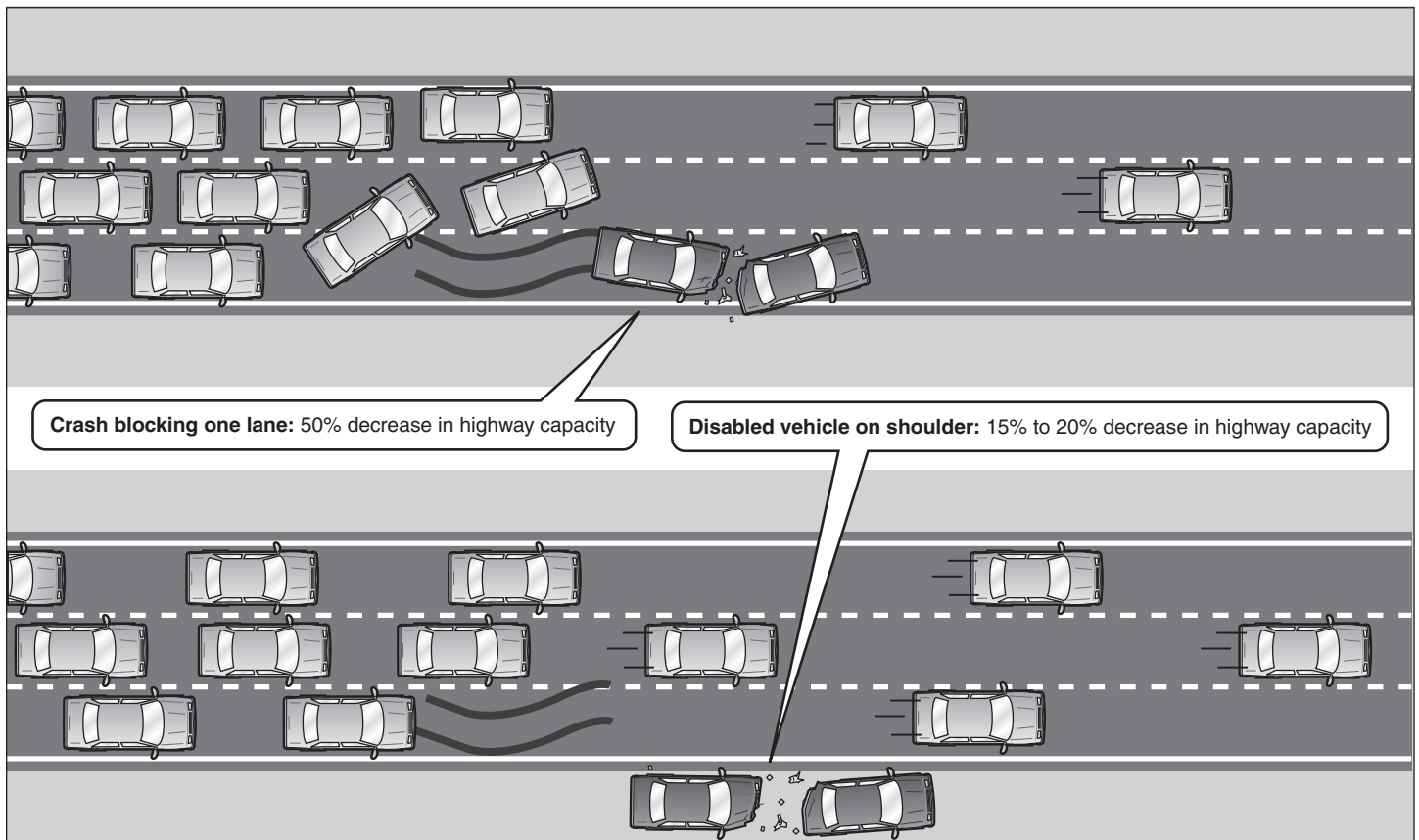
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Moreover, when a temporary disruption on the road occurs, these design and operation problems can hamper a road's ability to recover quickly. There are three main types of temporary disruptions—vehicle incidents, weather-related events (such as heavy rain), and work zones.<sup>9</sup> These temporary disruptions, which can cause congestion even on a road with low traffic volume, can grind the traffic on a whole road network to a halt if they occur on roads that already have design problems such as no left-turn lanes, or operational problems such as poorly timed traffic signals. According to FHWA, these three types of temporary disruptions account for about 50 percent of all congestion delays, with 25 percent of all delays related to vehicle incidents, 15 percent to weather, and 10 percent to work zones. As figure 3 shows, the impact of a vehicle incident is magnified depending on how much of a roadway is affected. Compounding the effect, local transportation agencies often do not have an effective protocol to share information quickly and may lack a coordinated approach to manage such incidents, such as who is responsible for clearing an accident, and how to do so. The difficulty of predicting the effect that such incidents will have on the time it takes shipments to traverse the road network can also induce freight operators to factor additional time into their schedules or businesses into warehousing additional inventory, thereby increasing the cost of conducting business.

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<sup>9</sup>One major FHWA program to mitigate work zone disruptions is the Highways for LIFE program. This program focuses on construction techniques, such as the use of prefabricated bridge and pavement elements and scheduling construction at night or on weekends that can reduce road closures, thereby limiting the impact of these events.

**Figure 3: Percentage of Highway Capacity That Is Reduced When Vehicle Incidents Occur**



Source: GAO analysis of FHWA information.

Note: The percentages are estimates for three-lane highways only and may vary with actual circumstances.

## Traditional Funding Structure Does Not Provide Incentives for Efficient Use of Roads

The federal and state transportation revenue-raising structure, which collects the majority of revenues through fuel taxes and other user fees, does not convey to drivers the full costs of their use of the road. These taxes and fees—such as fuel taxes or sales taxes—are not tied to the time when drivers actually use the road or which road they use. For example, the tax rate on gasoline is the same regardless of whether users drive in congested or uncongested periods. Except for these taxes and fees, drivers may generally perceive the use of the road as “free.” However, the use of roads during congested periods can impose a variety of costs on other drivers and the society at large, such as the following:

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- When drivers enter an already crowded road, this creates even longer delays for everyone and thus an additional cost for everyone in loss of valuable time stuck in traffic.
  - Drivers may more likely get into an accident on a congested road. The greater potential of an accident occurring may create more uncertainty in predicting travel time, increasing costs for the traveling public and businesses because they need to schedule additional time to allow for possible delays.
  - Research shows that vehicles emit substantially more air pollution per mile when driven in congested traffic than in uncongested situations, which is a cost to society and is borne more heavily by the public living near the congested corridors.

The existing revenue-raising structure provides no incentive for users to take these costs into account when making their driving decisions. From an economic perspective, a mechanism is needed that gives users price incentives to consider these costs in deciding when, where, and how to drive. Because the existing structure does not reflect the economic, social, and environmental costs of driving at peak periods, drivers who may have flexibility to share rides, use mass transit, use more indirect but less congested routes, or defer their trips to uncongested times have no financial incentives to do so. Without such incentives, the transportation system will be headed for more frequent occurrences of congestion that last longer, resulting in more time spent traveling, greater fuel consumption, and higher emissions in the long run.

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### Current Investment Decision-Making Process Has a Limited Focus on Selecting Projects That May Produce the Highest Net Social Benefits

The final factor inhibiting efficient use of the road network relates to the ability to identify—and put in place—infrastructure investments that are most likely to be efficiently used. Making the best use of scarce resources for transportation infrastructure requires a process that allows decision makers to identify which investments would produce the highest net social benefits; however, this information is limited in the current decision-making process. Two characteristics inhibit decisions on this basis. Specifically, the current process is highly compartmentalized by transportation mode and is not driven by systematic economic analysis. Both characteristics, as explained below, can lead to investment decisions that, from the standpoint of making the transportation network as efficient as possible, produce suboptimal results.

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- *Funding is compartmentalized by transportation mode.* Many transportation experts maintain—and our past work<sup>10</sup> tends to confirm—that the current structure of funding at the federal and state level is highly compartmentalized, or stove-piped. Funding is often tied to certain programs or types of projects, such as highways or transit, and it has also been increasingly designated for specific local uses.<sup>11</sup> This structure provides state, regional, and local agencies with little incentive to systematically compare the trade-offs between investment alternatives across different modes of transportation. As a result, they may choose to finance projects that do not produce the highest estimated social benefits to society. By definition, projects that produce the highest estimated social benefits further the efficient use of scarce resources for transportation infrastructure.<sup>12</sup> For example, due to the stove-piped funding, decision makers may decide to fund a smaller mass transit project instead of a high-occupancy toll (HOT)<sup>13</sup> lane network project, which could require additional funding designated for other programs. The HOT lane network project, despite its potentially higher cost than the smaller transit project, could create a more efficient use of the road by allowing single drivers to pay to use the existing car pooling lanes and therefore provide greater overall public benefits. In addition, the toll revenue collected from the paying drivers can be used to subsidize the riders of existing transit lines

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<sup>10</sup>GAO, *Highway and Transit Investments: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results*, [GAO-05-172](#) (Washington, D.C.: Jan. 24, 2005).

<sup>11</sup>See also, Thomas M. Downs, "Is There a Future for the Federal Surface Transportation Program?", *Journal of Transportation Engineering* 131, 6 (June 2005), and Ann Brach and Martin Wachs, "Earmarking in the U.S. Department of Transportation Research Programs," *Transportation Research Part-A* 39 (2005). Brach and Wachs observed that transportation research funds have been increasingly earmarked for specific institutions.

