HIGHWAY PRICING:
SOLUTION TO WASHINGTON’S TRAFFIC PROBLEMS?

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PREFACE

This report was prepared by the policy analysis workshop at the School of Public Affairs of the University of Maryland. The policy analysis workshop is a course in the master’s program of the School. Each student devotes a full semester of course work to the study of an important public policy issue. This year there were nine students with undergraduate majors ranging from civil engineering to biology to business.

The combined efforts of the students amounted to more than 1,000 hours, including review of the literature, meetings with experts, and other methods of study. The environmental section of the policy analysis workshop is supervised by Professor Robert H. Nelson of the environmental policy program of the School of Public Affairs.

The Executive Summary presents the principal findings, conclusions and recommendations. The report is available on the web under “faculty papers” and “Robert Nelson” at www.puaf.umd.edu

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EXECUTIVE SUMMARY

From 1980 to 2000, vehicle miles traveled (VMT) on U.S. highways grew by 80 percent. During the same two decades, lane miles of U.S. highways increased only four percent. The Federal Highway Administration estimates that 46 percent of the national highway system will approach or exceed capacity during peak periods in 2020 compared with 28 percent in 1998.

Problems with traffic delays and backups are particularly acute in the Washington metropolitan region. The Texas Transportation Institute recently ranked the Washington area third worst in the nation for traffic congestion, which it estimates costs the area close to $2.3 billion per year in lost productivity.

While growth in VMT is outpacing roadway capacity, funds for all modes of transportation have dwindled. The Washington area has available from existing sources only $12.2 billion of the $25.4 billion needed to pay for critical improvements in the transportation system in the next six years. In a similar situation, the area’s transit authority has available only $1.9 billion of the $4.1 billion it needs in the next six years. Like the areas’ highways, Metro is nearing capacity, is experiencing increased maintenance burdens, and lacks the funds to meet future service demands.

The Washington area needs a new approach to its transportation system. Highway pricing, if implemented properly, can be an important part of this new approach. Highway pricing can reduce congestion while supplying much needed revenue for many transportation purposes. An area-wide highway pricing system, if well planned and implemented, could also contribute to managing growth, improving air quality, and expanding public transportation options. While equity issues are raised, there are means of addressing these concerns.

This report examines various options for highway pricing that might help to solve the Washington region’s transportation crisis. The concept of highway pricing has been supported by economic theory, as first introduced by A. C. Pigou in 1920 in a seminal book, The Economics of Welfare. In 1969, the Nobel Prize-winning economist, William Vickrey, published one of the most influential works on road pricing. Vickrey asserted that the basis for charging motorists for road use should be the social costs that they impose on others and not the use of the road itself. Unregulated use of roads results in congestion; this in turn leads to social waste in terms of time spent waiting in traffic and increased car accidents. Vickrey argued that road pricing is more responsive to real time situations, imposes fewer social costs, and is less expensive to implement compared with adding road capacity.

Highway pricing is now being used or seriously considered in many parts of the world, thanks to newly available technologies such as EZ Pass and Global Positioning Systems (GPS). Some of the most successful examples include Singapore’s electronic road pricing system; London’s cordon pricing; Germany’s truck toll system; San Diego’s I-15 HOT lanes; Los Angeles’ I-91 lanes; and Trondheim, Norway’s area pricing. These
established highway-pricing systems have undergone feasibility studies, public opinion polls, cost assessments, and technology analyses. Because they have been studied and documented, these cases can provide valuable lessons for the Washington region.

However, despite the considerable amount of study and experience from around the world, specific features of the Washington area may complicate the application of similar pricing strategies here. This report identifies specific political and geographic characteristics of the Washington region that might have an impact on the success or failure of highway pricing. One particular complication is that three separate political jurisdictions—the District, Maryland, and Virginia—must work in concert to create a successful regional highway pricing system.

Building more roads will not solve the transportation problems of the Washington area; the region already has a large road network. Instead, demand for existing roads should be managed more effectively. A highway pricing system that reflects social costs can use the power of the market to manage current road capacity and to begin to create a transportation system that will keep the Washington area moving in the 21st century. A highway pricing system for both trucks and cars on certain roads and at certain times would be a good start. The revenues generated should be heavily committed to an improved and expanded public transportation system.

