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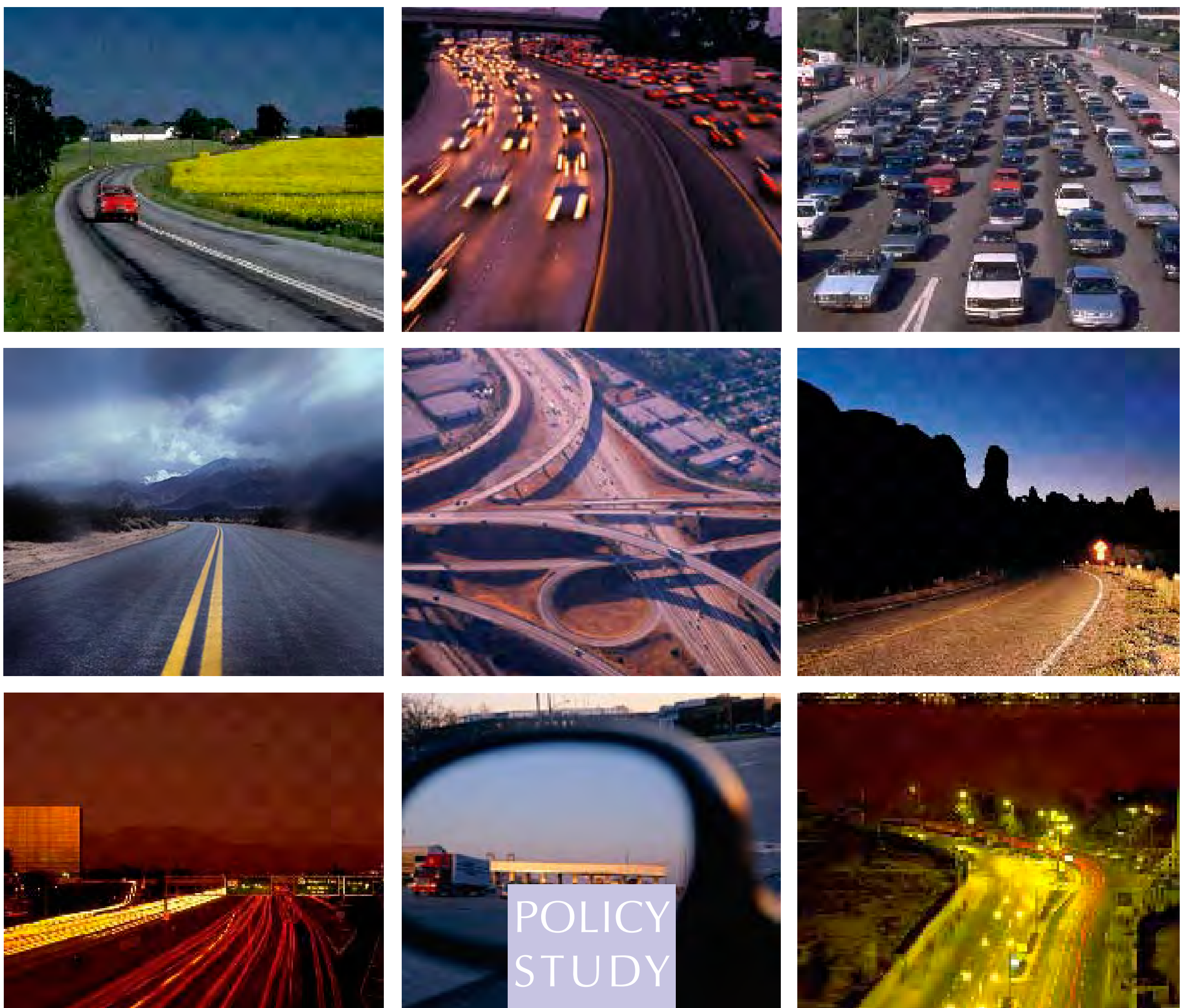
ADDING FAST LANES TO MILWAUKEE'S FREEWAYS: CONGESTION RELIEF, IMPROVED TRANSIT, AND HELP WITH FUNDING RECONSTRUCTION

By Robert W. Poole, Jr. and Kevin Soucie



POLICY STUDY 342

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Adding FAST Lanes to Milwaukee's Freeways:
Congestion Relief, Improved Transit, and Help with Funding Reconstruction

By Robert W. Poole, Jr. and Kevin Soucie

Executive Summary

Greater Milwaukee has a large and growing problem of traffic congestion. In 1982, the average resident spent five hours per year stuck in traffic. By 2003, that total had grown to 23 hours. Trips at rush hour now take more than 20 percent longer to make than at other times of day. The cost of wasted time and fuel averages $310 per person per year in the Milwaukee area, and is likely to grow significantly in coming decades.

Freeway congestion has also had a devastating impact on bus service and has severely hindered transit's time-savings competitiveness with the automobile. "Freeway Flyers," stuck in the same traffic jams as cars, have lost their "express bus" advantage as an alternative for commuters. As a result, transit continues to lose commuter market share, circling down the death spiral of service cuts and fare increases.

One seldom discussed cost of freeway congestion is the greatly reduced ability of emergency vehicles (police, fire, paramedic) to get where they need to go rapidly and reliably. In responding to life-threatening emergencies, every second counts. Yet congested freeway lanes may make it impossible for these public safety vehicles to get through when they are urgently needed.

Some may attribute recent traffic delays to construction work on the Marquette Interchange—and that may be partially correct. But it is a mistake to think that traffic jams will go away once the Marquette is completed. In fact, all evidence indicates that traffic congestion will continue to worsen. Southeastern Wisconsin is in the early stages of a $6.2 billion reconstruction and modernization of its aging freeway system. Simply widening much of the system by adding one

lane in each direction (as proposed by SEWRPC) will reduce congestion initially, but projected growth will overwhelm the expanded system in the not-too-distant future—and support is unlikely for further widening due to costs, political opposition, and land-use constraints. Hence, this reconstruction cycle may be the last real chance the region has to consider a more sustainable long-term approach to its freeway system.

This report proposes that on the most congested core portion of the rebuilt freeway system, the inner lane in each direction be configured as a "FAST Lane," on which traffic always flows at the freeway speed limit thanks to variable pricing—adjusting tolls to maintain free-flow traffic conditions. The use of pricing means there will be tolls, but no toll booths. The variable tolls will be charged electronically, via transponder. There is no need for stopping, slowing down, or using coins. Nearly a decade of experience with such priced lanes on two California freeways shows that variable pricing works well to keep such lanes flowing freely, at the speed limit, during highly congested peak periods. The pricing also generates revenue that more than covers the cost of constructing the FAST Lanes.

FAST Lanes assure motorists that no matter how bad traffic gets, they will always have a relief-valve available when they really need it. Some have begun to call this concept "congestion insurance." Just as people purchase insurance to guard them against life's other hazards (fire, theft, accidents), with a network of FAST Lanes they will be able to purchase insurance to guard them against being late. The initial cost of this "insurance" is very low: simply the cost of opening an account and installing a transponder on the car's windshield. From that point on, account-holders have the peace of mind that whenever they are running late and really need to be somewhere on time, they have a means of buying that faster trip for a price that is lower than the cost of being late. This will always be true since it will be the individual driver who chooses whether or not to pay for a specific trip. Data from the long-established California HOT lanes support the premise that most people don't use these lanes every day (which for most would be quite costly). Rather, the overwhelming majority uses the lanes in the "congestion insurance" mode, once or twice a week. Data also show that the system is popular with people of all income levels, so all segments of society benefit from the availability of FAST Lanes.

The proposed FAST Lanes system would encompass the approaches to downtown on I-94 from the south and from the west, on I-43 and US 45 from the north, plus the inner core of freeways near downtown (I-894 and I-94/43 north-south, and I-94 and I-43 east-west). This is the portion of the freeway system where congestion is projected to be worst, even after the widening. It is consequently the area where relief is most needed and where willingness to pay to avoid congestion will be greatest. Our proposed construction phasing of the FAST Lanes is designed to get the highest revenue-producing segments in operation first.

Our analysis projects traffic on the freeways and on the FAST Lanes segments through 2045. Based on a starting rush-hour toll equivalent to 15 cents/mile (in 2005 dollars), we estimate that the proposed FAST Lanes would generate enough revenues to support a toll revenue bond issue of about $1 billion. To put it in perspective, that kind of new voluntary (non-tax) revenue could finance the cost of rebuilding the entire Marquette Interchange with money left over. It certainly would make a significant contribution toward the $6.2 billion cost of the overall freeway reconstruction program.

FAST Lanes also provide uncongested guideways for express buses, enabling Freeway Flyers, UBUSes (University buses) and other transit services to operate faster, more efficiently, and more reliably than on regular, congested freeway lanes. Restoration of the time-savings advantage can help transit recapture some of its lost share of the commuter market. In addition, FAST Lanes will provide a greatly improved means for emergency vehicles to reach the scene of incidents, or to get to the portion of the metro area where they need to be, in significantly less time.

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Part 1

Why FAST Lanes?

A. Milwaukee's Congestion Problems

The Southeastern Wisconsin freeway system has grown increasingly congested since it was built in the 1960s and 1970s. The Southeastern Wisconsin Regional Planning Commission (SEWRPC) reports that in 1972, only 9.1 miles (or 5.6 percent) of the system suffered from congestion during rush hours, but by 1999 this had grown to 64.7 miles (or nearly one-fourth of the entire system).[1]

The Texas Transportation Institute, in its 2005 report on traffic congestion in urban areas around the country, estimates that residents of the greater Milwaukee metro area in 2003 spent 18,249,000 hours in traffic congestion, wasting nearly 12 million gallons of fuel.[2] The average cost, per person, that year was $310 in wasted time and wasted fuel. The average person in the metro area spent 23 extra hours stuck in traffic in 2003. That's a sharp contrast with 1982, the earliest year in the TTI database. In that year, the average person in the Milwaukee area spent only five hours stuck in traffic.

TTI also calculates, for every metro area, a travel time index. This index compares how long it takes to make a trip at rush hour as opposed to at non-congested times when traffic flows freely. In greater Milwaukee in 1982, the TTI was 1.05—meaning that a rush-hour trip took only 5 percent more time than a non-rush-hour trip. But by 2003, the Milwaukee-area TTI had increased to 1.21, since rush-hour trips took 21 percent longer. All this, of course, was computed without considering the subsequent impacts of construction disruptions from work on the Marquette Interchange.

The SEWRPC report projects traffic levels only to 2020. Their projections show that if the freeways are not widened, the number of miles of freeway impacted by congestion will nearly double, from 64.7 miles in 1999 to 122.4 miles in 2020, accounting for 44 percent of the freeway system. With the addition of one more lane in each direction on the most congested portions of the system, SEWRPC projects that 2020 congestion will be reduced to 58 miles, a slight decrease from 1999 levels. However, extreme or severe congestion will still exist on the most central portions of the system, especially the freeway loop surrounding downtown Milwaukee and several key approaches from the north, west, and south.

Unfortunately for traffic congestion, growth in population and travel will not cease in 2020. Indeed, many metro areas are already using 2030 as the planning horizon in their long-range transportation plans. Later in this report, we project central freeway traffic to 2040 and beyond. For now, the point to remember is that while the planned lane additions will provide some congestion relief, that relief is not likely to be long-lasting.

B. Priced Lanes vs. General–Purpose Lanes

During the past decade, a growing number of transportation planners have begun to rethink the addition of regular ("general-purpose") lanes to freeways. These planners recognize the need for additional capacity, but are also struck by:

- The tendency of continued growth to fill up the new lanes over time;
- The high cost, political opposition, and limited right of way available for any further freeway widening after this one;
- The desire to provide congestion relief that will be longer-lasting (or more sustainable over time).

These concerns have led to increased support for configuring new lanes not as traditional general-purpose lanes but as some form of "managed lanes."[3] The underlying idea is that since we cannot afford to keep on adding lanes indefinitely, it makes sense to get higher value out of the lane additions that we do make. What kind of higher value are they talking about?

The earliest special-purpose lanes were carpool lanes, generally known as high occupancy vehicle (HOV lanes). The idea was to have these new lanes carry more people per hour, by permitting only vehicles with multiple occupants to use them. While a few HOV lanes carry more people per hour at rush hour than regular lanes, most end up with significant excess capacity (sometimes called the "empty lane syndrome"). There are no current plans to make use of HOV lanes in the Milwaukee area, and in our view, this is just as well, since other forms of specialized lanes can provide much greater value and transportation benefits.

The second type of managed lanes, HOT lanes, has been far more successful. As first proposed in 1993[4], the idea was that since a typical HOV lane has considerable excess capacity, the extra capacity could be sold to those willing to pay a market price for a faster trip when they are in a pinch, bypassing congestion on the regular lanes. Two different versions of the idea were implemented in California during the 1990s, and both have been judged as great successes.