<sup>12</sup>Clifford Winston and Ashley Langer, "The Effect of Government Highway Spending on Road Users' Congestion Costs," *Journal of Urban Economics* 60 (2006), argued that the current system allocates federal funding and state funding based partly on formulae which place great weight on the size of a state's road system and on a jurisdiction's road mileage, respectively. To allocate resources more efficiently, this system would need to be revised to be based more on the level of congestion and, even then, it is still not as effective as congestion pricing.

<sup>13</sup>"HOT" lanes allow drivers who drive by themselves to pay to use less congested carpool lanes and thereby speed up their trips.

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and, therefore, potentially increasing ridership and further reducing congestion.<sup>14</sup>

- *Economic analysis does not drive decisions.* Decisions about what projects to fund are seldom subjected to rigorous economic analysis. Our prior work found that economic analysis, such as benefits and costs analysis, is not systematically used in the decision-making process.<sup>15</sup> Many tools and methods to perform economic analysis are available, and these tools have the potential to provide decision makers with valuable information such as potential social, environmental, and safety effects of alternative transportation projects. For example, benefit and cost analyses integrate and monetize the quantifiable benefits and costs of each alternative, thereby allowing decision makers to more easily compare different investment alternatives. In most instances, however, such analyses are not performed and, if they are, they are often just one factor—and not necessarily the most important one—that decision makers consider. The limited extent to which formal economic analysis is systematically used makes it difficult for decision makers to assure they are funding projects that best ensure the efficient use of scarce resources.

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## Various Techniques Have Been Developed to Make the Current Infrastructure More Efficient

Our review of transportation literature and our discussions with transportation officials identified two main categories of congestion mitigation techniques that are currently being used to make the current infrastructure more efficient. The first category includes techniques that enhance existing road capacity through better operations and transportation technology. These types of congestion mitigation techniques range from incident response vehicles that more quickly restore traffic flow after accidents to the deployment of transportation technology, such as metering traffic onto freeways and optimizing the

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<sup>14</sup>California, Colorado, Florida, Texas, Virginia, and Washington all have HOT lanes or have projects planned that will use variably priced tolls to alleviate congestion by managing the level of traffic. All of these states have received grants under FHWA's Value Pricing Pilot Program to either develop or implement the projects.

<sup>15</sup>GAO, *Surface Transportation: Many Factors Affect Investment Decisions*, [GAO-04-744](#) (Washington, D.C.: June 30, 2004).

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timing of traffic signals that can improve traffic flow.<sup>16</sup> For example, Washington State, recognizing that vehicle crashes can significantly reduce the capacity of freeways, implemented an incident response program consisting of camera surveillance, private tow companies, and roving patrol vehicles to enable a rapid response to incidents. To help clear incidents even faster, Washington State has a “steer it, clear it” law that requires drivers to move their vehicles off a main freeway if it is possible to do so. Another example of enhancing capacity through operations is utilizing access management, which is a set of techniques designed to control and limit vehicle access to highways, major arterials, and other roadways. For instance, transportation agencies have implemented access management techniques to improve traffic flow and reduce delays by increasing spacing between interchanges and redesigning intersections.

The second category of congestion mitigation techniques involves reducing congestion by influencing driver behavior on when and where to drive. These techniques range from employer transit subsidies and flexible work schedule programs to congestion pricing. By providing transit subsidies or flexible work schedules, employers make it easier for drivers to drive during less congested times or not drive to work at all. Congestion pricing also attempts to influence driver behavior by charging drivers higher prices during peak hours. As of today, a major example of states implementing road pricing techniques on highways in the United States is the converting of high-occupancy vehicles (HOV) lanes to HOT lanes, which are priced lanes that offer drivers of vehicles that do not meet the occupancy requirements the option of paying a toll to use lanes that are otherwise restricted to HOV vehicles.<sup>17</sup> Another form of congestion pricing is called cordon pricing, which charges a fee for any vehicle that enters a congested area, such as a city center. Although this type of congestion pricing has only been implemented in foreign countries to date, cities in

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<sup>16</sup>Signal timing is one of many Intelligent Transportation System (ITS) technologies. ITS technologies use communications, electronics, sensors, and computer hardware and software to improve the performance and safety of freeways, roads, and transit systems. Other congestion mitigation techniques using ITS technologies include traffic cameras, message signs, traveler information Web sites, traffic sensors, ramp meters, and electronic toll collection systems. See GAO, *Highway Congestion: Intelligent Transportation Systems’ Promise for Managing Congestion Falls Short, and DOT Could Better Facilitate Their Strategic Use*, [GAO-05-943](#) (Washington, D.C.: Sept. 14, 2005).

<sup>17</sup>For example, the occupancy requirement for some HOV lanes is at least three people; in these instances, a HOT lane would allow a vehicle with two people to use the lane if the driver pays a toll.

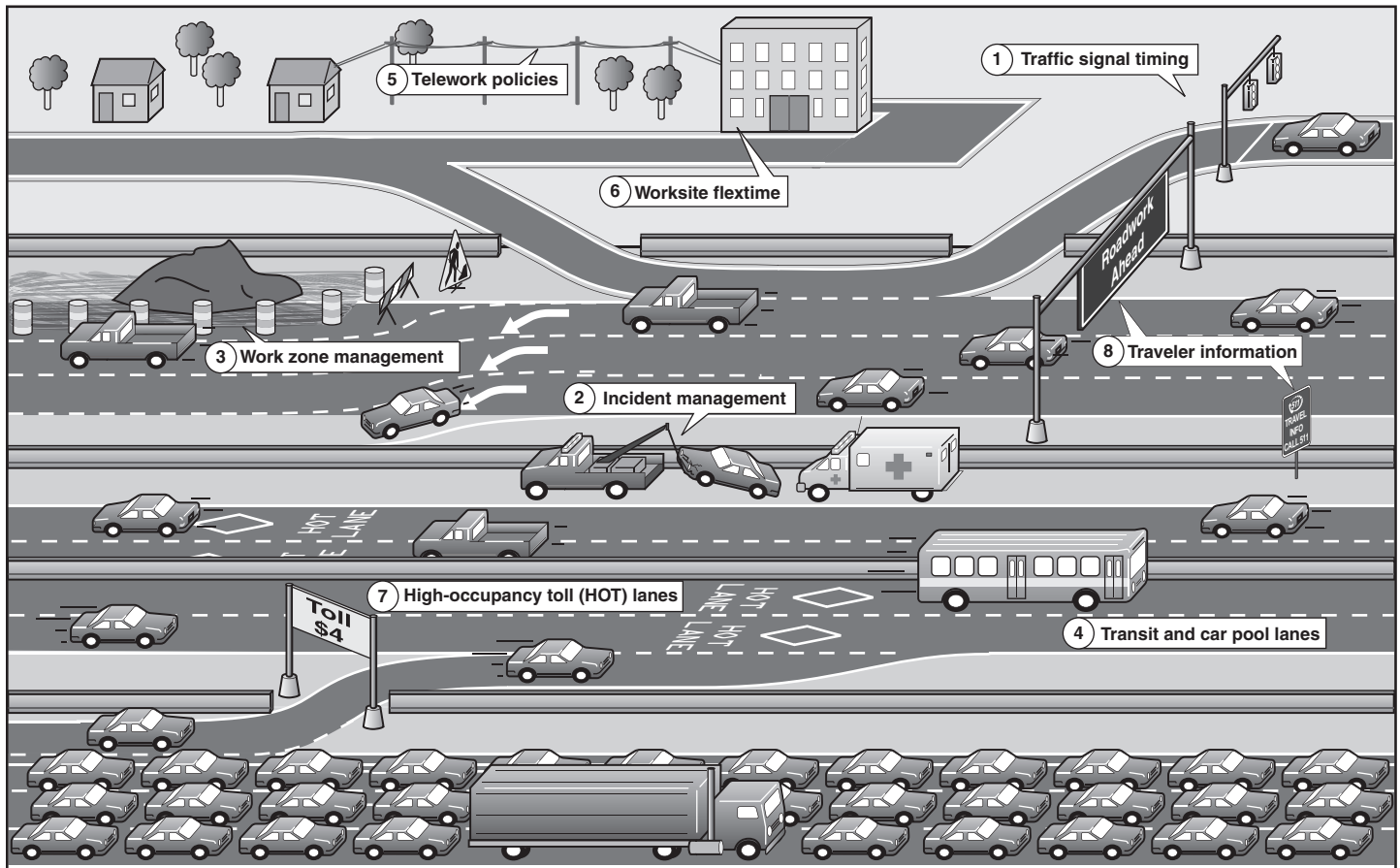
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the United States such as New York and San Francisco are studying the potential implementation of cordon pricing.

These various techniques can often be used in tandem to produce a more robust congestion mitigation strategy. Figure 4 depicts a cross section of eight different techniques that both enhance existing capacity and influence driver behavior and demand. The strategies shown range from signal timing and extensive use of HOV and HOT lanes to workplace efforts designed to reduce traffic or shift it to less congested times of the day. For a more detailed list of congestion mitigation techniques see appendix II.