Specific forms of highway pricing for the Washington area that this report examines include High Occupancy Toll (HOT) lanes, Fast And Intertwined Regular (FAIR) lanes, Potomac bridge tolls, truck tolls, and GPS-based tolls.¹ The report proposes that the initial pricing efforts in the Washington area should involve the highways and bridges with the most urgent congestion problems. These include I-50, I-270, I-66, SR 267, I-95/395, I-495, the Potomac River bridges, and the Chesapeake Bay Bridge. The report makes the following recommendations:

RECOMMENDATIONS

General Recommendations Regarding Highway Pricing

- **New pricing systems should be implemented incrementally so the public will have time to adapt and to understand better the benefits of pricing.**

  **Trying a pricing system out on a short run and temporary basis may also help to increase public acceptance.**

  Gradual implementation of HOT lanes will give the public time to become familiar with the idea of regional highway pricing. Converting existing HOV lanes to HOT lanes should be the first step in a gradual evolution toward a regional network of highway pricing. A temporary pricing system, scheduled to end in 2005, is being used in Trondheim, Norway. The

¹ HOT lanes allow single occupant vehicles (SOVs) to use HOV lanes for a toll; FAIR lanes also allow SOVs to use HOT lanes for a toll, but provide credits to those who remain in general purpose lanes. These credits can be banked and used in the HOT lanes.
time limited character of the Trondheim pricing policy is contributing to public acceptance.

• **Initiate a campaign in the Washington area to educate the public about the benefits of highway pricing.** Though highway pricing has been in operation in some U.S. cities for many years, the U.S. public does not know much about the concept of highway pricing. This unfamiliarity, along with concerns about equity, the tradition of free roads, and a general reluctance to privatize a public good, will result in varying degrees of public resistance to pricing. To encourage acceptance of highway pricing, an education campaign or information program will be necessary for Washingtonians. This program should address the objections of current users of HOV lanes. They may be among the strongest opponents to HOT lanes because additional vehicles will use “their” lanes.

• **Devote a generous portion of revenues raised by highway pricing to public transportation.** A substantial portion of the revenues from highway pricing should be used to upgrade the existing Metro system (to improve tracks, repair stations, clean and upgrade cars, add more cars, etc.) and to add Bus Rapid Transit (BRT) on the converted HOV/HOT lanes. BRT would provide a regional bus system that operates like Metro rail but with the capacity to move many more people than light rail, possibly in excess of 50,000 per hour, at much less cost. Adding more BRT routes to improve access to Metro rail stations should also be funded.

Using revenues to expand Metro services and to provide a new BRT system is an important way to make highway pricing more acceptable to the Washington area public. The use of highway pricing revenues for transit should help to address equity concerns by providing more transportation options to poorer people who will not be able to afford to pay tolls every day – and who also may not be able to risk unpredictable delays in general purpose unpriced lanes.

• **Consider transportation, land use, and development decisions together for the entire Washington region.** It is important to consider the combined regional interactions among transportation and land development policies. If a policy such as highway pricing in one area will affect development or housing costs in another, the affected area should have the opportunity to participate in policy decisions. If land use and transportation decisions are considered together on a regional scale, it is more likely that highway and land planners will develop policies that will respect property rights, preserve land for agricultural and environmental purposes, and allow for affordable housing that is accessible to transportation alternatives.

• **In general, variable highway pricing according to the traffic load and time of day is preferable to fixed prices for highway use.** Variable pricing and flat fee pricing are two ways to charge for road use. Although flat fees might be used as a first step, and could raise substantial revenues, variable pricing should be the preferred policy. Variable pricing takes into account different types of
vehicles, highway congestion, and time of day, assigning higher fees to all vehicles during peak hours and perhaps charging less for fuel-efficient vehicles such as hybrids. In addition, variable pricing can be more equitable, giving motorists some flexibility to choose the time of their trip. Variable (also referred to as dynamic) pricing is a more precise way to reduce traffic congestion and thereby keep priced lanes flowing while maintaining maximum capacity.

- **Federal legislation should be enacted requiring that automobile manufacturers install GPS on all new vehicles.** Normal vehicle turnover rate takes approximately 20 years to complete, which would significantly delay universal adoption of GPS technology in new vehicles. However, a Congressional mandate requiring universal installation of GPS technology (beginning in say three years) would be an important first step in realizing any wide-scale application of highway pricing. Opponents of highway pricing argue that pricing major thoroughfares during rush hours will divert traffic into residential neighborhoods and side streets not designed to handle a large volume of traffic. However, the installation of GPS technology in every car would allow for comprehensive pricing of all road use that could be used to deter traffic from using alternate residential routes. Comprehensive highway pricing would also provide the means to implement “ozone pricing”—the charging of higher highway prices during ozone alerts for all vehicles in order to discourage driving during these periods.