In San Diego County, an underutilized two-lane, reversible HOV facility in the median of congested I-15 was converted to HOT lanes, using electronic toll collection (no toll booths) to collect a market-price toll that is adjusted every six minutes, based on how much traffic is in the HOT lanes at that time. The toll is adjusted to keep traffic in those lanes moving at or near the speed limit. Typical rush-hour tolls range from 50 cents to $4.00 for the eight-mile trip. Fully implemented in 1998, the project has been so popular that construction is now under way on a major expansion, widening the project to four lanes (with a movable barrier) and lengthening it from the current eight miles to 20 miles. Surveys showed support in the 70-80 percent level for this approach as being the best way to cope with congestion in the I-15 corridor. That support held true across all income levels, all age groups, among men and women, and among all ethnic groups.[5]

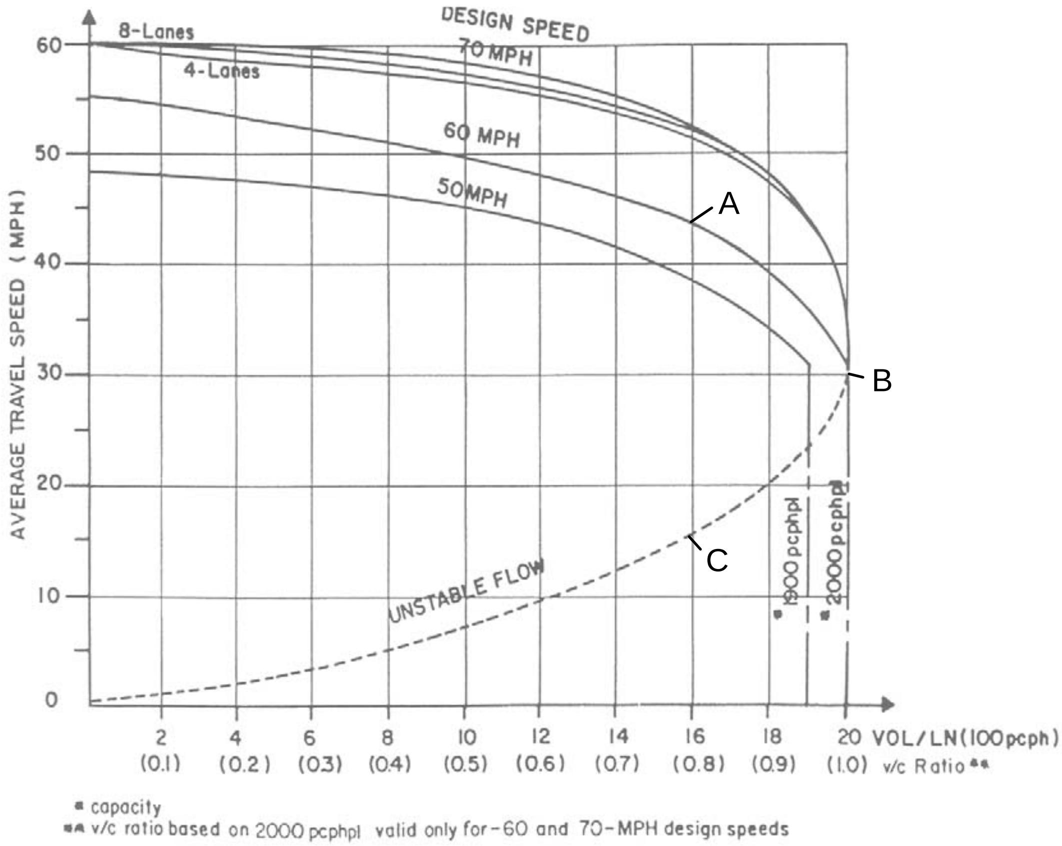
In Orange County, the HOT lanes project was all new construction. New toll lanes were added to the wide median of the highly congested SR 91 freeway, a commuter route from the bedroom communities of inland Riverside County to the employment areas of coastal Orange County. In this case, since a major goal was to pay for the new lanes out of toll revenues, only carpools of three or more (HOV-3) were allowed to use the lanes without paying (and even those vehicles are required to pay half-price during the afternoon peaks between 4 and 6 PM). As on I-15, tolls are charged electronically (no toll booths), but on the 91 Express Lanes there is a pre-set toll schedule with different rates for most daylight hours and differences among days of the week (Thursday and Friday afternoons heading eastbound are the very busiest times, and hence have the highest tolls). Opened at the end of 1995, this project, too, has been highly successful, keeping traffic flowing at the speed limit even during the busiest parts of peak periods.

Both California projects have been extensively studied since opening in the mid-1990s. Several broad conclusions have emerged. First, charging prices that are higher when demand is greatest works effectively to keep the HOT lanes from getting overloaded during rush hours. Thus, pricing keeps the HOT lanes free-flowing, letting them function as a kind of safety valve on the freeway. That means all kinds of time-sensitive trips have new alternatives not possible without these special lanes: emergency vehicles, transit buses, delivery vans, as well as ordinary travellers with trips that absolutely, positively have to be made on time.

Second, on both projects the data show that the large majority of users are not five-day-a-week regular users. For example, the 91 Express Lanes have issued 176,000 windshield-mounted transponders to 115,000 account-holders. But on any given weekday, only about 30,000 individuals use those lanes.[6] What most people do is to use the HOT lanes as a kind of "congestion insurance." You open an account and put the transponder on your windshield so that you have the option of using the HOT lanes on those occasions when you really need to get somewhere on time, and it's worth paying to do so. This accounts for the fact that there is significant usage of the HOT lanes, in both counties, by people in the lowest 25 percent of the income distribution.

Third, because of the nature of severe congestion, at rush hours the HOT lanes actually have much higher vehicle throughput (higher performance) than the general-purpose lanes. Figure 1 shows the relationship between speed and throughput. Before the rush-hours, low volumes of traffic are zipping along at the speed limit (point A). As traffic volumes increase, speeds begin to decrease, until the maximum flow-rate of the lane is reached (at anywhere from 1800 to 2000 vehicles/hour, depending on the lane configuration), shown as point B. Beyond that point, cars get too close together, and people start hitting their brakes to keep a safer distance. That typically leads to a cascade of slowdowns, in which traffic becomes "chaotic" and flow breaks down into stop-and-go conditions (point C), with volumes becoming less and less as speed also decreases. Traffic stuck in this kind of chaotic condition can sometimes take an hour or more to recover (on severely congested freeways).[7]

Figure 1: Traffic Throughput vs. Speed



What pricing does is to keep traffic flowing at or near the sweet spot shown by point B, at high speeds and nearly maximum flow. The idea is to prevent overcrowding of the priced lanes during rush hour, so as to maintain conditions at point B, thereby preventing breakdown into unstable conditions of both low speed and low flow. Because pricing has been proven to do this on the two California projects, we now have real data showing the superior throughput of HOT lanes at rush hour. On the 91 Express Lanes, at the busiest times, those two lanes handle 49 percent of the throughput despite being only 33 percent of the total lane capacity (two out of six lanes in each direction).[8]

C. Types of Priced Lanes

In principle, any type of lane for which access is limited (compared with general-purpose lanes) in order to achieve performance goal(s) can be considered a managed lane. But in practice, two principal models, reflecting the different approaches taken in the two successful California projects, have emerged to battle the significant traffic congestion problem in urban areas.

One approach, similar to that being taken in San Diego, is to emphasize the role of priced lanes in fostering carpooling, with pricing used mainly as a way of ensuring efficient use of the excess capacity remaining after carpool demand is met. In this model, costs of developing any needed new capacity (beyond the minor costs involved in converting existing HOV lanes for electronic toll collection) are paid for out of traditional highway funding sources. Net toll revenues (after operating and maintenance costs) are used to subsidize transit service in the corridor. That model is being used by SANDAG (the metropolitan planning organization for greater San Diego) to expand the existing I-15 HOT lanes, and it is also the model they plan to use for adding brand-new priced lanes to three other freeways over the next 25 years.

The other model, similar to that followed in Orange County, focuses on priced lanes providing congestion relief for motorists. In this model, toll revenues are seen as an important funding source for building the new lanes. Hence, in this model free passage for carpools is either not provided at all (the Express Toll Lanes (ETL) model) or is restricted to higher levels of occupancy such as HOV-3, HOV-4, or only vanpools and buses. The market-priced toll revenues of the 91 Express Lanes in California have proven to be sufficient to support the construction, operation, and maintenance of that $135 million new-lanes project. Studies being done for whole systems of ETLs or HOT lanes in several metro areas suggest that even with this model of tolling, the costs of urban lane additions are often so high that toll revenues may only cover between one-third and two-thirds of the cost of the new capacity. In most of those studies, at least some of the new capacity must be built either elevated or on very costly purchased right of way, neither of which was required in Orange County.

Despite the differences between these two models, one factor that is increasingly common in planning such lanes is the synergy between bus rapid transit and priced lanes. If pricing can keep those lanes flowing smoothly at or near the speed limit during rush hours, and can maintain such conditions on a long-term basis, then priced lanes become the virtual equivalent of exclusive busways.[9] In other words, from the transit agency's perspective, the availability of priced lanes gives them an uncongested guideway on which they can operate reliable, high-speed express bus service on a sustainable basis. Houston has such a project under construction to add four managed lanes to the Katy Freeway (I-10). The local transit agency, METRO, is guaranteed 25 percent of these lanes' capacity for use by carpools of three or more (HOV-3), vanpools, and buses. The Harris County Toll Road Authority, which is financing and will operate the HOT lanes, has agreed to keep toll levels high enough to ensure uncongested traffic. METRO, in turn, has agreed to increase carpool occupancy requirements above HOV-3 if and when necessary, to maintain uncongested conditions for its bus service.

D. Priced Lanes in Practice, 2005

Until 2005, there were only a handful of priced lanes in operation in the United States. Besides the two California projects, there were two modest projects on I-10 and US 290 in Houston. Both of those involved HOV lanes which developed excess capacity when the rush-hour occupancy level was increased from HOV-2 to HOV-3. Local officials began selling excess capacity to HOV-2 vehicles, under a program called QuickRide (but single-occupant vehicles were not allowed). The market of paying two-person carpools turned out to be quite modest, so these lanes have not had the kind of success experienced by the two California projects.

But the last few years have seen a major increase in activity with regard to priced lanes. In Minneapolis, the HOV lanes on I-394 were converted to HOT lanes and opened to traffic in May 2005. Denver will complete a similar conversion in early 2006 on I-25 North. And legislation has been enacted authorizing conversion to HOT of the HOV lanes on SR 167 in Seattle and the development of new HOT lanes on I-580 and I-680 in California's Silicon Valley.

Two major freeway reconstruction projects in Texas include large-scale provisions for new HOT lanes. As noted previously, the rebuilt Katy Freeway (I-10) in Houston will include four such lanes, with variable pricing. And the design for the reconstruction of the LBJ Freeway in Dallas (I-635) will include up to six HOT lanes, in some cases in tunnels beneath the regular lanes. Planners at Virginia DOT have approved a private-sector proposal to add four HOT lanes to the southwest quadrant of the Washington Beltway (I-495); that project has won the editorial support of the *Washington Post*. Studies of similar priced lanes are under way for the Maryland portion of the Beltway, as well as a number of other major freeways in both the Washington and Baltimore areas of Maryland.

Table 1 provides an overview of the status of priced lanes projects around the country as of late-2005. The column headed "Proposed" lists projects that have been proposed by private-sector firms under state public-private partnership legislation. Nearly all of these proposals were made in 2004 or 2005. Colorado, Georgia, Texas, and Virginia are the areas of greatest private-sector activity at this point, though 20 states (including Wisconsin) have some form of enabling legislation for toll-based, public-private partnership projects in transportation.

The table also indicates the large number of feasibility studies either completed or under way, generally by state DOTs or metropolitan planning organizations (MPOs) in urban areas. It is also worth noting that various priced lane plans have been included in the long range transportation plans of at least four MPOs thus far.