**Figure 4: Select Congestion Management Techniques that Enhance Capacity and Influence Driver Behavior and Demand**



**Congestion mitigation techniques that enhance capacity**

<p>1  <b>Traffic signal timing</b> – coordinating the timing of a series of traffic signals along an arterial to reduce stops and move vehicles at a uniform speed.</p>	<p>2  <b>Incident management program</b> – a planned and coordinated program to detect, respond to, and remove traffic incidents to reduce congestion.</p>	<p>3  <b>Work zone management</b> – using highway shoulders and crossover lanes during construction to maintain road capacity.</p>	<p>4  <b>Transit and car pool lanes</b> – dedicating lanes for buses and car pools on freeways and arterials thus increasing capacity by reducing single-occupancy vehicles.</p>
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**Congestion mitigation techniques that influence driver behavior**

<p>5  <b>Telework policies</b> – allowing employees to work at home a certain number of workdays, which results in less work-related travel.</p>	<p>6  <b>Worksite flextime</b> – flexible arrival and departure times to/from work that encourage employees to avoid most congested travel times.</p>	<p>7  <b>HOT lanes</b> – a priced lane that offers single-occupancy vehicle drivers the option of paying a toll to use lanes that are otherwise restricted.</p>	<p>8  <b>Traveler information</b> – providing up-to-the-minute traveler information, such as travel times, roadwork, accidents, and alternative routes via cell phone or Web access.</p>
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Source: GAO.

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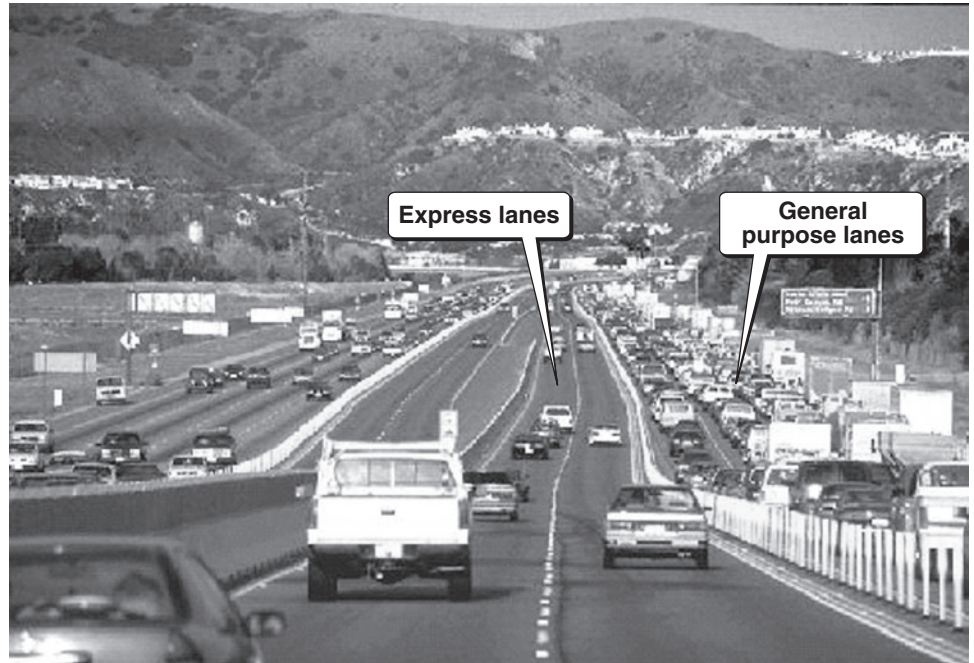
Although studies and evaluations of specific projects that have implemented congestion mitigation techniques vary in quality and scope, transportation research has generally shown that such techniques have the potential to help reduce congestion and make better use of existing transportation infrastructure capacity.<sup>18</sup> Specifically, some examples of studies and evaluations suggest that techniques such as incident response programs, signal timing coordination, and HOT lanes help maximize existing capacity by providing improved traffic flows, reduced delays, and increased vehicle speeds. Following are examples:

- In Washington State, transportation officials have monitored the results of their incident response program and found that the average time to clear incidents has decreased from 33 minutes to 16 minutes, which in turn reduced the amount of time that the incident was creating congestion by about half.
- A study of a traffic signal optimization project in the Denver area showed that the project resulted in a 13 percent reduction in vehicle travel times and a 17 percent improvement in travel speed.
- An evaluation of the Express (HOT) lanes for the State Route 91 project in Orange County, California, showed that although the HOT lanes represent only 33 percent of the capacity of State Route 91, they carry an average of 40 percent of the traffic during peak travel times (see fig. 5).

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<sup>18</sup>As we reported in 2005 in our review of ITS projects, though studies of ITS projects have found positive impacts, most of the studies we reviewed did not include information on the cost effectiveness of the ITS project, such as benefit-cost analyses (see [GAO-05-943](#)).

**Figure 5: Express Lanes and General Purpose Lanes on State Route 91 in Orange County, California**



Source: Caltrans.

In our review of transportation research and discussions with transportation officials, we found that congestion mitigation techniques are most effective when tailored to the particular situation. For example, because they encourage some additional traffic from single-occupancy vehicles, HOT lanes have generally been used in cities with congested freeways and underutilized HOV lanes. Similarly, because it discourages vehicles from entering a central urban zone, cordon pricing is used in large cities with developed transit systems that provide alternative modes of travel to the city centers. In addition, congestion mitigation techniques have been found to be more effective when used in combination. For example, the following techniques have been effective:

- When a major accident occurs on a freeway, message signs with traffic information can be used to divert traffic to a parallel arterial, while incident response vehicles work to clear the freeway.
- With the installation of ramp meters, lines of queuing vehicles sometimes can back up onto local arterials. To help address this problem, other techniques, such as optimizing signal timing, can be used to reduce the

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rate at which vehicles enter the freeway ramp.

- Electronic toll collection technology can be used to collect tolls from HOT lane vehicles. This significantly reduces the delays caused by vehicles stopping to pay at toll booths.

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## Transportation Decision Makers Are Using Similar Approaches for Implementing Congestion Mitigation Techniques, but Challenges Exist

At locations we reviewed, officials chose varying congestion mitigation techniques but tended to implement them with a similar three-pronged approach: (1) changing planning and related processes to give them higher priority, (2) developing creative mechanisms to fund them, and (3) collaborating with multiple stakeholders to put them in place. However, officials told us that many of the congestion mitigation techniques they used had been able to provide benefits only at the margins because several persistent issues prevented them from using these congestion mitigation techniques more fully. These issues ranged from resolving jurisdictional authority to identifying sources that would provide sufficient funding for larger-scale projects.

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## Officials Report Giving Congestion Mitigation Techniques More Priority in Their Transportation Planning

State and local transportation officials we interviewed told us that they are changing their transportation planning priorities to reflect a greater emphasis on congestion mitigation techniques. To make these congestion mitigation techniques a priority, officials have established new goals and priorities, modified their project selection process, restructured their organizations, and adopted new policies and initiatives.

## Setting Goals That Incorporate Congestion Mitigation

Officials from the transportation agencies we visited reported establishing goals related to using the existing road infrastructure more efficiently by implementing congestion mitigation techniques. They generally said they had incorporated these goals into both their long-range and short-range transportation plans.<sup>19</sup> Table 1 shows examples of these goals identified in their plans. Our review of these plans showed that the new goals reflect a shift in emphasis—that is, a movement from the traditional approach that has been and, in many cases still is focused on the construction of new

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<sup>19</sup>Long-range plans identify transportation needs for the next 20 years. Short-term transportation plans, called Transportation Improvement Programs (TIP), describe projects selected to support long-range transportation plan goals. Federal law requires that, within these plans, each metropolitan planning organization consider at least seven factors, one of which is to promote efficient system management and operation.

road capacity or the maintenance of existing road infrastructure, to a greater emphasis on managing the system more efficiently.

**Table 1: Examples of Long-range and Short-range Transportation Plans at Locations GAO Visited**

Location	Added emphasis on managing existing infrastructure more efficiently
San Diego, CA	Long-range plan (through 2030) now includes a focus on making the best use of the existing transportation system and a shift in emphasis from expanding the system to managing demand. The plan highlights such techniques as improving traffic information provided to drivers, continuing the current incident management program, developing new HOT lanes, improving transit and telework programs, and continuing their van pool and car pool programs.
Orlando, FL	Long-range plans include a goal of better managing and operating the system, specifically prioritizing incident management programs, and linking land-use strategies with the transportation plan.
Seattle, WA	The City of Seattle's Comprehensive Plan (the 20-year policy plan) recognizes that expanding streets and roads to accommodate cars is generally unproductive. In addition, opportunities to widen or construct new streets in Seattle are extremely limited because of its built-out, urban environment. The plan suggests increasing the use of transit, walking, bicycling, carpooling, and other alternatives, such as addressing parking in the city.
Denver, CO	Short-range transportation plan now includes funding for intelligent transportation systems and demand management programs, such as improving ramp metering for entering highways, improving signal timing on roads, and expanding outreach to employers to promote telework and flextime work.
Bellevue, WA	Long-range planning program routinely includes projects that examine how land-use decisions influence system performance and their short-range transportation plan includes using operations methods, such as real time traffic flow and ITS applications to optimize traffic flow.

Source: GAO.

**Modifying Project Selection Process to Emphasize Congestion Mitigation Goals**

Some transportation agencies we visited modified their transportation project selection process to provide greater emphasis to projects that use congestion mitigation techniques. For example, in considering which projects to select for funding, the metropolitan planning organization for the Denver region now awards points to projects that use certain congestion mitigation techniques, such as installing left-turn lanes, promoting car pools, coordinating traffic lights, or managing incidents. Officials said they hope awarding points will provide incentives for local planners to include such congestion mitigation techniques in their projects. Several other metropolitan planning organizations we interviewed, such as Virginia's Hampton Roads Planning District Commission, had modified their project selection process to promote projects that have a regional objective, which prior to these changes, would have had a low probability of funding under the previous allocation program. Officials said that by modifying the selection process, they can better align which projects are selected to their overall goal of using the existing infrastructure more efficiently.