Table 1: Priced Lanes Recap, 2005						
Jurisdiction	**In Operation**	**Under Construction**	**Approved**	**Proposed**	**Feasibility Study**	**In LR Plan**
Arizona						
Phoenix					Network of HOT lanes	
California						
Alameda Co.			I-680			
Los Angeles Co.					I-710, SR 60, I-15	I-710, SR 60
Marin Co.					US 101	
Orange Co.	SR-91				SR-57	
San Diego Co.	I-15	I-15 expansion				I-5, I-805, SR-52
Santa Clara Co.					US 101, SR 87, SR 85	
Sonoma Co.					US 101	
Bay Area region						Network of HOT lanes
Colorado						
Denver		I-25N		I-70,C-470	Network of HOT lanes	
Florida						
Miami				I-95	I-95, SR-821, SR-836	SR-836
Orlando					I-4	
Tampa		SR-618				
Georgia						
Atlanta				GA-316, GA-400, I-75, I-285, I-575	HOT and Truck Only Toll lanes	
Maryland						
Baltimore					I-95, I-695	
DC suburbs					I-495, I-270, US-50, ICC	
Minnesota						
Mpls/St. Paul	I-394				Network of HOT lanes	
North Carolina						
Piedmont Triad					I-40	
Research Triangle					I-40	
Oregon						
Portland					I-205, SR 212/224	
Texas						
Dallas			I-635	I-35W, I-820, I-30, SH 183	Network of HOT lanes	
Houston	I-10, US 290	I-10			Network of HOT lanes	
San Antonio					I-35, I-10, SH 160	
Virginia						
Hampton Roads					VPPP study	
DC suburbs				I-495, I-95, I-395	VPPP study	
Washington						
Seattle			SR-167			

Part 2

FAST Lanes Design Considerations

There is no standard configuration for HOT or priced lanes. What follows is a very brief discussion of some of the design issues which must be addressed in planning for the inclusion of such lanes on an urban freeway. An excellent reference on this subject was produced by Parsons Brinckerhoff for the Federal Highway Administration and should be consulted for further details.[10]

A. Type of Separation

By definition, access to priced lanes is restricted; hence, the lanes must be separated in some way from the adjacent general-purpose lanes. Methods of doing this vary. The HOT lanes on I-15 in San Diego were originally built as a barrier-separated, reversible (i.e., operating in the peak direction only) facility. That remains their configuration today, and that will be the configuration of the expanded project now under construction. At the other end of the spectrum, a portion of the new HOT lanes project on I-394 in Minneapolis (also a conversion from HOV lanes) is separated only by a double white line on the pavement from the adjacent lanes. An intermediate approach is represented by the 91 Express Lanes in Orange County, which uses plastic pylons in addition to pavement striping to delineate the HOT lanes. Plastic pylons are more effective as lane separators in localities where they are used, preventing accidents caused by interlopers darting in and out of the HOT lanes, but some DOTs do not consider them compatible with snow-plowing equipment.

This question was addressed in a recent feasibility study of proposed HOT lanes for the Washington Beltway (I-495) in Virginia. Engineering company HNTB did a safety study, one aspect of which was snow removal issues related to the type of barrier separation to be used.[11] The researchers queried transportation officials responsible for snow removal in five northeastern states. "Generally, no one saw the presence of the buffer strip as a unique problem with respect to snow removal," and said it could be accommodated by "a combination of careful plowing and snow-blowing." Regarding plastic pylons, the study said "the pylons may be removed during plowing, as is the case for raised pavement markers and other devices affixed to the roads. Many departments report dislodging these devices annually and include periodic replacement as part of their operating budgets." The report also notes that on the SR 91 HOT lanes in California, "plastic pylons have at best a life of 12 to 18 months before replacement is required" in any case.

B. Pricing Alternatives

The ability to vary the price for using the FAST Lanes is the key to keeping traffic flowing at or near the speed limit. There are currently two methods in use to do this. One is to use a periodically adjusted published price schedule, with different prices for different hours of the day (and days of the week) based on observed traffic flow patterns. The other is to adjust the prices more or less in real time, based on the actual, measured amount of traffic in the lanes. The former method is used on the 91 Express Lanes in Orange County; the latter is used on the I-15 HOT lanes in San Diego. Both have worked effectively to manage traffic and avoid congestion. The trend seems to be toward the quasi-real-time variable pricing model; that approach is being used on the new I-394 HOT lanes and is planned for the new Katy Freeway HOT lanes, and is being considered for the second phase of the Denver I-25 North HOT lanes.

Two crucially important points must be kept in mind about such pricing. First, it is only feasible using all-electronic toll collection. That means toll booths cannot be used. There is no practical way to charge many different prices during the course of a day using cash toll payment. Second, prices must be allowed to increased over time, when necessary, to keep traffic flowing smoothly. On the 91 Express Lanes, the Orange County Transportation Authority has put in place a pricing policy that automatically increases the toll rate for a particular time block (e.g., between 3 PM and 4 PM on Thursdays) if traffic levels have been above a certain pre-congestion threshold during that time block for 12 weeks in a row. This policy is explained on the agency's Web site and is widely known. There is no need for a political decision, a meeting, or any other positive action in order to increase toll rates to manage traffic flow. Likewise, under the variable pricing regime in San Diego, a software algorithm makes a new pricing decision every six minutes, raising or lowering the toll rate for the next six minutes based on just-measured traffic levels.

C. Technology Needs

Since priced lanes require 100 percent electronic tolling, all those who wish to use such lanes must open an account and acquire a transponder, which is mounted on the windshield. Since neighboring Illinois is in the process of making its toll system compatible with the increasingly standard E-ZPass system, now used across the Midwest and the Northeast, any such system in Milwaukee would be able to adopt that same transponder technology and make interoperability agreements with the E-ZPass consortium of toll agencies. Thus, Milwaukee-area users could use their transponders when they visited other states in those regions.

The transponders are "read" by transmit/receive units that are generally mounted on overhead gantries, either at each entrance and exit or at various points along the managed lanes facility. The gantry-mounted units communicate with a local computer processor that records transactions. Those devices, in turn, interface with a central processor that maintains account records and compiles overall data on the operations. Since electronic toll collection is used on nearly every significant toll road, bridge, and tunnel in the country these days, the technologies involved are all well-proven.

Privacy is sometimes a concern with electronic toll collection, so it is important to note how this issue can be addressed in the proposed FAST Lanes program. First, it should be noted that use of the FAST Lane is completely up to the driver, so if privacy is an overriding concern on a particular trip, the person has the option of using the general-purpose lanes instead. Second, most systems give users the option of opening an anonymous account, where all payments are made in cash and the identity of the customer is not recorded. As long as there are sufficient funds in the account at the time of a toll transaction, no camera enforcement information of the vehicle will be taken. In addition, as a general rule, access to the computer database would be limited to law enforcement with a court order. Data could not be used in civil cases.

D. Enforcement

In the earliest and simplest form of managed lane—HOV lanes—enforcement is a matter of basic fairness. Motorists who go to the trouble of forming carpools are supposed to be rewarded with a less congested lane, so enforcement is aimed at keeping the bargain by keeping cheaters out. It is done by a combination of fines and random patrol car enforcement.

For toll lanes, good enforcement safeguards expected revenues from those who would steal a valuable service by using it without paying. If toll revenues are dedicated to paying off construction bonds, proper enforcement is critical to the project's financial success or failure. A credible enforcement regime could have a positive effect on the rating given to the project's toll revenue bonds.

All electronic toll systems include video enforcement equipment, in which the license plates of a vehicle without a valid transponder and account are imaged so that follow-up action can be taken due to non-payment.

There is increasing support for developing new priced lanes as Express Toll Lanes (ETLs), in which all personal and commercial vehicles pay the market-based toll for their type of vehicle (e.g. cars vs. trucks). This allows enforcement to be done entirely with gantry-mounted electronics and video. Such systems can still allow free passage to pre-authorized high-occupancy commuter vehicles such as buses, vanpools, and even employer-sponsored carpools. These pre-authorized vehicles can be given special transponders authorizing them to free (or reduced-rate) passage. Maryland and Florida DOTs seem to be the leading proponents of the ETL model at this point. And as more states do feasibility studies of possible networks of priced managed lanes, they increasingly appreciate the revenue difference between ETLs and traditional HOT lanes (like San Diego's) that permit free passage by HOV-2s, thereby giving away most of their revenue potential.

E. Recommended Configuration for Milwaukee

Based on the above discussion, we propose that in rebuilding the Milwaukee-area freeway system, the inner lanes be developed as priced lanes. In most cases, they would be a single lane in each direction, but on portions of the system where traffic flow is heavily directional (inbound in the morning, outbound in the afternoon), the new lanes could be developed as two-lane, reversible facilities. Separation would be via striping and plastic pylons. There would be real-time variable pricing (as in San Diego and Minneapolis), done via all-electronic tolling at highway speed. The system would be compatible with, and interoperable with, E-ZPass. All buses using the new lanes would be charged, except for emergency vehicles, buses, and employer-sponsored vanpools.

We suggest that these new lanes be called FAST lanes. That term was developed as an acronym during congressional debates over reauthorization of the federal surface transportation program, standing for Fast And Sensible Toll lanes. However, we propose for Milwaukeeans to discover that "For A Speedier Trip: use the FAST Lanes."

Part 3

Proposed Milwaukee FAST Lanes Network

A. Location

A major purpose of the planned widening of the Milwaukee-area freeway system, from six to eight lanes, is to provide additional capacity to cope with recent and projected traffic growth. Yet even with the planned capacity increase, the inner portion of the system (approaching and surrounding downtown Milwaukee) is expected to still experience "severe" or "extreme" congestion in 2020. This is graphically illustrated by Map 76 in SEWRPC's freeway reconstruction plan report.[12] Clearly, this is the portion of the system most in need of relief, where the largest fraction of motorists would be willing to pay to bypass congestion.

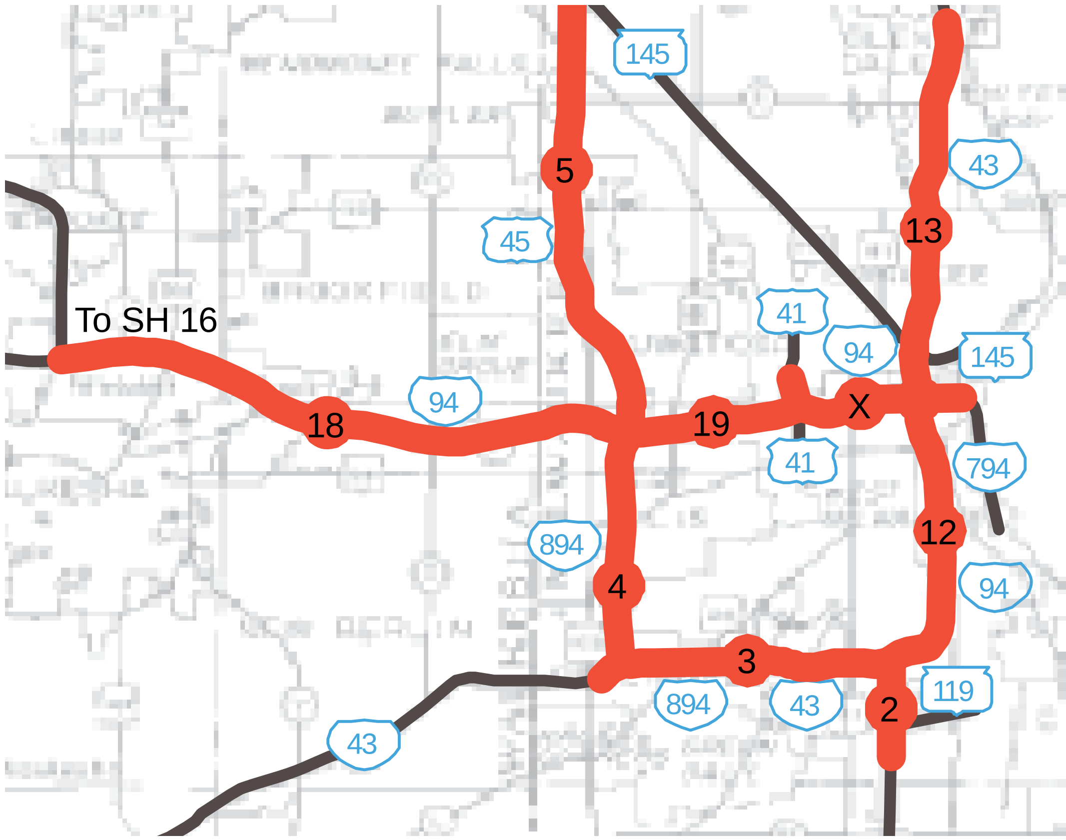
Therefore, we have defined the core FAST Lanes system to cover this portion of the system, as shown in Table 2 and Figure 2.

Table 2: Components of Proposed FAST Lanes Network

SEWRPC Segment #	Route	From and to	Rt.-mi.	Direction
2a	I-94	Rawson to Mitchell IC	3.1	N-S
3	I-43/894	Mitchell IC to Hale IC	3.6	E-W
4	I-894/US45	Hale IC to Zoo IC	2.5	N-S
5	US45	Zoo IC to North IC	8.3	N-S
12	I-43/94	Mitchell IC to Marquette IC	4.2	N-S
13	I-43	Marquette IC to Silver Spring Dr.	4.8	N-S
18	I-94	SH16 to Zoo IC	9.9	E-W
19	I-94	Zoo IC to Stadium IC	2.2	E-W
X	I-94	Stadium IC to Marquette IC	1.7	E-W
Interchanges				
50	Zoo	I-94/894 & US45	5.0	I
51	Marquette	I-43/94/794	6.3	I
52	Hale	I-43/94 & US45	2.6	I
53/58	Mitchell & Airport	I-43/94/894 & SH119	3.8	I
59	Stadium	I-94/US41	1.3	I
TOTALS			**59.3**	

Source: Table 32 of SEWRPC Regional Freeway System Reconstruction Plan.

Figure 2: Map of Proposed FAST Lanes Network



B. Configuration

In widening the Milwaukee-area freeway system, WisDOT faces the challenge of minimizing the need for additional right of way in dense, built-up areas. The proposed network of FAST lanes would be located on the inner core of the freeway system, where this challenge is most acute. Hence, the question arises: would making the fourth lane (in each direction) a limited-access lane add to the right of way challenge, by widening the footprint of the freeway?

As noted previously, priced lanes must be separated in some way from the adjacent general-purpose lanes. That requires additional space, potentially making the freeway cross-section wider. Our previous discussion made the case for using a form of buffer separation, making use of plastic pylons plus double striping to separate the FAST Lanes from the general-purpose lanes.

Design guidelines for single-lane HOV and HOT facilities have been compiled by the Texas Transportation Institute in the previously referenced white paper on single-lane managed lane facilities.[13] Table 3 is reproduced from that document, and Figure 3 illustrates the elements involved. As can be seen, the total clear width, including buffer and shoulder, can range from 16 to

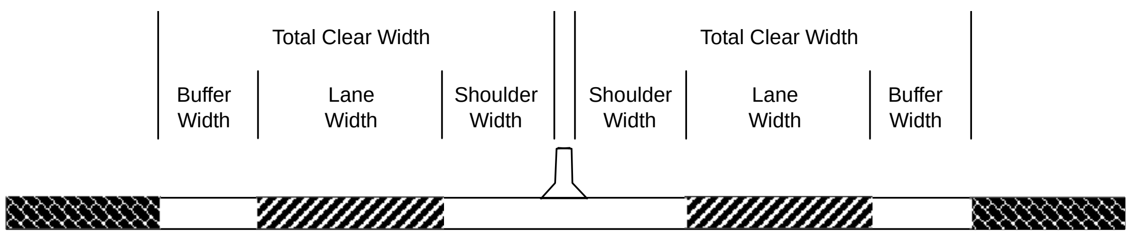
30 feet, using a standard 12 feet for the priced lane itself. The difference comes from the range of shoulder widths (from 2 to 14 feet) and buffer widths (from 2 to 4 feet). One option not included in this table, but which has been put into practice on some freeways in Los Angeles, is narrowing the lane width from 12 to 11 feet. Since heavy trucks will not be permitted in these lanes, that may be an acceptable trade-off.

Table 3: Managed Lane Single-Lane Design Guidelines Buffer-Separated Concurrent Flow

Design Element	AASHTO	Caltrans	TxDOT	FHWA-HOT Desired	FHWA-HOT Reduced
Total Clear Width	18-30 ft.	26 ft.	26 ft.	30 ft.	16 ft.
Lane Width	12 ft.	12 ft.	12 ft.	12 ft.	12 ft.
Shoulder Width	2-14 ft.	10 ft.	10 ft.	14 ft.	2 ft.
Buffer Width	4 ft.	4 ft.	4 ft.	4 ft.	2 ft.

Source: Texas Transportation Institute

Figure 3: Managed Lanes Cross-Section



Source: Texas Transportation Institute

We were unable to obtain from WisDOT their proposed cross-sections for each of the segments listed in Table 2, which will make up the FAST Lanes network. Thus, we are not in a position to comment on how Table 3's range of clear widths compares to what WisDOT currently plans for the inside lane plus shoulder on these segments of the rebuilt freeway system. But especially if an 11-foot FAST Lane width were permitted (which would make the total clear width as little as 15 feet, where necessary), it would appear feasible to fit the proposed FAST Lanes into the planned cross-sections of these portions of the freeway system.

C. Construction Phasing

The current SEWRPC plan calls for doing the freeway reconstruction and widening in four stages: the Marquette during 2005-2008, a set of segments approaching the downtown core in 2009-2015, the downtown core and several approaching segments during 2016-2025, and outlying portions during 2026-2035.[14]

One premise of a priced lanes approach is that toll revenues generated from those lanes could be bonded against, to raise additional monies to help pay for the overall freeway reconstruction project. In turn, being able to do so might make it possible to accelerate the phasing of portions of the project, so that their traffic-improvement benefits could be realized sooner.

Our proposed FAST Lanes system is based on identifying the highest-traffic portions of the freeway system and implementing FAST Lanes instead of new general-purpose lanes on that portion of the system. But even within the set of freeway segments identified in Table 2, the inner core segments (3, 4, l2, 19, and X) have higher traffic—and hence greater revenue potential—than the others. To the extent that bonding toll revenue streams to raise up-front capital for the modernization is important, it would make sense to phase the reconstruction so that the highest revenue segments are built and put into operation first. That suggests modifying SEWRPC's proposed phasing somewhat, so as to rebuild the inner core of the freeway system, including the FAST Lanes, immediately after completion of the Marquette, with the segments that feed into the inner core reconstructed next (along with their FAST Lanes).

Therefore, our subsequent analysis of traffic and revenue is based on the construction phasing shown below in Table 4. We further assume that the Design-Build procurement process is used. Design-Build has a proven record of getting large-scale construction projects done more quickly, and with smaller cost overruns, than conventional two-stage Design-Bid-Build procurement.[15] We have therefore assumed four-year implementation periods, rather than the longer periods assumed in the SEWRPC plan.

Table 4: Proposed Phasing for Freeway Segments with FAST Lanes

Segment #	Route	Rt.-mi.	Phasing	Incremental Cost, $M	Incremental Cost, Then-Year $M
51	Marquette	6.3	2005-2008	$155	$163.2
3	I-43/I-894	3.6	2009-2012	20	24.2
4	I-894/US 45	2.5	2009-2012	26	31.4
12	I-43/I-94	4.2	2009-2012	32	38.7
19	I-94	2.2	2009-2012	16	19.3
X	I-94	1.7	2009-2012	16	19.3
50	Zoo	5.0	2009-2012	14	16.9
52	Hale	2.6	2009-2012	3	3.6
53/58	Mitchell & Airport	3.8	2009-2012	3	3.6
59	Stadium	1.3	2009-2012	7	8.5
2a	I-94	3.1	2013-2016	13.3	18.4
5	US 45	8.3	2013-2016	60	83.2
13	I-43	4.8	2013-2016	39	54.1
18	I-94	9.9	2013-2016	58	80.4
Total		**59.3**		**$462.3**	**$564.8**

Part 4

Traffic and Revenue Analysis

The next step in the analysis, after defining the FAST Lanes network, was to estimate the traffic that would be attracted to the lanes, and the prices that could be charged over a long-term planning period. That permits an estimate of FAST Lane revenues which, in turn, can be used to estimate the bonding capacity (how much can be raised up front) of the proposed project.

A. Traffic Projections

SEWRPC provided traffic figures for each of the segments in Table 2, giving the range of average daily traffic (ADT) along each segment for 1999 and the projected level for 2020. We used the average of the range for each segment, to simplify the analysis. Comparing the 2020 and 1999 figures, we calculated the annual traffic growth rate implied for each segment. These ranged from a low of 1.15 percent for segment 2a to a high of 1.9 percent for segment 3. Using these annual growth rates, we projected annual traffic on each segment from 1999 through 2045.

For each segment, we then prepared a spreadsheet such as that shown in Table 5 for the traffic projection for Segment 4. The first data column shows the overall daily traffic for the average weekday. We know from SEWRPC that 35 percent of daily traffic occurs during the five peak hours of the 24-hour weekday (two hours in the morning and three hours in the afternoon). Hence, the next column takes 35 percent of the total traffic and divides that by five hours to estimate the average traffic during each peak hour.

The next column shows the assumed traffic in the FAST Lane during each peak hour. During the early years, when there are no FAST Lanes, that traffic level is zero. The last column then shows the average amount of peak-hour traffic in each of the general-purpose (GP) lanes. Until the new lanes are built and enter service (in this case, in 2013), there are just six lanes, so this is just the previous number divided by six. But starting in 2013, we assume the FAST Lanes begin to take a significant amount of traffic, given that the GP lanes are congested, attempting to handle over 2,000 vehicles/hour during the peak hours. To be conservative, we assume that in its first year of operation, each FAST Lane attracts an average of 600 vehicles/hour during the peak, and that over the subsequent 10 years, FAST Lane traffic builds to the maximum permitted level of 1600/hour. That 1600 paying vehicles per lane per hour is consistent with the idea of reserving 100 spaces per hour for buses and vanpools, to fully utilize the 1700 vehicles/lane/hour consistent with uncongested flow in a single-lane facility.

Table 5: Sample Traffic Projection (Segment # 4)						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	144,500	10115	0	0	10,115	1686
2000	146,400	10248	0	0	10,248	1708
2001	148,400	10388	0	0	10,388	1731
2002	150,400	10528	0	0	10,528	1755
2003	152,500	10675	0	0	10,675	1779
2004	154,500	10815	0	0	10,815	1803
2005	156,600	10962	0	0	10,962	1827
2006	158,700	11109	0	0	11,109	1852
2007	160,900	11263	0	0	11,263	1877
2008	163,000	11410	0	0	11,410	1902
2009	165,200	11564	0	0	11,564	1927
2010	167,500	11725	0	0	11,725	1954
2011	169,700	11879	0	0	11,879	1980
2012	172,000	12040	0	0	12,040	2007
2013	174,300	12201	1200	600	11,001	1834
2014	176,700	12369	1400	700	10,969	1828
2015	179,100	12537	1600	800	10,937	1823
2016	181,500	12705	1800	900	10,905	1818
2017	183,900	12873	2000	1000	10,873	1812
2018	186,400	13048	2200	1100	10,848	1808
2019	188,900	13223	2400	1200	10,823	1804
2020	191,500	13405	2600	1300	10,805	1801
2021	194,100	13587	2800	1400	10,787	1798
2022	196,700	13769	3000	1500	10,769	1795
2023	199,400	13958	3200	1600	10,758	1793
2024	202,000	14140	3200	1600	10,940	1823
2025	204,800	14336	3200	1600	11,136	1856
2026	207,500	14525	3200	1600	11,325	1888
2027	210,300	14721	3200	1600	11,521	1920
2028	213,200	14924	3200	1600	11,724	1954
2029	216,100	15127	3200	1600	11,927	1988
2030	219,000	15330	3200	1600	12,130	2022
2031	222,000	15540	3200	1600	12,340	2057
2032	224,900	15743	3200	1600	12,543	2091
2033	228,000	15960	3200	1600	12,760	2127
2034	231,100	16177	3200	1600	12,977	2163
2035	234,200	16394	3200	1600	13,194	2199
2036	237,400	16618	3200	1600	13,418	2236
2037	240,600	16842	3200	1600	13,642	2274
2038	243,800	17066	3200	1600	13,866	2311
2039	247,100	17297	3200	1600	14,097	2350
2040	250,400	17528	3200	1600	14,328	2388
2041	253,800	17766	3200	1600	14,566	2428
2042	257,200	18004	3200	1600	14,804	2467
2043	260,700	18249	3200	1600	15,049	2508
2044	264,200	18494	3200	1600	15,294	2549
2045	267,800	18746	3200	1600	15,546	2591

The last column shows that the opening of the FAST Lanes provides significant relief in the GP lanes for at least 15 years, before the (assumed) continued growth in traffic results in congestion as bad as what existed prior to the opening of the FAST Lanes. By about 2040, traffic in the GP lanes becomes severely congested, and thereafter the numbers in the last column cannot be taken literally, since GP lanes are not capable of handling the volume of traffic shown. Rather, those numbers represent the apparent demand for freeway travel, only a portion of which can be accommodated via autos in the GP lanes. The balance would have to either shift modes (e.g., to bus and vanpool), shift time of day (to outside of peak hours), shift route (to surface streets), or not take place at all. The only other alternative would be a further expansion of the freeway system in that time frame. (Note: for two of the five segments in the first phase, numbers X and 19, we have assumed a faster growth of FAST Lane traffic, taking only seven years to reach full utilization rather than 10, due to greater congestion on the GP lanes on those segments.)

Table 5 is representative of all the segments that would be built in the first phase of FAST Lanes development, encompassing the inner core of freeways and the associated interchanges, from 2009-2012. (Spreadsheets for all segments can be found in the Appendix.) For the second set, on routes heading to and from the downtown core, traffic is not quite as high. For this set of FAST Lanes, which would open to traffic in 2017, we assumed that first-year average peak traffic would be 600/lane/hour, increasing over a 10-year period to the full 1600/lane/hour for segments 2a and 5. For the heavier-traffic segments 13 and 18, we assumed a seven-year ramp-up. Congestion relief on the adjacent GP lanes continues until about 2035-2038 for these segments, by which time peak-hour traffic levels would be back to the levels that prevailed just before the opening of the FAST Lanes.

The important point to remember here is that if the fourth-laning of these freeway segments were done by adding GP lanes instead of FAST Lanes, those new GP lanes would become seriously congested in this 2040 time frame, whereas the FAST Lanes will remain uncongested on an ongoing basis, thanks to the use of pricing. That means a FAST Lanes fourth-laning is more sustainable than GP-lanes fourth-laning. It ends the struggle we face to continually try to build our way out of traffic congestion. The benefits discussed below in Part 5 (for motorists, emergency vehicles, and transit vehicles) will continue on a long-term basis.