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Restructuring Organizations to Align with Transportation Planning Goals

To ensure that their organizations are aligned with transportation goals, transportation agencies in a number of locations we visited had restructured their organizations by creating new departments or committees. For example, Seattle's metropolitan planning organization, the Puget Sound Regional Council, created a new team dedicated to working on projects that improve the operations of the transportation system. This department was designed to work with other transportation agencies to improve mobility through implementing demand management, improving operational efficiency, and identifying capacity solutions at the corridor and regional planning levels. Orlando's metropolitan planning organization created a management and operations department and a subcommittee composed of local planners and traffic engineers, which is responsible for sustaining and increasing funding for projects that use congestion mitigation techniques, such as incident management, and strategies to manage driver behavior.

Adopting Policies or Regulations That Promote Congestion Mitigation Techniques

At some locations we visited, greater use of congestion mitigation techniques was also spurred by state policies. We found the following examples:

- In 1991, Washington State's legislature passed a law designed to reduce traffic congestion, reduce air pollution, and petroleum consumption by requiring metropolitan planning organizations to foster employer-based programs that decrease the number of commuting trips made by people driving alone. Since the law was passed, the number of vehicle trips has dropped statewide. In the central Puget Sound region, where Seattle is located, the number of vehicle trips made during the morning commuter hours has dropped by 14,000, reducing peak travel delay by an estimated 11.6 percent, on average, each weekday morning in the region.
- California requires all urbanized areas to monitor the performance of the transportation system, develop programs to address short-term and long-term congestion, and better integrate transportation and land-use planning through congestion mitigation programs. In response, San Diego's metropolitan planning organization, the San Diego Association of Governments, developed a congestion mitigation program that encourages the use of strategies other than road widening or extensions to address congestion at low costs, such as encouraging transit use, establishing programs for car pools, and teleworking programs.
- Oregon through its Interchange Area Management Plan rules has introduced new requirements that stipulate local governments jointly manage access on crossroads in the vicinity of interchanges. Specifically, regulations require that new intersections at crossroads be placed at least

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1,320 feet from the interchange ramp terminals, thereby reducing the potential backups on the highway exit ramps.

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**Agencies Report  
Developing New Methods  
to Fund the Use of  
Congestion Mitigation  
Techniques**

Transportation officials told us that the mode-specific, or stove-piped funding structure for transportation projects, together with a general lack of resources for transportation projects, constrains their ability to invest in congestion mitigation techniques. As a result, they said, they often have to find alternative methods to supplement traditional funding sources. The methods they cited included imposing additional tolls, local taxes, or development impact fees; developing partnerships with private industry; and designating separate funding.

**Imposing Tolls, Local Taxes, or  
Development Impact Fees**

A number of state and local governments in the locations we visited had imposed additional tolls, local taxes, and development impact fees to provide funding for the implementation of congestion mitigation techniques. Officials said they had done so because traditional funding sources were not generating sufficient resources. Many of these revenue sources were focused in a specific region and were geared toward implementing specific congestion mitigation techniques. For example, voters in the San Francisco region passed an increase in toll fees on the region's seven state-owned bridges to support the Regional Traffic Relief Plan, which funds such projects as expanding transit options, as well as improving transit connections and several freeway bottlenecks. Several other regions passed sales, property, or gasoline taxes. For example, San Diego passed a half-cent sales tax to implement a number of congestion mitigation techniques to help improve traffic congestion on the most highly congested corridors in the region. This included funding for new HOV and managed lanes along highways, new connectors to the highways, and transit improvements.

Some localities generated additional transportation funding through another source—development impact fees.<sup>20</sup> They used this approach particularly when new development had a significant effect on the current road network. Florida, for example, has passed a law that regulates large-scale developments that have substantial impacts on the transportation system. This program allows local governments to assess new developments and assign fees related to their impact on the local

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<sup>20</sup>Development impact fees are payments made by developers for the cost of additional infrastructure necessary as a result of the new development.

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Developing Partnerships with  
Private Industry

infrastructure, including transportation. Between 1993 and 2004, this program provided local governments with \$2 billion statewide for efforts to improve transportation infrastructure, including ways to reduce congestion.

Transportation agencies reported developing partnerships with private industry to help fund congestion mitigation techniques. According to transportation experts, working with private companies can offer a number of benefits for the transportation agency, such as expediting the project schedule, reducing costs, and providing access to private funding sources. Examples we identified included the following:

- In 1995, California’s Department of Transportation partnered with a private company to develop a four-lane, 10-mile toll road of HOT lanes in the median of a freeway (State Route 91) in Orange and Riverside Counties. The company financed, managed, and collected revenues from the variable-priced tolls on the HOT lanes. In 2003, Orange County Transportation Authority purchased the HOT lanes and is now managing them.
- In Virginia, a private company is installing equipment to collect traffic data on all of the state’s highways and some major arterial roads, which could be used for local intelligent transportation systems and for transportation planning. The company will have permission to sell the information to private companies and individual drivers but will also allow the local jurisdictions to obtain and use the data for free.
- State Farm Insurance entered a partnership with the Florida Turnpike to provide funding for the State Farm Safety Patrol—a 24-hour roadway assistance and service program that provides free driver assistance to motorists along Florida’s Turnpike. State Farm provides funding annually to the Florida Turnpike and, in exchange, places advertisements on the State Farm Safety Patrol vehicles. These vehicles help improve mobility by minimizing the duration of incidents, assisting disabled drivers, and removing road debris—all of which can help reduce vehicle crashes. (See fig. 6.)



**Figure 6: Florida Road Ranger Incident Response Vehicle**



Source: Florida DOT.

### Designating Specific Funding within Existing Resources

Some transportation agencies we visited have designated a certain amount of funding out of their traditional transportation funding for congestion mitigation techniques. Officials at these agencies said doing so ensures that congestion mitigation projects receive some funding. For example, each year from 2007 to 2011, Denver’s metropolitan planning organization plans to designate \$20 million to \$23 million of its state and federal funding for congestion mitigation techniques such as van and car pool programs and traffic signal improvements. Similarly, the Orlando metropolitan planning organization has designated \$2 million annually of its state and federal funds for its intelligent traffic system program. Orlando officials said that they have decided to increase this funding to \$4 million annually in the future because of the potential for improving efficiency.

### Transportation Agencies Are Collaborating with Multiple Stakeholders

Transportation agencies we visited reported working with multiple partners to implement congestion mitigation techniques. According to officials, the success of these techniques depends on such coordination. For example, in Washington State, the Department of Transportation and the state patrol established standard operating procedures for such matters as data sharing, traffic management, and incident response. In

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several other states we visited, transportation agencies have established a goal of clearing a highway accident within 90 minutes of when the first responder arrives. Coordinating signal timing across jurisdictions was another technique for which transportation officials said collaboration was important.

We found a number of examples where transportation agencies participate in multijurisdictional groups to help ensure that transportation plans encompass regional and comprehensive perspectives. For example, the Central Florida Metropolitan Planning Organization Alliance was created to coordinate regional transportation planning. This council consists of six metropolitan planning organizations that include ten counties in Central Florida, and its membership includes metropolitan planning organizations' board members and staff, and state transportation staff. Similarly, several metropolitan planning organizations that we visited have committees focused on regional planning. Participants on these committees include representatives from regional jurisdictions and transit agencies.

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### Persistent Issues Keep Congestion Mitigation Techniques from Having Greater Effect

While officials at the locations we visited were making greater use of these congestion mitigation techniques, they also said a number of issues prevented them from implementing these techniques to the extent desired. As a result, they said, that congestion mitigation techniques they were implementing could provide only marginal improvement to the efficiency of the road network. Issues they cited included the following:

- *Lack of authority.* Officials of local government agencies said some congestion mitigation techniques need to be implemented by federal or state agencies and cannot be legally implemented by local transportation agencies. For example, while cities implement congestion mitigation techniques like intelligent transportation systems, they generally cannot implement large-scale techniques such as congestion pricing on major state highways. Being able to integrate congestion mitigation techniques comprehensively, they said, may be critical for seeing improvements on the road network.
- *Barriers to obtaining additional funding.* Finding alternative funding for projects can be difficult, officials said. Efforts to impose new charges, such as toll fees on roads, may be opposed by the public, since the public can feel as though it is being charged twice for use of the roads. In some states, funding sources such as development impact fees are not authorized by law, and those that are authorized by law have a number of provisions on how local governments can use revenues that may affect

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their ability to use these fees to their fullest.

- *Lack of complete and reliable data.* The lack of complete and reliable data hinders the ability of transportation officials to make fully informed decisions about implementing congestion mitigation techniques. For example, data about traffic flow throughout the day, rather than at a single time, are crucial to produce valid representations of travel needs and problems. However, reliable and complete data are not always available—which can result in forecasting errors or limit the ability to conduct outcome evaluations.<sup>21</sup>
- *Difficulties in resolving jurisdictional issues.* Many transportation officials we interviewed noted the struggle to align different perspectives when trying to work regionally on projects. Often, they said, there are competing ideas of which jurisdictions should be responsible for the management and funding of projects that cross boundaries.
- *Limitations of the current funding and decision-making process.* Transportation officials noted that the current funding and decision-making processes, with their orientation to particular modes of transportation and their limited reliance on analysis of the costs and benefits of various transportation alternatives, provide a built-in preference for projects that build or maintain transportation infrastructure rather than try to use existing structure more efficiently. Although congestion mitigation techniques may produce the highest estimated social benefit, in times of constrained budgets, many officials said that obtaining money for congestion mitigation projects can be difficult.