B. Pricing Estimate

As noted in Part 2, the purpose of pricing these special lanes is to prevent them from getting overloaded during peak periods, permitting them to remain free-flowing at maximum throughput. For a single-lane facility, this is generally considered to be 1700 vehicles per hour. Since we propose reserving 100 places per hour for non-paying buses and vanpools, that means a maximum of 1600 paying vehicles per lane per hour—or 3200 for the two-lane FAST Lanes addition to each of the freeway segments in question.

How high would the price have to be to limit FAST Lanes traffic to this free-flowing level? We have limited data thus far on which to base an estimate. Only the two California HOT lanes, on I-15 and SR 91, have multiple years of data available, permitting us to observe in some detail the operations and performance of lanes with variable pricing. But by properly taking into account the differences in congestion levels between freeways in Los Angeles/Orange County, San Diego, and Milwaukee, we can get some idea of the price level that will probably be needed in Milwaukee.

The latest Urban Mobility Report from the Texas Transportation Institute provides several different measures of congestion for each of the 85 metro areas in its database. The two most widely used are the total annual hours of delay per person and the travel time index. The latter is the ratio of the time it takes to make a trip at rush hour compared with making that same trip during uncongested non-peak times (e.g. a TTI of 1.3 means that it takes 1.3 times as long to get from A to B during rush hour).

We hypothesize that there is a relatively straightforward relationship between the intensity of traffic congestion in a metro area and the average peak-hour toll necessary to ensure uncongested flow on priced lanes. We make a first guess at this relationship in Figures 4 and 5 by plotting the average peak-hour, peak-direction toll charged in 2005 on the I-15 and SR 91 HOT lanes on the vertical axis and the level of congestion on the horizontal axis. If there were priced lanes in operation in other metro areas, we would be able to plot additional points on these graphs. We also assume that the market-clearing price under conditions of zero congestion is zero. By connecting these points with a line, we create a first approximation of a relationship between price and congestion.

Figure 4: Peak-Period Tolls vs. Annual Hours of Delay

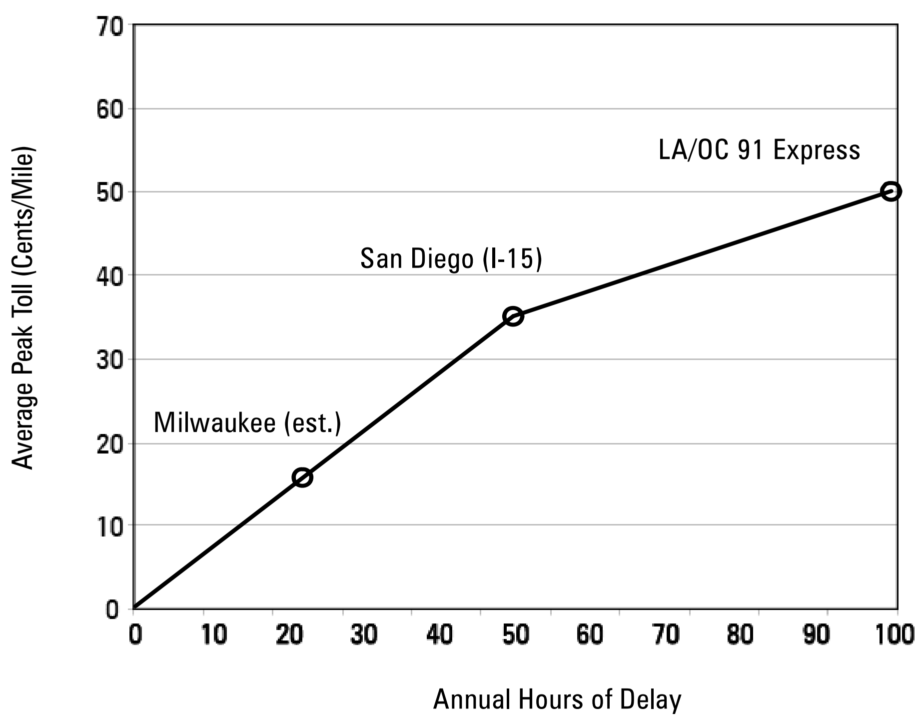
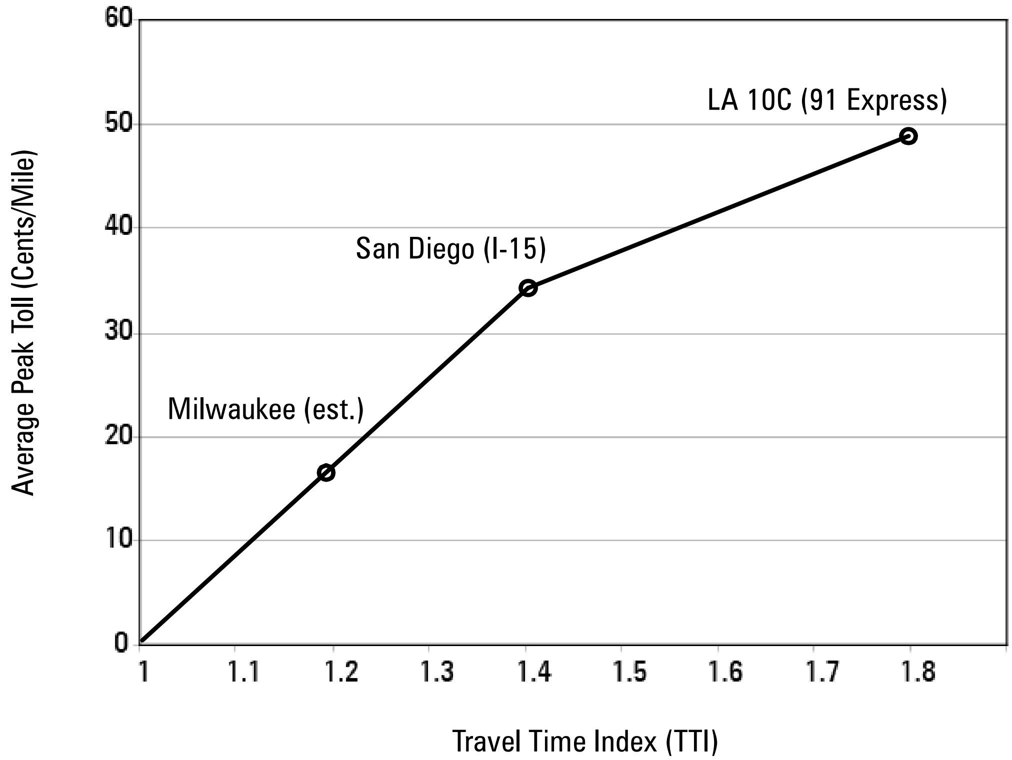


Figure 5: Peak-Period Tolls vs. Travel Time Index



With that line established on each graph, we then locate the congestion level for Milwaukee, as reported by TTI and use that to find the point on the line, in each case, that corresponds to a potential price level. This gives us 15 cents/mile in Figure 4 and 17 cents/mile in Figure 5. To be conservative, we will use the lower figure in the revenue projection which follows.

One more point must be established before moving on to the revenue projection. We have produced an estimate of the average peak-hour, peak-direction toll that would clear the market on Milwaukee FAST Lanes in 2005. But as discussed previously, the first set of FAST Lanes would not begin operating until 2013 and the second set in 2017. By that point, with higher levels of traffic in Orange County, San Diego, and Milwaukee, the market-clearing price would be higher in each case. Any detailed estimate of how much higher it would have to be is beyond the scope of this preliminary study. However, we can approximate this effect by adjusting the 2005 price by the assumed rate of inflation over the subsequent 40 years, which we take to be 3.5 percent. (The actual rate charged on any segment would vary, depending on how much time savings users would gain at a particular time. Our procedure here is intended to project the overall revenue by using an estimate of the average of these charges during peak hours.)

C. Revenue Projection

Table 6 presents the results of the revenue projection, carried out based on the assumptions discussed above. The first set of FAST Lanes is constructed during 2009-2012 and open to traffic in 2013. After inflation-adjusting the 2005 price to 2013 levels, it averages $.197/mile during peak hours in 2013. Multiplying the number of FAST Lane route-miles (33.2) by five peak hours per day times the peak-hour volume (1280) times the $.197/mile charge gives us the peak-period revenue for the average weekday during 2013. Based on 250 weekdays per year, the next column gives us total peak-period revenue for the year.

Table 6: Revenue Projection

Year	Rt-miles	Wkday FL peak vol.	Av peak toll	Peak rev/wkday	Annual peak rev	Ann. non-peak rev	Total rev
2013	33.2	1280	0.197	$41,859	$10,464,640	$3,034,746	$13,499,386
2014	33.2	1520	0.204	$51,447	$12,861,697	$3,729,892	$16,591,589
2015	33.2	1760	0.211	$61,655	$15,413,728	$4,469,981	$19,883,709
2016	33.2	2000	0.218	$72,515	$18,128,646	$5,257,307	$23,385,953
2017	59.3	1870	0.226	$125,341	$31,335,306	$9,087,239	$40,422,545
2018	59.3	2090	0.234	$144,990	$36,247,576	$10,511,797	$46,759,373
2019	59.3	2310	0.242	$165,861	$41,465,319	$12,024,943	$53,490,262
2020	59.3	2470	0.251	$183,557	$45,889,184	$13,307,863	$59,197,047
2021	59.3	2630	0.259	$202,288	$50,571,924	$14,665,858	$65,237,782
2022	59.3	2790	0.268	$222,105	$55,526,242	$16,102,610	$71,628,853
2023	59.3	2950	0.278	$243,062	$60,765,412	$17,621,969	$78,387,381
2024	59.3	3050	0.288	$260,097	$65,024,140	$18,857,001	$83,881,141
2025	59.3	3100	0.298	$273,613	$68,403,264	$19,836,946	$88,240,210
2026	59.3	3175	0.308	$290,041	$72,510,218	$21,027,963	$93,538,181
2027	59.3	3200	0.319	$302,556	$75,639,005	$21,935,311	$97,574,317
2028	59.3	3200	0.330	$313,145	$78,286,370	$22,703,047	$100,989,418
2029	59.3	3200	0.342	$324,106	$81,026,393	$23,497,654	$104,524,047
2030	59.3	3200	0.354	$335,449	$83,862,317	$24,320,072	$108,182,389
2031	59.3	3200	0.366	$347,190	$86,797,498	$25,171,274	$111,968,773
2032	59.3	3200	0.379	$359,342	$89,835,411	$26,052,269	$115,887,680
2033	59.3	3200	0.392	$371,919	$92,979,650	$26,964,098	$119,943,748
2034	59.3	3200	0.406	$384,936	$96,233,938	$27,907,842	$124,141,780
2035	59.3	3200	0.420	$398,409	$99,602,125	$28,884,616	$128,486,742
2036	59.3	3200	0.435	$412,353	$103,088,200	$29,895,578	$132,983,778
2037	59.3	3200	0.450	$426,785	$106,696,287	$30,941,923	$137,638,210
2038	59.3	3200	0.466	$441,723	$110,430,657	$32,024,891	$142,455,547
2039	59.3	3200	0.482	$457,183	$114,295,730	$33,145,762	$147,441,492
2040	59.3	3200	0.499	$473,184	$118,296,080	$34,305,863	$152,601,944
2041	59.3	3200	0.516	$489,746	$122,436,443	$35,506,569	$157,943,012
2042	59.3	3200	0.534	$506,887	$126,721,719	$36,749,298	$163,471,017
2043	59.3	3200	0.553	$524,628	$131,156,979	$38,035,524	$169,192,503
2044	59.3	3200	0.572	$542,990	$135,747,473	$39,366,767	$175,114,240
2045	59.3	3200	0.592	$561,995	$140,498,635	$40,744,604	$181,243,239

But that is not the end of the story. Experience with the 91 Express Lanes has shown a significant demand for using these lanes at non-peak periods and on weekends, even during the wee hours of the morning. Toll charges during such hours are much lower than during weekday peak hours. Revenue collected from all these non-peak hours totals 22.5 percent of the 91 Express Lanes' annual revenue. SEWRPC figures show significant weekend traffic on the freeway system. Hence, we assume a similar nonpeak/weekend factor for the proposed Milwaukee FAST Lanes. Finally, adding annual non-peak and annual peak-period revenue gives us total annual revenue.

The same basic calculations are repeated for each year of the spreadsheet. The only other factor worth noting is what changes in 2017 when the second set of FAST Lanes opens. First, the number of route-miles increases to 59.3. But the new lanes serve freeway segments that are not as highly congested as the first set of FAST Lanes. Thus, as noted previously, we assume a longer ramp-up period, and the average traffic on the entire set of FAST Lanes is the average of traffic on the older ones and on the new ones during those ramp-up years till 2027, when the entire FAST Lanes network reaches its maximum capacity.