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<sup>21</sup>FHWA is working with the National Transportation Operations Coalition (NTOC) and state and local governments on an ongoing project to develop a common set of operations performance measures and definitions. FHWA officials stated that piloting of the measures will take place as part of a National Cooperative Highway Research Program (NCHRP) study in 2007, with results expected in early 2008.

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## Various Strategies Exist for Increasing the Efficient Use of Infrastructure

Various strategies exist for increasing the efficient use of infrastructure, according to the officials and experts we talked with and the studies we reviewed.<sup>22</sup> These strategies include applying congestion mitigation techniques on a regional basis and linking federal-aid highway funding to performance. We grouped these strategies by the level of government best suited to consider and implement them, given their current authorities, roles, and responsibilities (see fig. 7). In some cases, all levels of government would need to be involved in implementing the strategy; in other cases, the federal government or a state or local government would be most appropriate to implement the strategy. These strategies are not mutually exclusive and ideally would be implemented in a comprehensive manner, according to transportation research and transportation officials and experts we interviewed.

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<sup>22</sup>Institute of Transportation Engineers, *Action Kit: Immediate Solutions for Transportation Operational Issues* (Washington, D.C.: 2005); American Association of State Highway and Transportation Officials, *Future Needs of the U.S. Surface Transportation System* (February 2007); Cambridge Systematics, *Traffic Congestion and Reliability: Linking Solutions to Problems* (Cambridge, MA: July 19, 2004); Cambridge Systematics, *Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation* (Cambridge, MA: Sept. 1, 2005); Transportation Research Board, *Performance Measures to Improve Transportation Systems: Summary of Second National Conference* (Washington, D.C.: 2005); Transportation Research Board, *Linking Transportation and Land Use: A Peer Exchange* (Washington, D.C.: July 2006).

**Figure 7: Strategies for Making More Efficient Use of Existing Infrastructure**

Strategy	State and local governments	Federal government
Consider how the private sector can be used in managing existing infrastructure.	●	●
Expand the use of the user-pay concept.	●	●
Measure results and manage with them in mind.	●	●
Implement a combination of supply-related and demand-related techniques.	●	
Apply congestion mitigation techniques on a regional basis.	●	
Integrate transportation planning more fully with land-use planning.	●	
Provide leadership to build support for implementing congestion mitigation techniques.	●	
Link federal-aid highway funding to performance.		●
Increase flexibility for local decision making for implementing innovative solutions.		●
Support projects that provide national public benefits.		●

Source: GAO.

### Three Strategies Crosscut All Levels of Governments

We identified three strategies that would likely require the attention and involvement of all levels of the government to be successfully implemented. These strategies are (1) considering how the private sector can be used in managing existing road infrastructure, (2) determining the feasibility of expanding use of the user-pay concept for managing demand and generating revenue for transportation investments, and (3) developing a systematic performance-based management approach to increase the accountability of public expenditures and to link performance to investment decisions.

### Consider How the Private Sector Can Be Used in Managing Existing Infrastructure

Public policymakers at the federal, state, and local levels could consider how the private sector can be used in the operation and management of the existing road infrastructure. Proponents believe that expanding the use of public-private partnerships could take advantage of the private sector's ability to manage assets with the intended outcome of providing a more efficiently operated road network. Private companies, driven by the need to make a return on investment, are incentivized to manage assets and provide services in efficient ways. Specifically, how efficiently they

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operate an asset directly affects the profits they derive from their investments and is directly linked to the overall success of the company. If a partnership is designed and structured appropriately, transportation agencies could leverage this incentive. To date, public-private partnerships in the United States have often been used to manage toll roads, such as State Route 91, as described earlier. In addition, a recently emerging public-private partnership model is where the private sector is awarded, through a long-term lease agreement, the concession to operate, maintain, and collect tolls on existing publicly owned highways. In return for the revenues collected by the tolls, these concessions often require that the private companies meet established performance standards, which can include maintaining the condition of the road to a specific standard, and allow increasing toll rates on an annual basis in line with inflation.<sup>23</sup>

The federal government and some state governments have also shown interest in developing public-private partnerships to support research and development of advanced technology that can help enhance the capacity of the existing road infrastructure. Transportation experts argue that advanced technology could potentially allow for more efficient use of the road network by improving safety and increasing the availability of transportation data to drivers and transportation planners. An example of governments partnering with private industry in supporting research and development of advanced technology is the Vehicle Infrastructure Integration (VII) program. The VII program uses technology installed in the road infrastructure and the individual vehicle to establish vehicle-to-vehicle and vehicle-to-roadside communications (see fig. 8). This system would use vehicles as collectors of real time traffic information and more complete data from highways and arterial roads, which would be processed and distributed to drivers, transportation planners, and traffic managers. In 2004, the federal government, the American Association of State Highway and Transportation Officials, 10 state departments of transportation, and several vehicle manufacturers<sup>24</sup> formed an informal VII working group to examine the feasibility of widespread deployment and to establish an implementation strategy. The VII coalition, which is made up

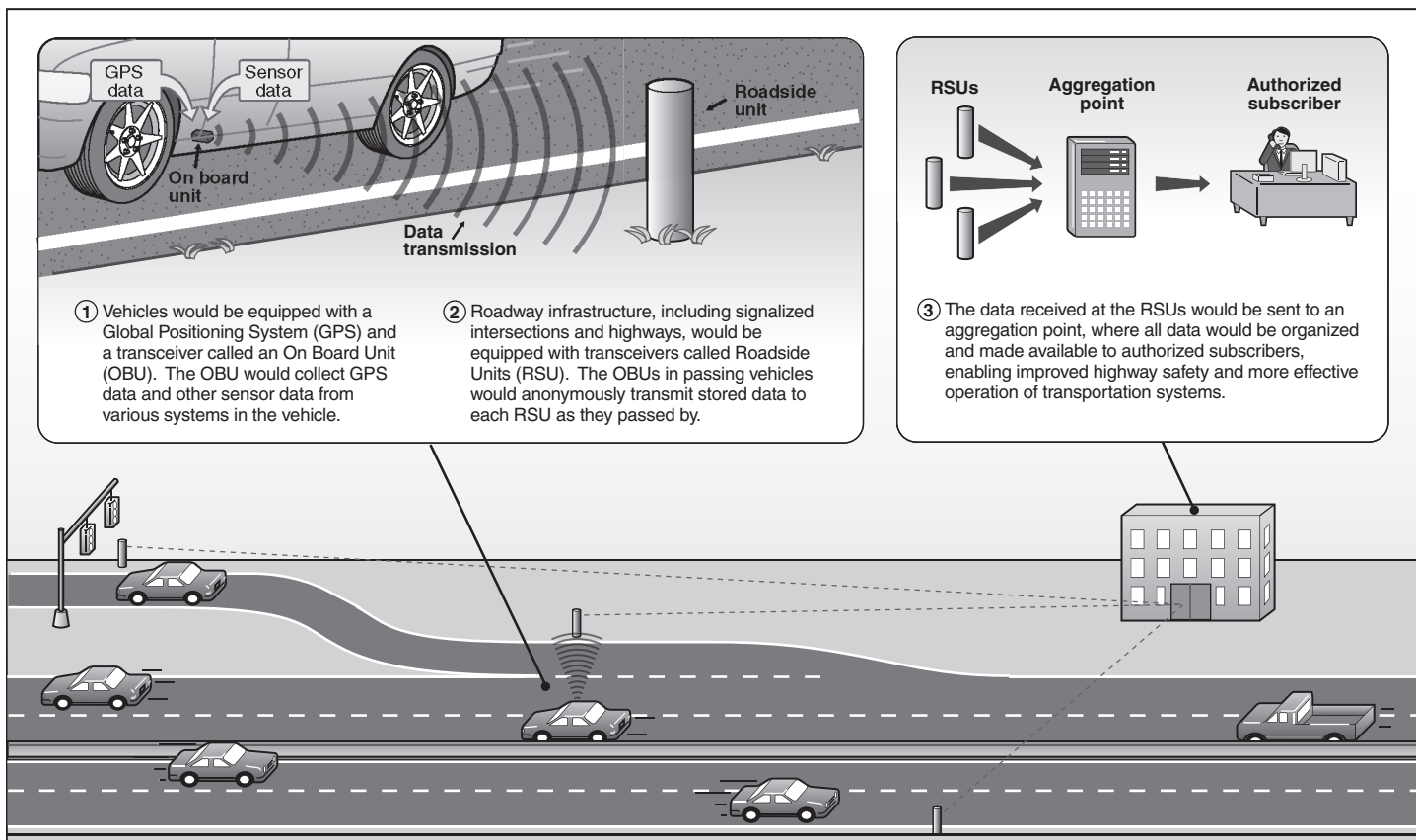
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<sup>23</sup>See our forthcoming report on public-private partnerships that will discuss in further detail the potential benefits and significant risks, and steps that must be taken to protect the public interest. This report is estimated to be published in the fall of 2007.