D. Financing Capability

In traditional toll road traffic and revenue studies, toll rates are assumed to be constant for many years at a time, with only occasional increases. Thus, most growth in annual revenue is due solely to growth in the volume of traffic. Hence, revenue growth from year to year is modest. The bonding capacity can be approximated as a simple multiple of the annual revenue after a few years of initial "ramp-up" as people get used to using the toll road. Multiples used range from 8 to 12 times that steady-state annual revenue flow—i.e., if the annualized revenue is $50 million, it should be possible to issue toll revenue bonds of between $400 and $600 million.

The revenue profile of a market-priced managed lanes facility, by contrast, is steeply rising, as can be seen from Table 6. While there is too little experience with such projects to establish a reliable rule of thumb, one analysis based on toll revenue projections for four proposed large-scale value-priced projects found that the net present value (NPV) of the 40-year revenue stream was between 12 and 20 times the revenue in year 10.[16] It therefore suggested using a rule of thumb that bonding capacity could be estimated at up to 15 times the revenue projected for year 10.

Table 6 shows total revenue in the 10th year to be nearly $72 million. Multiplying that by 15 gives $1.02 billion. That is considerably more than the incremental cost of adding the FAST Lanes to this portion of the freeway system, which Table 3 showed as $565 million (in then-year dollars). It appears as if bonding the toll revenues from this set of FAST Lanes could produce twice their incremental cost of construction. That means a decision to do the fourth-laning of the inner portions of the freeway system as FAST Lanes instead of general-purpose lanes could contribute about a billion dollars toward the overall cost of the freeway reconstruction project.

We understand that there are corridor impact issues associated with the planned lane additions, particularly on I-94 between the Marquette and Zoo Interchanges. The FAST Lanes approach offers new options for addressing such impacts. Because FAST Lanes would generate revenue that can finance more than SEWRPC's estimate of the incremental cost of constructing the lanes, design alternatives that were previously regarded as unaffordable may now become financially feasible. For example, on I-94, instead of having to build all four westbound lanes in an elevated configuration so as to avoid widening the existing right of way, the two FAST lanes could be built in a tunnel underneath the existing six general-purpose lanes. This would leave the freeway at the same width as it is today, with no impact on the adjacent cemeteries and with no additional traffic noise impacting the surrounding neighborhood.

Part 5

Transit and Motorist Benefits

A. Express Bus/BRT Operations

Freeway congestion has an impact on bus travel times and severely impacts transit's time-savings competitiveness with the automobile. Since "freeway flyers" travel in the same traffic lanes as cars, automobile drivers can travel the same route in the same amount of time as an express bus, thus substantially diminishing time-related incentives to use transit as an alternative, especially since the non-freeway portion of the trip is generally non-stop for the car, but many-stop for the bus. Except for a few modest upswings in ridership (mostly related to spikes in gas prices), transit ridership has been steadily decreasing in the region over the last 25 years.

Diminishing constituencies for bus travel have led to a corresponding erosion of state and local funding commitments to transit. The Milwaukee County Transit Service (MCTS) has found itself in the unenviable position of having to continually consider service cuts and fares increases. In addition, Milwaukee County is unique when compared to its peer urban transit systems in its reliance on property taxes to pay for transit expenditures. This downward spiral due to fare hikes and service cuts illustrates the need not only to find alternate sources of funding, but also to improve transit service to attract more riders. According to SEWRPC, transit system officials over the last few years have been able to minimize the budget damage by using federal transit aid that has been carried forward from previous years. However, according to SEWRPC, those federal carryover funds will be exhausted in the next few years, after which more extensive service cuts and additional fare increases may be needed if alternate funding sources are not found. Less reliable service at a higher cost will only reduce transit's competitiveness. While transit officials explore alternate funding sources, they clearly must improve service competitiveness to arrest and begin reversing transit's continued loss of market share.

Proposals are currently under review to expand rapid transit freeway buses connecting the Milwaukee central business districts with urbanized areas of the region, as well as with the urban centers of outlying counties. In addition, a proposal is on the table for a grid of higher-speed express transit service connecting major employment activity centers located largely in Milwaukee County. The attractiveness of these new transit services will be limited if these buses are traveling in the same congested freeway lanes as automobiles. However, a system of FAST Lanes could significantly improve the operational prospects of these proposals. How FAST Lanes factor precisely into SEWRPC's long-range transit plans is beyond the scope of this study. However, there are some more immediate transit opportunities to consider.

Since pricing keeps traffic in the FAST Lanes flowing at or near the speed limit during rush hours, these lanes, in effect, would function as virtual exclusive busways (VEBs[17]). They would give the transit agency reliable, uncongested guideways on which it can operate sustainable, high-speed express bus service. The reduced bus travel times would make transit a more attractive alternative for travel to employment, educational, medical, shopping and cultural destinations in the region.

Currently, Milwaukee County Transit Service (MCTS) runs eight routes of "freeway flyers" (Routes 39, 40, 43, 44, 45, 46, 47 and 49) that could use FAST Lanes. Additionally, MCTS runs a bus route from Ozaukee County (Rte 143) and another from Waukesha County (Rte 79) that would also use FAST Lanes. There are also three university-related "UBUS"es (Rtes 40U, 44U, and 49U) that travel to and from the University of Wisconsin-Milwaukee (UWM) campus and would operate on some portion of the FAST Lanes. Very few modifications, if any, would be needed for these routes to take advantage of FAST Lanes; however, it would be crucial to ensure that appropriate on and off ramps would be available for the existing Park-Ride lots served by these routes.

Buses on these routes are now transporting approximately 4500 rides (2250 AM inbound, and 2250 PM outbound). There are 95 inbound AM trips and 96 PM outbound trips on these routes. The maximum number of trips per hour is approximately 43, which falls well within the proposed 100 vehicles per hour set aside for transit. On average, each trip would travel on 5.1 miles of FAST Lanes.

Some of the current freeway bus service is near or at full capacity; therefore, any increase in ridership would be accompanied by an increase in service. However, the stronger demand brought by greater time savings through using FAST Lanes would mean that the farebox could support a higher percentage of the costs than the service without FAST Lanes. The greatest benefit would accrue to bus routes that are running well below capacity and are threatened with elimination. The increased rider demand brought by the improved time value means that the very same service would generate new revenue without an increase in operating costs.

In addition, a review of the schedules for freeway flyers and UBUSes reveals that as many as 75 additional trips would benefit from a faster return trip to Park-Ride lots in the reverse commute direction via FAST Lanes throughout the day. This time savings could mean more frequent service for passengers without additional costs. Furthermore, allowing MCTS to access the FAST Lanes would reduce transit operating costs by cutting down on the amount of time buses spend deadheading between the stations and bus route end points. It is estimated that 200 bus trips use the freeway each weekday to reach the start or end of bus route assignments (this is the case for freeway flyers, UBUSes, as well as for many local routes). As many as 75 of these 200 trips occur during peak periods when congestion causes costly delays to the transit system.

Besides the buses operated by Milwaukee County Transit Service (MCTS), some transit trips that could also use FAST Lanes are provided by Wisconsin Coach Lines (WCL). The vast majority of WCL's transit trips utilize the I-94 corridor to downtown Milwaukee from Waukesha County. WCL runs approximately 25 inbound AM trips with another 20 or so inbound PM trips from Waukesha. As expected, WCL runs about 30 PM trips from downtown Milwaukee to Waukesha in addition to their 15 or so reverse-commute AM trips. With a handful of other routes, WCL also serves parts of Racine and Kenosha Counties. Similarly, the Washington County Commuter Express operates four routes from West Bend into downtown Milwaukee during the morning commuting hours and 6 outbound in the afternoon.

FAST Lanes would provide "freeway flyers" and other bus rapid transit routes with virtual exclusive busways to maintain reliable and sustainable high-speed service. The increased efficiency and reliability can help reverse the decline of transit service and revenue by making it more competitive with single occupancy vehicle trips.

B. Vanpools and Other Paratransit

There are other forms of shared-ride transit that could benefit from the time savings provided by a network of FAST Lanes. Taxis, dial-a-ride-vans, and vanpools all represent what some have called paratransit—forms of shared riding typically not operated by the area's mass transit agency. These modes would become more competitive with driving alone by being able to offer meaningful time savings on the core of the freeway system.

Vanpools are an especially attractive opportunity. It generally means a shared-ride van, typically organized by an employer, carrying from 8 to 15 people. Some types of priced lanes permit paratransit, as well as buses, to use the facility at no charge. But even a $4 toll spread among eight people would be only 50 cents apiece, for a much faster trip. Vanpools can meet a need for "many to one" service (a number of pickup points but terminating at a single destination workplace) more flexibly than conventional bus service.

C. Emergency Vehicles

One seldom discussed cost of freeway congestion is the greatly reduced ability of emergency vehicles (police, fire, paramedic) to get where they need to go rapidly and reliably. In responding to life-threatening emergencies, every second counts. Yet congested freeway lanes may make it impossible for these public safety vehicles to get through when they are urgently needed.

Variably priced lanes are the only known way of ensuring high-speed, free-flowing lane availability on urban freeways during rush-hour conditions. Hence, the portion of the freeway system on which FAST Lanes exist will provide a greatly improved means for emergency vehicles to reach the scene of incidents, or to get to the portion of the metro area where they need to be, in significantly less time.

D. Motorists

Most of the impetus for various forms of priced lanes around the country is coming from the driving public's demand for relief from freeway congestion. Variable pricing works by preventing the priced lanes from being overloaded with vehicles during peak times, maintaining what traffic engineers call free-flow conditions, as explained in the text accompanying the previously discussed Figure 1. To the extent that traffic increases over time, future rush-hour prices will be higher than prices in the early years. But the pricing mechanism is sustainable, long-term. What this means is that motorists can be assured that no matter how bad traffic gets, in general, they will always have a relief-valve available when they really need it.

Some have begun to call this concept "congestion insurance." Just as people purchase insurance to guard them against life's other hazards (fire, theft, accidents), with a network of FAST Lanes they will be able to purchase insurance to guard them against being late. The initial cost of this "insurance" is very low: simply the cost of opening an account and installing a transponder on the car's windshield. From that point on, the account-holder has the peace of mind that whenever she is running late and really needs to be somewhere on time, she has a means of buying that faster trip for a small price.

What kinds of trips might these be, when paying a several-dollar toll would be better than being late?

- Getting to the day care center on time, before costly per-minute late fees start to mount up;
- Getting to work on time, when the boss has said one more late arrival will be grounds for termination;
- As a tradesperson, getting one more job in that day, rather than spending the time stuck on the freeway;
- Getting to the airport on time to leave on a family vacation.

As noted previously in this report, data from the California HOT lane projects supports the premise that most people don't use these lanes twice a day, every day (which would be quite costly). Rather, the large majority of them use the lanes in the "congestion insurance" mode, once or twice a week. As we noted previously, the 91 Express Lanes in Orange County have 176,000 account-holders, but on any given day, only about 33,000 of them use the lanes. And only a small fraction of those 33,000 are every-day commuters; most are those who, on that particular day, had a trip that was worth paying several dollars for.

This is what Milwaukee motorists would gain from the development of a network of FAST Lanes on the core of the freeway system.

Part 6

Conclusions and Recommendations

The greater Milwaukee area faces two major transportation challenges in coming decades. One is to come up with the $6.2 billion needed to complete the much-needed modernization of its aging freeway system. The second is to deal with the system's worsening problems of freeway congestion and declining transit market share.

Our proposal is that transportation planners and political and business leaders embrace an approach that can help solve these problems: incorporating FAST Lanes into the freeway reconstruction. Specifically, on the core portion of the freeway system, approaching and surrounding the downtown area, the inner lanes of the rebuilt freeways should be configured and operated as variably priced FAST Lanes.

That means access to the FAST Lanes would be limited to paying autos and light trucks (pickups, SUVs, etc.), with buses and other authorized transit and emergency vehicles using the lanes at no charge. The price to use the FAST Lanes would vary with the demand to use them—higher during rush hours and much lower at other times. All tolling would be done electronically, via windshield-mounted transponders. Enforcement would make use of the transponders and video cameras.

This approach would guarantee that on the most congested portion of the freeway system, one lane in each direction would always be uncongested, thereby facilitating high-value trips such as those made by emergency vehicles, transit vehicles, and the most important trips that individual motorists absolutely need to make and arrive on time.

We estimate that the toll revenues from the FAST Lanes would be sufficient to support a revenue bond issue of about $1 billion, which would make a sizeable contribution toward the $6.2 billion cost of reconstructing the entire freeway system. And the added funding would make it more feasible to resolve neighborhood concerns in certain corridors by making it possible to consider more costly alternatives such as tunneling.

The recently enacted federal SAFETEA-LU legislation provides a program under which states are encouraged to add priced lanes to Interstate highway facilities. Under the Express Toll Lanes pilot program, up to 15 such projects may be carried out anywhere in the United States, despite the general prohibition on charging tolls on the Interstates. Thus, Congress has declared that projects such as the proposed FAST Lanes are sound transportation policy.