<sup>24</sup>The VII Consortium is a nonprofit organization that is open to all vehicle manufacturers. Currently, the consortium membership includes BMW, Daimler Chrysler, Ford, GM, Honda, Nissan, Toyota, and VW.

of the VII working group and the executive leadership team, will report its initial findings in 2008.

**Figure 8: Representation of the VII Mobility Applications**



Sources: GAO and DOT.

Note: The VII information flow differs from the above graphic for many safety applications, where the data is sent to oncoming vehicles instead of the aggregator, and there is an interface to local signal control systems.

### Expand the Use of the User-Pay Concept

The user-pay concept—that is, users should help pay for the infrastructure they use—is a long-standing aspect of transportation policy in the United States. For instance, federal, state, and local governments have imposed excise taxes on motor fuels and other taxes on inputs into driving, such as taxes on tires or fees from registering vehicles or obtaining operating licenses. These taxes, in turn, are used to pay for highway projects. Similarly, some state and local governments charge tolls on certain roads. These tolls can generate revenues that are consistent with the user-pay principle because the driver is directly paying to use that specific road and

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the revenues collected from the toll go directly to pay for its construction, maintenance, and operation.<sup>25</sup>

The federal government and some state and local governments are studying new alternatives that expand the user-pay concept. At the federal level, Congress authorized a road user fees study,<sup>26</sup> which is to examine an option to assess highway user fees based on actual mileage driven. The final report is scheduled to be submitted to Congress in July 2009. At the state level, Oregon's Department of Transportation tested a pilot program that collects a mileage-based fee in lieu of the state gas tax. The program used on-vehicle mileage counting devices that record the number of miles driven and download mileage information at two gas stations that were equipped with mileage readers on the fuel pumps. Drivers are then charged a per-mile fee instead of the gas tax. The pilot program ended in March 2007, with a final study expected in September 2007.<sup>27</sup>

## Measure Results and Manage the Existing Infrastructure with Them in Mind

A performance-based management approach can increase accountability and performance of the existing infrastructure. As we have previously reported,<sup>28</sup> a performance-based management approach for transportation would include establishing performance targets, developing performance measures, and enhancing data quality.<sup>29</sup> An important element of a performance-based approach is evaluating the results of projects or

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<sup>25</sup>Some states are also increasingly funding transportation projects with alternative mechanisms that are not user-pay based. For example, some states are using revenues from sales taxes and the state's general fund for transportation projects.

<sup>26</sup>The study will be conducted by University of Iowa Public Policy Center.

<sup>27</sup>Oregon officials shared some preliminary observations with us in advance of the study's completion. Their preliminary conclusions were that the pilot project's successes were in the areas of zone differentiation (that is the counting devices was able to distinguish with accuracy when the car traveled into or out of different preprogrammed zones), mileage counting accuracy, transaction administration integration with gas tax collections, and mileage data transmission accuracy at the fuel pump. The largest lesson learned is that retrofitting of existing vehicles with mileage counting technology is highly problematic because technology applications for various vehicle makes and models are not standardized.

<sup>28</sup>See GAO, *Marine Transportation: Federal Financing and a Framework for Infrastructure Investments*, [GAO-02-1033](#) (Washington, D.C.: Sept. 9, 2002); GAO, *Freight Transportation: Strategies Needed to Address Planning and Financing Limitations*, [GAO-04-165](#) (Washington, D.C.: Dec. 19, 2003); and [GAO-05-172](#).

<sup>29</sup>Transportation asset management, which is a systematic process of maintaining, upgrading, and operating transportation assets, is one type of technique that incorporates many of the concepts of a performance-based approach.



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conducting outcome evaluations. Such evaluations allow the public to hold the government accountable for results. Outcome evaluations also offer transportation agencies the opportunity to learn from the successes and shortcomings of past projects to better inform future planning and decision making. Further, such evaluations help to provide better analytic information to decision makers. For example, information from outcome evaluations could help inform decisions, such as determining whether a community would generate higher benefits from investing in a ramp metering system on a highway or adding a new lane instead, or whether investing in transit provides higher benefits and lower costs compared with building a new road. However, outcome evaluations are not required for highway projects as a condition of federal funding and are not typically performed. In contrast, SAFETEA-LU requires before and after studies as a condition of receiving New Starts funds for completed transit projects.<sup>30</sup>

For transportation agencies to be able to use a performance-based management approach, transportation experts highlighted the importance of being able to collect comprehensive and robust traffic data. However, the ability of transportation agencies to collect traffic data is limited for two major reasons. First, the majority of our nation's highways and arterials do not have the data collection infrastructure to be able to provide continued and comprehensive data. This lack of coverage can leave significant data gaps in a local road network. Second, even when state and local governments have built data collection infrastructure, providing funding for its maintenance is difficult and, therefore, this infrastructure can fall into disrepair and not provide the data. While the development of a performance-based management approach should not be totally dependent on the readily available data, transportation research does state that agencies should try to optimize the use of existing or accessible data in their performance management system.

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### Several Strategies Relate Mainly to State and Local Governments

Although some strategies cut across all levels of government, other options are more appropriately considered by state and local governments, given their current roles and responsibilities. We identified four strategies that state and local transportation agencies, with their primary responsibility for building, maintaining, and operating the road infrastructure, could consider in their efforts to increase the efficient use of existing infrastructure. These options are (1) implementing a

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<sup>30</sup>Pub. L. No. 109-59, § 3011(a), codified at 49 U.S.C. § 5309(g)(2)(C).

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combination of supply-related and demand-related congestion mitigation techniques, (2) applying congestion mitigation techniques on a regional basis, (3) fully integrating transportation and land-use planning, and (4) providing leadership to build support for implementing comprehensive congestion mitigation techniques.

### Implement a Combination of Supply-Related and Demand-Related Techniques

Research on various congestion mitigation techniques indicates that efficient use of the existing road infrastructure is best accomplished through an approach that uses a combination of supply-related and demand-related techniques. Supply-related congestion mitigation techniques include enhancing the capacity and operation of the road supply by, for example, using intelligent traffic system and work zone management techniques. Demand-related congestion mitigation techniques, such as road pricing and a vanpool program, could improve the flow and performance of roads by reducing the number of drivers using existing roads during peak demand times. Although these congestion mitigation techniques can provide benefits when implemented individually, using them in a comprehensive manner will provide the greatest benefits, according to research. For example, implementing supply-related features of intelligent traffic systems can enhance the effectiveness of demand-related techniques like commuting on a flexible schedule by providing real-time traffic information to drivers so that they can adjust their departure times to avoid heavy congestion.

To demonstrate the benefits of using a comprehensive approach for reducing congestion, DOT has initiated the Urban Partnership Agreement. This program will provide financial resources, including some combination of grants, loans, and borrowing authority, to transportation agencies that implement congestion reduction initiatives that combine tolling, transit, telecommuting, and technology as part of a systemwide, comprehensive strategy. In addition to the financial assistance, DOT will also provide regulatory flexibility and dedicate expertise and personnel to help transportation agencies implement congestion mitigation techniques. DOT announced the selection of nine cities as preliminary partners and is planning to announce the selection of between one-five final partners by August 8, 2007.

### Apply Congestion Mitigation Techniques on a Regional Basis

Since road networks often cross multiple jurisdictions, state and local governments need to apply congestion mitigation techniques on a regional basis, according to transportation research. By working together, jurisdictions can ensure that their efforts to manage congestion include a combination of supply-related and demand-related congestion mitigation techniques. For example, traffic signal timing is one technique that can

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provide significant benefits to drivers by providing for the smooth flow of traffic along streets and highways. To fully enhance mobility, however, jurisdictions need to coordinate the timing along an entire corridor. A 2005 report by the National Transportation Operations Coalition found that a majority—56 percent—of jurisdictions did not report strong efforts in coordinating traffic signal timing across jurisdictions.<sup>31</sup>

Because of the importance of implementing these techniques on a regional basis, especially when there are major road corridors involved, a growing number of transportation agencies have implemented corridor management plans. Corridor management plans can take many forms and can be implemented in a number of ways. A recent Transportation Research Board study<sup>32</sup> reported that transportation agencies have used a variety of different instruments to implement these corridor management plans, such as memorandums of understandings and intergovernmental agreements. For example, the Iowa Department of Transportation entered into agreement with three local jurisdictions to implement an access management plan, which established access management standards on U.S. Highway 6, which runs east to west through Des Moines. This type of coordination has also been supported by DOT, through its Integrated Corridor Management Initiative. This initiative will provide federal funding to an agency or organization that demonstrates support of the overall concept of corridor management, which could consist of multiple jurisdictions.

### Integrate Transportation Planning More Fully with Land-Use Planning

Many transportation officials we spoke with stated that transportation planning by state and local government must be more fully integrated with land-use planning, such as zoning policies or growth management policies. There is a high level of interconnection between land use and transportation. For example, the traffic generated from a new major shopping center may overwhelm existing transportation infrastructure. However, in most areas, land use and transportation decisions are made by separate agencies or jurisdictions, with each having significant impact on the other's investment decisions. In cases where there is insufficient

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<sup>31</sup>National Transportation Operations Coalition, "National Traffic Signal Report Card: Technical Report," 2005. A total of 378 respondents fully completed the self-assessment. The number of signals represented by responding agencies corresponds to about one-third of all signals in the United States.

<sup>32</sup>National Cooperative Highway Research Program, *Synthesis 377: Cooperative Agreements for Corridor Management* (Washington, D.C.: 2004).