About the Authors

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Kevin Soucie is a consultant on transportation policy and government affairs with Soucie & Associates, based in Milwaukee. He received his B.A. in economics and political science from McGill and his M.A. in urban planning from the University of Wisconsin, Milwaukee. He was elected to three terms in the Wisconsin Assembly from 1974 through 1980, and chaired its transportation committee during his third term. He served as Director of Intergovernmental Affairs for Milwaukee County from 1989 through 1992. His transportation consulting work has encompassed freight rail, highways, and urban transit issues. He has chaired the Milwaukee City Transportation Commission and been a member of the Milwaukee City Plan Commission.

Related Reason Foundation Studies

Robert W. Poole, Jr. and Ted Balaker, *Virtual Exclusive Busways: Improving Urban Transit while Relieving Congestion*, Policy Study No. 337, September 2005.

Robert W. Poole, Jr., Peter Samuel, and Brian F. Chase, *Building for the Future: Easing California's Transportation Crisis with Tolls and Public-Private Partnerships*, Policy Study No. 324, January 2005.

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Peter Samuel and Robert W. Poole, Jr., *Putting Customers in the Driver's Seat: The Case for Tolls*, No. 274, September 2000.

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Appendix

Segment #2a						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	140,500	9835	0	0	9,835	1639
2000	142,100	9947	0	0	9,947	1658
2001	143,800	10066	0	0	10,066	1678
2002	145,400	10178	0	0	10,178	1696
2003	147,100	10297	0	0	10,297	1716
2004	148,800	10416	0	0	10,416	1736
2005	150,500	10535	0	0	10,535	1756
2006	152,200	10654	0	0	10,654	1776
2007	153,900	10773	0	0	10,773	1796
2008	155,700	10899	0	0	10,899	1817
2009	157,500	11025	0	0	11,025	1838
2010	159,300	11151	0	0	11,151	1859
2011	161,200	11284	0	0	11,284	1881
2012	163,000	11410	0	0	11,410	1902
2013	164,900	11543	0	0	11,543	1924
2014	166,800	11676	0	0	11,676	1946
2015	168,700	11809	0	0	11,809	1968
2016	170,600	11942	0	0	11,942	1990
2017	172,600	12082	1200	600	10,882	1814
2018	174,600	12222	1400	700	10,822	1804
2019	176,600	12362	1600	800	10,762	1794
2020	178,600	12502	1800	900	10,702	1784
2021	180,700	12649	2000	1000	10,649	1775
2022	182,800	12796	2200	1100	10,596	1766
2023	184,900	12943	2400	1200	10,543	1757
2024	187,000	13090	2600	1300	10,490	1748
2025	189,200	13244	2800	1400	10,444	1741
2026	191,300	13391	3000	1500	10,391	1732
2027	193,500	13545	3200	1600	10,345	1724
2028	195,800	13706	3200	1600	10,506	1751
2029	198,000	13860	3200	1600	10,660	1777
2030	200,300	14021	3200	1600	10,821	1804
2031	202,600	14182	3200	1600	10,982	1830
2032	204,900	14343	3200	1600	11,143	1857
2033	207,300	14511	3200	1600	11,311	1885
2034	209,600	14672	3200	1600	11,472	1912
2035	212,100	14847	3200	1600	11,647	1941
2036	214,500	15015	3200	1600	11,815	1969
2037	217,000	15190	3200	1600	11,990	1998
2038	219,500	15365	3200	1600	12,165	2028
2039	222,000	15540	3200	1600	12,340	2057
2040	224,600	15722	3200	1600	12,522	2087
2041	227,200	15904	3200	1600	12,704	2117
2042	229,800	16086	3200	1600	12,886	2148
2043	232,400	16268	3200	1600	13,068	2178
2044	235,100	16457	3200	1600	13,257	2210
2045	237,800	16646	3200	1600	13,446	2241

Segment #3						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	130,500	9135	0	0	9,135	1523
2000	133,000	9310	0	0	9,310	1552
2001	135,500	9485	0	0	9,485	1581
2002	138,100	9667	0	0	9,667	1611
2003	140,700	9849	0	0	9,849	1642
2004	143,400	10038	0	0	10,038	1673
2005	146,100	10227	0	0	10,227	1705
2006	148,900	10423	0	0	10,423	1737
2007	151,700	10619	0	0	10,619	1770
2008	154,600	10822	0	0	10,822	1804
2009	157,500	11025	0	0	11,025	1838
2010	160,500	11235	0	0	11,235	1873
2011	163,600	11452	0	0	11,452	1909
2012	166,700	11669	0	0	11,669	1945
2013	169,800	11886	1200	600	10,686	1781
2014	173,100	12117	1400	700	10,717	1786
2015	176,400	12348	1600	800	10,748	1791
2016	179,700	12579	1800	900	10,779	1797
2017	183,100	12817	2000	1000	10,817	1803
2018	186,600	13062	2200	1100	10,862	1810
2019	190,100	13307	2400	1200	10,907	1818
2020	193,800	13566	2600	1300	10,966	1828
2021	197,400	13818	2800	1400	11,018	1836
2022	201,200	14084	3000	1500	11,084	1847
2023	205,000	14350	3200	1600	11,150	1858
2024	208,900	14623	3200	1600	11,423	1904
2025	212,900	14903	3200	1600	11,703	1951
2026	216,900	15183	3200	1600	11,983	1997
2027	221,000	15470	3200	1600	12,270	2045
2028	225,200	15764	3200	1600	12,564	2094
2029	229,500	16065	3200	1600	12,865	2144
2030	233,900	16373	3200	1600	13,173	2196
2031	238,300	16681	3200	1600	13,481	2247
2032	242,900	17003	3200	1600	13,803	2301
2033	247,500	17325	3200	1600	14,125	2354
2034	252,200	17654	3200	1600	14,454	2409
2035	257,000	17990	3200	1600	14,790	2465
2036	261,800	18326	3200	1600	15,126	2521
2037	266,800	18676	3200	1600	15,476	2579
2038	271,900	19033	3200	1600	15,833	2639
2039	277,100	19397	3200	1600	16,197	2700
2040	282,300	19761	3200	1600	16,561	2760
2041	287,700	20139	3200	1600	16,939	2823
2042	293,200	20524	3200	1600	17,324	2887
2043	298,700	20909	3200	1600	17,709	2952
2044	304,400	21308	3200	1600	18,108	3018
2045	310,200	21714	3200	1600	18,514	3086

Segment #4						
Year	**Weekday ADT**	**Peak-hour**	**FL traffic**	**FL per lane**	**GP traffic**	**GP/lane**
1999	144,500	10115	0	0	10,115	1686
2000	146,400	10248	0	0	10,248	1708
2001	148,400	10388	0	0	10,388	1731
2002	150,400	10528	0	0	10,528	1755
2003	152,500	10675	0	0	10,675	1779
2004	154,500	10815	0	0	10,815	1803
2005	156,600	10962	0	0	10,962	1827
2006	158,700	11109	0	0	11,109	1852
2007	160,900	11263	0	0	11,263	1877
2008	163,000	11410	0	0	11,410	1902
2009	165,200	11564	0	0	11,564	1927
2010	167,500	11725	0	0	11,725	1954
2011	169,700	11879	0	0	11,879	1980
2012	172,000	12040	0	0	12,040	2007
2013	174,300	12201	1200	600	11,001	1834
2014	176,700	12369	1400	700	10,969	1828
2015	179,100	12537	1600	800	10,937	1823
2016	181,500	12705	1800	900	10,905	1818
2017	183,900	12873	2000	1000	10,873	1812
2018	186,400	13048	2200	1100	10,848	1808
2019	188,900	13223	2400	1200	10,823	1804
2020	191,500	13405	2600	1300	10,805	1801
2021	194,100	13587	2800	1400	10,787	1798
2022	196,700	13769	3000	1500	10,769	1795
2023	199,400	13958	3200	1600	10,758	1793
2024	202,000	14140	3200	1600	10,940	1823
2025	204,800	14336	3200	1600	11,136	1856
2026	207,500	14525	3200	1600	11,325	1888
2027	210,300	14721	3200	1600	11,521	1920
2028	213,200	14924	3200	1600	11,724	1954
2029	216,100	15127	3200	1600	11,927	1988
2030	219,000	15330	3200	1600	12,130	2022
2031	222,000	15540	3200	1600	12,340	2057
2032	224,900	15743	3200	1600	12,543	2091
2033	228,000	15960	3200	1600	12,760	2127
2034	231,100	16177	3200	1600	12,977	2163
2035	234,200	16394	3200	1600	13,194	2199
2036	237,400	16618	3200	1600	13,418	2236
2037	240,600	16842	3200	1600	13,642	2274
2038	243,800	17066	3200	1600	13,866	2311
2039	247,100	17297	3200	1600	14,097	2350
2040	250,400	17528	3200	1600	14,328	2388
2041	253,800	17766	3200	1600	14,566	2428
2042	257,200	18004	3200	1600	14,804	2467
2043	260,700	18249	3200	1600	15,049	2508
2044	264,200	18494	3200	1600	15,294	2549
2045	267,800	18746	3200	1600	15,546	2591

Segment #5						
Year	**Weekday ADT**	**Peak-hour**	**FL traffic**	**FL per lane**	**GP traffic**	**GP/lane**
1999	134,000	9380	0	0	9,380	1563
2000	135,700	9499	0	0	9,499	1583
2001	137,500	9625	0	0	9,625	1604
2002	139,300	9751	0	0	9,751	1625
2003	141,100	9877	0	0	9,877	1646
2004	142,900	10003	0	0	10,003	1667
2005	144,800	10136	0	0	10,136	1689
2006	146,700	10269	0	0	10,269	1712
2007	148,600	10402	0	0	10,402	1734
2008	150,500	10535	0	0	10,535	1756
2009	152,500	10675	0	0	10,675	1779
2010	154,400	10808	0	0	10,808	1801
2011	156,500	10955	0	0	10,955	1826
2012	158,500	11095	0	0	11,095	1849
2013	160,600	11242	0	0	11,242	1874
2014	162,600	11382	0	0	11,382	1897
2015	164,800	11536	0	0	11,536	1923
2016	166,900	11683	0	0	11,683	1947
2017	169,100	11837	1200	600	10,637	1773
2018	171,300	11991	1400	700	10,591	1765
2019	173,200	12124	1600	800	10,524	1754
2020	175,400	12278	1800	900	10,478	1746
2021	177,700	12439	2000	1000	10,439	1740
2022	180,000	12600	2200	1100	10,400	1733
2023	182,300	12761	2400	1200	10,361	1727
2024	184,700	12929	2600	1300	10,329	1722
2025	187,100	13097	2800	1400	10,297	1716
2026	189,500	13265	3000	1500	10,265	1711
2027	192,000	13440	3200	1600	10,240	1707
2028	194,500	13615	3200	1600	10,415	1736
2029	197,000	13790	3200	1600	10,590	1765
2030	199,600	13972	3200	1600	10,772	1795
2031	202,200	14154	3200	1600	10,954	1826
2032	204,800	14336	3200	1600	11,136	1856
2033	207,500	14525	3200	1600	11,325	1888
2034	210,200	14714	3200	1600	11,514	1919
2035	212,900	14903	3200	1600	11,703	1951
2036	215,700	15099	3200	1600	11,899	1983
2037	218,500	15295	3200	1600	12,095	2016
2038	221,300	15491	3200	1600	12,291	2049
2039	224,200	15694	3200	1600	12,494	2082
2040	227,100	15897	3200	1600	12,697	2116
2041	230,100	16107	3200	1600	12,907	2151
2042	233,000	16310	3200	1600	13,110	2185
2043	236,100	16527	3200	1600	13,327	2221
2044	239,200	16744	3200	1600	13,544	2257
2045	242,300	16961	3200	1600	13,761	2294

Segment #12

Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	137,500	9625	0	0	9,625	1604
2000	139,400	9758	0	0	9,758	1626
2001	141,400	9898	0	0	9,898	1650
2002	143,400	10038	0	0	10,038	1673
2003	145,400	10178	0	0	10,178	1696
2004	147,400	10318	0	0	10,318	1720
2005	149,500	10465	0	0	10,465	1744
2006	151,600	10612	0	0	10,612	1769
2007	153,700	10759	0	0	10,759	1793
2008	155,800	10906	0	0	10,906	1818
2009	158,000	11060	0	0	11,060	1843
2010	160,200	11214	0	0	11,214	1869
2011	162,500	11375	0	0	11,375	1896
2012	164,700	11529	0	0	11,529	1922
2013	167,000	11690	1200	600	10,490	1748
2014	169,400	11858	1400	700	10,458	1743
2015	171,800	12026	1600	800	10,426	1738
2016	174,200	12194	1800	900	10,394	1732
2017	176,600	12362	2000	1000	10,362	1727
2018	179,100	12537	2200	1100	10,337	1723
2019	181,600	12712	2400	1200	10,312	1719
2020	184,100	12887	2600	1300	10,287	1715
2021	186,700	13069	2800	1400	10,269	1712
2022	189,300	13251	3000	1500	10,251	1709
2023	192,000	13440	3200	1600	10,240	1707
2024	194,600	13622	3200	1600	10,422	1737
2025	197,400	13818	3200	1600	10,618	1770
2026	200,100	14007	3200	1600	10,807	1801
2027	202,900	14203	3200	1600	11,003	1834
2028	205,800	14406	3200	1600	11,206	1868
2029	208,700	14609	3200	1600	11,409	1902
2030	211,600	14812	3200	1600	11,612	1935
2031	214,500	15015	3200	1600	11,815	1969
2032	217,500	15225	3200	1600	12,025	2004
2033	220,600	15442	3200	1600	12,242	2040
2034	223,700	15659	3200	1600	12,459	2077
2035	226,800	15876	3200	1600	12,676	2113
2036	230,000	16100	3200	1600	12,900	2150
2037	233,200	16324	3200	1600	13,124	2187
2038	236,500	16555	3200	1600	13,355	2226
2039	239,800	16786	3200	1600	13,586	2264
2040	243,100	17017	3200	1600	13,817	2303
2041	246,500	17255	3200	1600	14,055	2343
2042	250,000	17500	3200	1600	14,300	2383
2043	253,500	17745	3200	1600	14,545	2424
2044	257,000	17990	3200	1600	14,790	2465
2045	260,600	18242	3200	1600	15,042	2507