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Building Support for  
Congestion Mitigation  
Techniques

coordination between land use and transportation planners, transportation agencies may be required to make unanticipated expenditures for transportation infrastructure.

During a Transportation Research Board-sponsored peer exchange on linking transportation and land use, transportation officials identified a number of efforts that are currently being used to better integrate transportation and land-use decisions. State transportation officials indicated that they have identified several new areas of activity that incorporate the concepts of smart growth and transportation planning.<sup>33</sup> For example, the Pennsylvania Department of Transportation's Transportation Project and Land Use Coordination Initiative provides federal transportation planning funds to local communities for studies and coordinated activities linking land-use planning and transportation.

Our past work<sup>34</sup> has found that strong leadership is needed to help build support for implementing congestion mitigation techniques on a comprehensive basis. There are some techniques, such as the use of congestion pricing, which must sometimes overcome political and public opposition. Strong leadership can communicate the essential ideas and values of a project and, therefore, highlight the benefits that these techniques can provide for drivers. For example, in Minnesota, a task force of state and local officials, citizens, and business leaders was convened in 2001 to explore a range of road pricing options, including the conversion of HOV lanes to HOT lanes, and make recommendations to elected officials. Since tolling had been fairly controversial in the past, the task force was seen as a way to provide a more credible and independent review. Ultimately, with the task force's and Governor's support, legislation passed that converted HOV to HOT lanes on a major highway. Figure 9 provides a brief description of Minnesota's experience with HOT lanes.

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<sup>33</sup>The Urban Land Institute defines smart growth as development that is environmentally sensitive, economically viable, community-oriented, and sustainable.

<sup>34</sup>See GAO, *Highway Finance: States' Expanding Use of Tolling Illustrates Diverse Challenges and Strategies*, [GAO-06-554](#) (Washington, D.C.: June 28, 2006).

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**Figure 9: Minnesota’s “MnPass” Program**

Minnesota opened the MnPass Express Lanes in May 2005. The MnPass provides single-occupancy drivers the opportunity to pay a toll to use the HOV lanes on Interstate 394, which carries traffic to and from downtown Minneapolis and western suburbs. The results of the HOT lanes have been significant. A recent survey concluded that support for allowing single passenger vehicles to use the HOV lane for a fee remained high, with 65 percent of respondents indicating this was a “good idea,” 1 year after the HOT lane was implemented. In addition, this survey showed that 93 percent of users were satisfied with the electronic tolling used by MnPass, 88 percent were satisfied with the traffic speed in the HOT lanes, and 72 percent were satisfied with the safety of merging between the HOT lanes and general purpose lanes. The results are based on a survey of 1,228 residents aged 18 years and older living within the study area in Minnesota.

Source: NuStats, MnPass Evaluation Attitudinal Panel Survey Wave 3 (Austin, TX.: August 2006).

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**Several Strategies Relate Mainly to the Federal Government to Consider**

The federal government provides funding to state and local governments for road and transit infrastructure, establishes legislation and regulations that influence the performance and safety of the system, and administers transportation programs that cover a range of areas. Given these roles and responsibilities, there are several strategies that the federal government could consider to help promote the efficient use of infrastructure, including (1) linking funding more directly to performance, (2) increasing the flexibility provided to state and local government to promote innovate solutions, and (3) focusing on projects (or transportation corridors) of national interest.

**Link Federal-Aid Highway Funding to Performance**

The federal government could link funding to state and local efforts to improve the efficiency and performance of the existing road infrastructure. We have previously reported that the federal-aid highway funding is currently not linked to performance.<sup>35</sup> As a result, the federal government misses an opportunity to use financial incentives to improve performance and to hold agencies accountable for results. The federal government could use incentives that link funding to particular outcomes, such as implementing congestion mitigation techniques to encourage state and local governments to use existing infrastructure more efficiently. Incentives could also be used to increase state, regional, and local agencies’ utilization of analytical information and tools to ensure that decision makers are making investment decisions that fully examine all alternatives, including congestion mitigation techniques.

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<sup>35</sup>See [GAO-05-172](#).

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## Increase Flexibility to State and Local Decision Makers

The federal government could provide additional flexibility to state and local governments for implementing innovative solutions to reduce congestion and enhance mobility, according to transportation experts. This flexibility could take many forms. First, the federal government could build on trends giving states greater flexibilities and discretion with their federal-aid highway program funds.<sup>36</sup> Increasing flexibility and discretion would recognize the changing nature of FHWA's role and the federal-aid highway program, which has been functioning, to some extent, as a revenue sharing, general purpose grant program. Devolving funding responsibilities to the states in a manner consistent with that function would build on the flexibilities already present and would not require abandoning the program's regulatory component. For example, states and localities could use federal-aid highway funding to implement travel demand management techniques such as increasing the number of vanpools.

The federal government could also continue to liberalize some of the long-standing federal restrictions on states and local governments' use of congestion mitigation techniques, such as road pricing techniques. By removing these restrictions, the federal government would allow state and local governments to expand the use of certain user-pay options. For example, because states have recognized that many HOV lanes have been underused and, therefore, have excess capacity, HOT lanes are becoming more widely accepted by state and local governments as a way to maximize existing road capacity by managing demand and offering drivers additional choices. SAFETEA-LU enhanced and clarified provisions on the states' ability to build or convert existing HOV lanes on interstate highways into HOT lanes, as long as states monitor and assess the operation of the lanes to ensure the lanes do not become degraded.<sup>37</sup> However, there are still restrictions on the states' ability to implement road pricing techniques on general purpose lanes. For example, SAFETEA-

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<sup>36</sup>States have broad flexibility to transfer funds between the various federal-aid grant programs. For example, states may transfer up to 50 percent of their Interstate Maintenance and National Highway System Program funds to other programs, including the Surface Transportation Program, which has broad eligibility rules. In addition, authorizing statutes, most recently amended by SAFETEA-LU, provided the states broad authority to transfer federal-aid Highway funds to transit projects and vice versa.

<sup>37</sup>The Federal Transit Administration (FTA) issued guidance on the terms and conditions on which FTA will classify HOV lanes that are converted to HOT lanes as "fixed guideway miles" for purposes of the transit funding formulas administered by FTA.

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## Placing Additional Focus on Projects That Provide National Public Benefits

LU includes an explicit restriction on the use of road pricing techniques on Interstate 4 in Orange County, Florida.

The federal government could refocus its role and become more active in the management of the surface transportation infrastructure on projects that are within the national interest. In our prior work,<sup>38</sup> we have stated that government investment in transportation projects, such as freight improvement projects or intermodal projects at airports, may be warranted if there is the potential of producing benefits to the public and if these projects are unattractive to the private sector. Public benefits could include reducing the external costs of transportation, such as reducing fuel emissions and roadway congestion. Considering whether the project has the potential to reduce the external cost of transportation provides an indication of a project's potential for yielding a good return. The federal government could take a more active role, beyond funding and oversight, if certain projects could provide public benefits. For example, in our freight work, we highlighted that improving freight mobility through the implementation of a short sea shipping service may have the effect of shifting some freight from truck to water and, as a result, reduce external costs such as pollution and congestion. Federal options could range from providing public subsidies to the private sector to taking on a more active planning role, such as during the development of the interstate highway system. However, such options would involve a fundamental shift in federal transportation policy, and officials would have to implement this option carefully to ensure that this support would result in real economic benefits, from a national perspective, and not represent a transfer of economic activity from one area to another.

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## Concluding Observations

The demand on our nation's road infrastructure is expected to continue increasing for the foreseeable future. This continued demand comes at a time when many of the nation's major roadways are at capacity during peak hours—creating increasing levels of congestion throughout the nation. Given today's fiscal, environmental, and land-use concerns, the days when our nation could build our way out of congestion have passed.

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<sup>38</sup>GAO, *Intermodal Transportation: Potential Strategies Would Redefine Federal Role in Developing Airport Intermodal Capabilities*, [GAO-05-727](#) (Washington, D.C.: July 26, 2005); and GAO, *Freight Transportation: Short Sea Shipping Option Shows Importance of Systematic Approach to Public Investment Decisions*, [GAO-05-768](#) (Washington, D.C.: July 29, 2005).

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In general, however, transportation policy is still focused on building or maintaining road capacity—not efficiently operating and managing the existing infrastructure. Many transportation experts emphasize that transportation policy should be refocused to allow decision-makers to use all the tools at their disposal to more efficiently operate and manage their infrastructure—including nonbuild congestion mitigation techniques, such as congestion pricing. Congress and DOT have recognized the importance and benefits of efficiently managing and operating the existing infrastructure. Some state and local governments have also adopted congestion mitigation techniques, such as HOT lanes. However, to date, such efforts at the state and local level have been confined to a limited number of locations and have not typically been a part of a more comprehensive strategy to operate and manage the existing infrastructure more efficiently. Until congestion mitigation techniques are used in a more comprehensive manner, the full potential of these techniques will not be realized. DOT’s emphasis on increasing the efficient use of existing infrastructure in its national strategy to reduce congestion is an important step forward. As DOT moves forward with the implementation of this strategy, it will likely have the opportunity to explore strategies to provide incentives to state and local governments to consider and implement congestion mitigation techniques in a more comprehensive manner, including the strategies we identified.

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## Agency Comments and Our Evaluation

We provided copies of this report to DOT for its review and comment. DOT officials provided technical clarifications, which we incorporated as appropriate.