Segment #13						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	131,000	9170	0	0	9,170	2293
2000	132,400	9268	0	0	9,268	2317
2001	133,900	9373	0	0	9,373	2343
2002	135,400	9478	0	0	9,478	2370
2003	136,900	9583	0	0	9,583	2396
2004	138,400	9688	0	0	9,688	2422
2005	139,900	9793	0	0	9,793	2448
2006	141,400	9898	0	0	9,898	2475
2007	143,000	10010	0	0	10,010	2503
2008	144,600	10122	0	0	10,122	2531
2009	146,200	10234	0	0	10,234	2559
2010	147,800	10346	0	0	10,346	2587
2011	149,400	10458	0	0	10,458	2615
2012	151,100	10577	0	0	10,577	2644
2013	152,700	10689	0	0	10,689	2672
2014	154,400	10808	0	0	10,808	2702
2015	156,100	10927	0	0	10,927	2732
2016	157,800	11046	0	0	11,046	2762
2017	159,600	11172	1800	900	9,372	2343
2018	161,300	11291	2000	1000	9,291	2323
2019	163,100	11417	2200	1100	9,217	2304
2020	164,900	11543	2400	1200	9,143	2286
2021	166,700	11669	2600	1300	9,069	2267
2022	168,500	11795	2800	1400	8,995	2249
2023	170,400	11928	3000	1500	8,928	2232
2024	172,300	12061	3200	1600	8,861	2215
2025	174,200	12194	3200	1600	8,994	2249
2026	176,100	12327	3200	1600	9,127	2282
2027	178,000	12460	3200	1600	9,260	2315
2028	180,000	12600	3200	1600	9,400	2350
2029	181,900	12733	3200	1600	9,533	2383
2030	183,900	12873	3200	1600	9,673	2418
2031	186,000	13020	3200	1600	9,820	2455
2032	188,000	13160	3200	1600	9,960	2490
2033	190,100	13307	3200	1600	10,107	2527
2034	192,200	13454	3200	1600	10,254	2564
2035	194,300	13601	3200	1600	10,401	2600
2036	196,400	13748	3200	1600	10,548	2637
2037	198,600	13902	3200	1600	10,702	2676
2038	200,800	14056	3200	1600	10,856	2714
2039	203,000	14210	3200	1600	11,010	2753
2040	205,200	14364	3200	1600	11,164	2791
2041	207,400	14518	3200	1600	11,318	2830
2042	209,700	14679	3200	1600	11,479	2870
2043	212,000	14840	3200	1600	11,640	2910
2044	214,400	15008	3200	1600	11,808	2952
2045	216,700	15169	3200	1600	11,969	2992

Segment #18						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	118,000	8260	0	0	8,260	2065
2000	120,000	8400	0	0	8,400	2100
2001	122,100	8547	0	0	8,547	2137
2002	124,100	8687	0	0	8,687	2172
2003	126,200	8834	0	0	8,834	2209
2004	128,400	8988	0	0	8,988	2247
2005	130,600	9142	0	0	9,142	2286
2006	132,800	9296	0	0	9,296	2324
2007	135,000	9450	0	0	9,450	2363
2008	137,300	9611	0	0	9,611	2403
2009	139,700	9779	0	0	9,779	2445
2010	142,000	9940	0	0	9,940	2485
2011	144,400	10108	0	0	10,108	2527
2012	146,900	10283	0	0	10,283	2571
2013	149,400	10458	0	0	10,458	2615
2014	151,900	10633	0	0	10,633	2658
2015	154,500	10815	0	0	10,815	2704
2016	157,200	11004	0	0	11,004	2751
2017	159,800	11186	1800	900	9,386	2347
2018	162,500	11375	2000	1000	9,375	2344
2019	165,300	11571	2200	1100	9,371	2343
2020	168,100	11767	2400	1200	9,367	2342
2021	171,000	11970	2600	1300	9,370	2343
2022	173,900	12173	2800	1400	9,373	2343
2023	176,800	12376	3000	1500	9,376	2344
2024	179,800	12586	3200	1600	9,386	2347
2025	182,900	12803	3200	1600	9,603	2401
2026	186,000	13020	3200	1600	9,820	2455
2027	189,200	13244	3200	1600	10,044	2511
2028	192,400	13468	3200	1600	10,268	2567
2029	195,700	13699	3200	1600	10,499	2625
2030	199,000	13930	3200	1600	10,730	2683
2031	202,400	14168	3200	1600	10,968	2742
2032	205,800	14406	3200	1600	11,206	2802
2033	209,300	14651	3200	1600	11,451	2863
2034	212,900	14903	3200	1600	11,703	2926
2035	216,500	15155	3200	1600	11,955	2989
2036	220,200	15414	3200	1600	12,214	3054
2037	223,900	15673	3200	1600	12,473	3118
2038	227,700	15939	3200	1600	12,739	3185
2039	231,600	16212	3200	1600	13,012	3253
2040	235,500	16485	3200	1600	13,285	3321
2041	239,500	16765	3200	1600	13,565	3391
2042	243,600	17052	3200	1600	13,852	3463
2043	247,700	17339	3200	1600	14,139	3535
2044	251,900	17633	3200	1600	14,433	3608
2045	256,200	17934	3200	1600	14,734	3684

Segment #19						
Year	Weekday ADT	Peak-hour	FL traffic	FL per lane	GP traffic	GP/lane
1999	158,500	11095	0	0	11,095	1849
2000	161,000	11270	0	0	11,270	1878
2001	163,600	11452	0	0	11,452	1909
2002	166,200	11634	0	0	11,634	1939
2003	168,900	11823	0	0	11,823	1971
2004	171,600	12012	0	0	12,012	2002
2005	174,300	12201	0	0	12,201	2034
2006	177,100	12397	0	0	12,397	2066
2007	180,000	12600	0	0	12,600	2100
2008	182,800	12796	0	0	12,796	2133
2009	185,800	13006	0	0	13,006	2168
2010	188,700	13209	0	0	13,209	2202
2011	191,800	13426	0	0	13,426	2238
2012	194,800	13636	0	0	13,636	2273
2013	197,900	13853	1400	700	12,453	2076
2014	201,100	14077	1700	850	12,377	2063
2015	204,300	14301	2000	1000	12,301	2050
2016	207,600	14532	2300	1150	12,232	2039
2017	210,900	14763	2600	1300	12,163	2027
2018	214,300	15001	2900	1450	12,101	2017
2019	217,700	15239	3200	1600	12,039	2007
2020	221,200	15484	3200	1600	12,284	2047
2021	224,700	15729	3200	1600	12,529	2088
2022	228,300	15981	3200	1600	12,781	2130
2023	232,000	16240	3200	1600	13,040	2173
2024	235,700	16499	3200	1600	13,299	2217
2025	239,500	16765	3200	1600	13,565	2261
2026	243,300	17031	3200	1600	13,831	2305
2027	247,200	17304	3200	1600	14,104	2351
2028	251,200	17584	3200	1600	14,384	2397
2029	255,200	17864	3200	1600	14,664	2444
2030	259,200	18144	3200	1600	14,944	2491
2031	263,400	18438	3200	1600	15,238	2540
2032	267,600	18732	3200	1600	15,532	2589
2033	271,900	19033	3200	1600	15,833	2639
2034	276,200	19334	3200	1600	16,134	2689
2035	280,700	19649	3200	1600	16,449	2742
2036	285,200	19964	3200	1600	16,764	2794
2037	289,700	20279	3200	1600	17,079	2847
2038	294,400	20608	3200	1600	17,408	2901
2039	299,100	20937	3200	1600	17,737	2956
2040	303,900	21273	3200	1600	18,073	3012
2041	308,700	21609	3200	1600	18,409	3068
2042	313,600	21952	3200	1600	18,752	3125
2043	318,700	22309	3200	1600	19,109	3185
2044	323,800	22666	3200	1600	19,466	3244
2045	329,000	23030	3200	1600	19,830	3305

Endnotes

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[1] Table 23, in *A Regional Freeway System Reconstruction Plan for Southeastern Wisconsin*,Waukesha: Southeastern Wisconsin Regional Planning Commission, May 2003.

[2] Tables 1, 2, 3, and 5 from David Schrank and Tim Lomax, *The 2005 Urban Mobility Report* (College Station, TX: Texas Transportation Institute, May 2005).

[3] Tina Collier and Ginger Goodin, "Managed Lanes: A Cross-Cutting Study," FHWA-HOP-05-037 (Washington, DC: Federal Highway Administration, November 2004).

[4] Gordon J. Fielding and Daniel B. Klein, *High Occupancy Toll Lanes*, Policy Study #170 (Los Angeles: Reason Foundation, November 1993).

[5] R. J. Zuelsdorf, E. J. Regan, et al., "I-15 Managed Lanes Project, San Diego, California, USA," Wilbur Smith Associates, paper presented at IRF Asia Pacific Roads Conference, Sydney, September 2002.

[6] Email from Jon Ramirez, Cofiroute USA, the operator of the 91 Express Lanes, Sept. 16, 2005.

[7] Chao Chen and Pravin Varaiya, "The Freeway-Congestion Paradox," *Access* (University of California Transportation Center), No.20, Spring 2002, p. 40.

[8] Patrick DeCorla-Souza and William G. Barker, "Innovative Public-Private Partnership Model for Road Pricing/BRT Infrastructure," *Public Transportation*, Vol. 8, No. 1, 2005.

[9] Robert W. Poole, Jr. and Ted Balaker, *Virtual Exclusive Busways*, Policy Study No.337 (Los Angeles, Reason Foundation, September 2005).

[10] Benjamin G. Perez and Gian-Claudia Sciara, *A Guide for HOT Lane Development* (Washington, DC: Federal Highway Administration, 2003).

[11] HNTB Corporation, "Capital Beltway High Occupancy Toll (HOT) Lanes Safety Study," May 6, 2003. It can be found as Appendix B in the overall HOT lanes proposal document, online at www.virginiadot.org/business/resources/Fluor_Capital_Beltway_HOT_Lanes_Proposal_8mb.pdf.

[12] *A Regional Freeway System Reconstruction Plan*, pp. 198-99.

[13] Toycen and Goodin, *Managed Lanes*.

[14] Toycen and Goodin, *Managed Lanes*, Map 79, p. 238.

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[15] Tom Warne and Tom Schmitt, "Design-Build Contracting for Highway Projects: A Performance Assessment," Tom Warne and Associates, LLC, May 2005 (available at www.agc-ca.org).

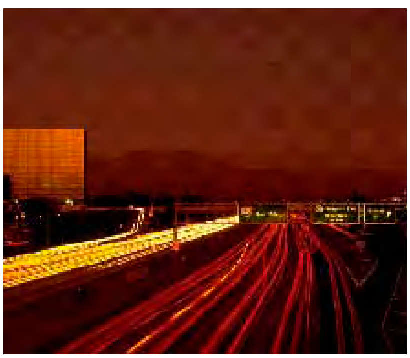
[16] Robert W. Poole, Jr. and Ted Balaker, "Design and Evaluation of Nationwide Deployment of Urban Area HOT Networks," prepared for Science and Technology Policy Institute, Institute for Defense Analysis, March 15, 2005, pp. 15-16.

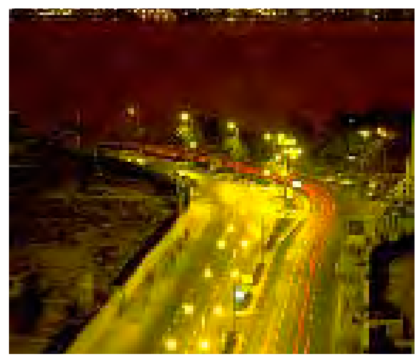
[17] Robert W. Poole, Jr. and Ted Balaker, *Virtual Exclusive Busways: Improving Transit while Relieving Congestion*, Policy Study No. 337 (Los Angeles: Reason Foundation, September 2005), www.reason.org/ps337.pdf.











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