We will send copies of this report to congressional committees with responsibilities for surface transportation programs, DOT officials, including the Secretary of Transportation, and the administrator of FHWA. We will make copies available to others on request. In addition, the report will be available at no charge on the GAO web site at <http://www.gao.gov>.



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If you have any questions about this report, please contact me at [heckerj@gao.gov](mailto:heckerj@gao.gov) or by telephone at (202) 512-2834. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Sincerely yours,

A handwritten signature in black ink, reading "JayEtta Z. Hecker". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

JayEtta Z. Hecker  
Director, Physical Infrastructure Issues

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# Appendix I: Objectives, Scope, and Methodology

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The objectives of this report were to (1) identify the factors that inhibit the efficient use of the existing infrastructure of roads and highways, (2) identify what techniques have been developed for making the current infrastructure more efficient and what is known about the results, (3) how local decision makers have implemented these techniques, and (4) what strategies exist for increasing the efficient use of existing infrastructure?

To identify the factors that inhibit the efficient use of the existing infrastructure of roads and highways, we reviewed reports and studies issued by federal, state, and local agencies, transportation research organizations, and academia, as well as our past work in surface transportation. A GAO economist reviewed these reports and studies, which were identified by searching economics and transportation literature, and found their methodology and economic reasoning to be sound and sufficiently reliable for our purposes.

To identify the techniques that have been developed to make more efficient use of the transportation infrastructure and what is known about the results of these techniques, we interviewed Department of Transportation's Federal Highway Administration officials and state and local transportation officials from our site visit locations, as well as representatives from various associations with experience implementing and/or analyzing the results of such techniques. We also reviewed transportation research by transportation organizations and studies and evaluations of individual projects conducted by federal, state, and local transportation agencies.

To determine how local decision makers have implemented these techniques and what is known about the extent to which these approaches are making the current infrastructure more efficient, we conducted site visits or interviews of federal, state, and local transportation officials about urban areas in five states that have experience with implementing various congestion management techniques—Denver, Colo.; Northern Virginia, Va.;<sup>1</sup> Orlando, Fla.; San Diego, San Francisco-Oakland, and San Jose, Calif.; and Seattle, Wash. We selected this nongeneralizable sample of states based on geographical diversity and after reviewing the Texas Transportation Institute's 2005 "Urban Mobility Report" to identify states with congested urban areas; and by interviewing agency officials, association representatives, and reviewing studies and reports to

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<sup>1</sup>These interviews were conducted by telephone.

determine states that had a higher level of experience planning and implementing various congestion mitigation techniques. We also interviewed officials in Aurora and Boulder, Colo.; Altamonte Springs, Fla.; Hampton Roads, Va.;<sup>2</sup> and Bellevue and Issaquah, Wash. to gain some insight into the implementation of congestion mitigation techniques in smaller jurisdictions. We also reviewed how other states have implemented congestion mitigation techniques, and we note these in this report.

To identify the strategies that might be employed for addressing anticipated strains on infrastructure over the long term, we reviewed public and private sector research, studies, and proposals on the development of new long term strategies and built on the perspectives gained from our past work in transportation infrastructure and congestion. This was supplemented with interviews of officials in the Department of Transportation (DOT) and the Federal Highway Administration (FHWA) and stakeholders including the American Association of State Highway and Transportation Officials, Institute of Transportation Engineers, ITS America, and Environmental Defense. We conducted our work from September 2006 through July 2007 in accordance with generally accepted government auditing standards.

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<sup>2</sup>These interviews were conducted by telephone.

# Appendix II: Congestion Mitigation Techniques and Benefits

Transportation agencies nationwide use a wide array of congestion mitigation techniques to manage congestion and maximize the existing transportation infrastructure. These techniques have the potential to provide benefits that improve efficiency by improving traffic flow, altering existing commuter patterns that cause congestion, and increasing the use of alternative transportation modes such as public transit and car pools. In general, these congestion mitigation techniques can be placed into two basic categories, techniques that are aimed at enhancing existing capacity, and techniques that influence driver behavior.

*Techniques that enhance capacity:* These are techniques that are designed to increase the existing systems' capacity to improve travel flow. For example, incident management programs are designed to more rapidly deploy response vehicles that remove accident vehicles and debris and more quickly restore traffic flow after accidents. Table 2 provides a brief description of selected congestion mitigation techniques designed to enhance capacity, and the potential benefit of each technique.

**Table 2: Selected Congestion Mitigation Techniques That Enhance Capacity**

Technique	Benefit
<b>Traffic signal timing</b> —coordinating the timing of a series of traffic signals along an arterial to reduce stops and move vehicles at a uniform speed.	Optimizing traffic signal timing increases vehicle speeds and traffic volumes and reduces accidents on major arterials.
<b>Incident management program</b> —is a planned and coordinated program to detect, respond to, and remove traffic incidents.	Removing vehicles from the accident scene helps to reduce incident-related congestion and restore traffic capacity as safely and quickly as possible.
<b>Work zone management</b> —using techniques such as warning signs, reversible lanes, and public awareness campaigns during road construction.	Use of work zone management techniques during road construction helps to minimize construction delays and related congestion.
<b>Bus, vanpool, and car pool lanes</b> —setting aside dedicated high-occupancy vehicle (HOV) lanes for buses, vanpools, and car pools on freeways.	Dedicated lanes for buses, vanpools, and car pools provide a faster, more predictable travel time. By increasing the average number of people per vehicle, HOV lanes increase the overall capacity of the roadway.
<b>Access management</b> —a set of techniques that state and local governments can use to control vehicle access to highways, major arterials, and other roadways, for example, limiting access to freeways, increasing the spacing between signals and interchanges, and use of frontage and service roads.	Techniques such as controlling signal spacing improves traffic flow and reduces congestion and accidents.

**Appendix II: Congestion Mitigation  
Techniques and Benefits**

<b>Technique</b>	<b>Benefit</b>
<b>Integrated corridor management</b> —the operational coordination of specific transportation networks comprising a corridor, and the coordination of agencies responsible for corridor mobility.	Managing a corridor in an integrated manner is aimed at reducing travel times, improving travel predictability, and increasing transit ridership in the corridor.
<b>Asset management</b> —a systematic process of maintaining, upgrading, and operating transportation assets cost effectively by applying engineering principles, sound business and economic practices, and a framework for planning and decision making.	An asset management program that includes regular maintenance and rehabilitation of roads can result in improved speed and reliability of passenger and freight travel.

Source: GAO.

*Techniques that influence driver behavior:* These are techniques that are designed to reduce vehicle demand on the existing system by reducing the frequency of travel and travel during peak periods, altering the routes traveled, and providing incentives to use alternate transportation modes. For example, high-occupancy toll (HOT) lanes could charge single-occupancy vehicles a higher price during peak congestion times, and this provides incentives for drivers to travel at less congested times. Other policies, such as employer transit subsidies and flexible work schedule programs, can also shift drivers' use of the road network and thus reduce demand on the existing transportation infrastructure. Table 3 provides a brief description of selected congestion mitigation techniques designed to influence driver behavior and the potential benefit of each technique.

**Table 3: Select Congestion Mitigation Techniques That Influence Driver Behavior**

<b>Technique</b>	<b>Benefit</b>
<b>High-occupancy toll (HOT) lanes</b> —a priced lane that offers drivers of vehicles that do not meet the occupancy requirements the option of paying a toll to use lanes that are otherwise restricted to high-occupancy vehicles.	HOT lanes can channel traffic into underutilized lanes and decrease congestion on regular lanes thus increasing the overall throughput of a corridor. HOT lanes can also shift demand to less congested times by charging a lower toll just before and after peak period.
<b>Cordon-based pricing</b> —a form of congestion pricing where drivers are charged a fee to enter a congested area such as a city center during peak periods.	Charging a fee to enter a central business district during peak periods encourages travelers to shift their behavior by either traveling at another time or by using alternative transportation modes such as buses and trains.
<b>Employer transit and vanpool subsidies</b> —employers pay for employee monthly transit pass expenses.	Designed to provide an incentive for employees to use transit services resulting in reduced traffic demand on the road network.
<b>Real Time Traveler Information Web sites</b> —Web sites that provide up-to-the-minute information on traffic conditions such as speeds, levels of congestion, and camera views of roads and incidents before the commuter starts out.	Providing information on congestion, commute times, and alternate routes allows a traveler to change time of departure, route, or mode of transport to avoid congestion and arrive at a destination in timely manner.

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**Appendix II: Congestion Mitigation  
Techniques and Benefits**

<b>Technique</b>	<b>Benefit</b>
<b>Worksite flextime</b> —allows employees to set their own arrival and departure time to/from work—within established time boundaries agreed to by their employer.	Encourages employees to avoid the most congested travel times, reducing the demand on roadway and/or transit systems during peak-demand periods.
<b>Telework policies</b> —allow employees to work at home during a portion of the workweek.	Working at home results in fewer trips to work and reduced demand on roads and transit systems.
<b>Land use and development policies and incentives</b> —policies and incentives that encourage future growth near existing road and transit services.	Locating new residential development near existing transit facilities will make more efficient use of existing transit services with the potential to reduce demand on existing roads.
<b>Parking management</b> —managing the supply and price of parking such as limiting the amount of single-occupancy parking spaces, charging higher parking fees, or providing preferential parking for car pools and vanpools.	Managing parking supply and price provides a disincentive for driving alone and an incentive for using alternate modes of travel.

Source: GAO.

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# Appendix III: GAO Contact and Staff Acknowledgments

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## GAO Contact

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## Staff Acknowledgments

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