**Highway Pricing in Maryland (see Chapter 2)**

Both US 50 and I-270 have underutilized HOV capacity that can be converted to FAIR lanes and HOT lanes respectively at a much lower cost than adding new roadway capacity. Priced lanes could run alongside general-purpose lanes with a small, open access median to separate the lanes. Officials have proposed adding rubber, cylindrical pylons along violation prone areas along I-270 to reduce enforcement costs and prevent cheating. This report also examines pricing options for the Chesapeake Bay Bridge during peak times of use, but further research is needed to determine the effects on bridge traffic and vacationers.

- **Implement FAIR lanes on US 50.** Dynamic peak variable pricing on existing HOV lanes on US 50 could generate $214,000 annually above operating costs and put to use the 900 peak period spaces on HOV lanes of this road that are now going unutilized. This net gain could increase to $460,000 annually if demand is at the high end of available estimates. Equity issues have not been resolved for the installation of HOT lanes alone on US 50. These are the issues that in 2001 caused former Governor Parris Glendening to terminate studies of a HOT lane for US 50. However, the establishment of “FAIR lanes” as well as HOT lanes may satisfy social equity requirements and still generate significant public revenues. Drivers in the non-HOV and more congested FAIR lanes do not pay for this road use but instead receive a credit that can be applied to any future travel in HOT lanes. The credits might go to any drivers in FAIR lanes or, alternatively might go only to certain groups of drivers such as those with annual
incomes less than a maximum amount. If FAIR lane credits were limited to drivers with incomes below say $30,000, total revenue generated from the priced lanes on US 50 might decrease by only 10 percent.

- **Implement HOT lanes on I-270.** The underutilization of existing HOV lanes on I-270 indicates that conversion to a new HOT lane would be feasible on this road. In addition, I-270 does not have the degree of equity concerns of US 50. Public opinion at present appears to be in favor of the creation of HOT lanes on I-270. The relative affluence of drivers on the corridor, compared with other areas of the state, avoids the equity concerns raised for US 50. Assuming priced lanes would use all spare capacity during peak hours and that users would be willing to pay $0.21 a mile, annual revenues could be approximately $1.25 million.

- **Conduct further research regarding highway pricing on the Chesapeake Bay Bridge to determine if it is a viable candidate for a variable pricing system for peak periods.** A Maryland Transportation Authority (MTA) study concluded that the Chesapeake Bay Bridge is not a good candidate for variable highway pricing because travel demand for the bridge is inelastic. The study concluded that a high percentage of out-of-state travelers use the bridge and that new and higher tolls at peak Friday and Sunday times would be less effective in diverting traffic because such travelers are less informed about local tolls. Further research is needed to determine if tolls beyond $8 at peak periods (the toll studied by MTA) would reduce bridge congestion. Research should also examine the possibility of using toll revenues to subsidize buses to eastern shore destinations as an alternative for those who cannot pay a toll or who prefer to avoid driving and sitting in traffic at peak periods. Such a bus service would free up road space on the bridge; any additional new revenues from variable bridge tolls could be used to help restore Chesapeake Bay.

**Highway Pricing in Virginia (see Chapter 3)**

Northern Virginia has one of the most extensive transportation networks and one of the most successful HOV systems in the country. But, like Maryland, it also faces high population growth rates and inadequate transportation revenues to keep up with growing demands. The Virginia Department of Transportation (VDOT) is studying the feasibility of new highway pricing at peak times in Northern Virginia. The Capital Beltway/I-495, I-66, SR 267 (the Dulles toll road), and I-95/395 are under consideration.

The Metropolitan Washington Council of Governments (MWCOC) has proposed for consideration a regional HOT lane network to be implemented by 2030. MWCOC’s transportation plan recommends the introduction of HOT lanes on all 70 miles of existing HOV lanes in Northern Virginia and suggests doubling the number of HOV lanes in the region for a total of 385 HOT lane miles. Other options to improve the transportation situation in Northern Virginia, have been examined in the NOVA 2020 plan, include extending Metro rail service, providing express bus service to and from principal employment areas, and building additional Virginia Regional Expressway (VRE) service stops. Together, these two plans would cost the Commonwealth $30
billion, of which only 50 percent can reasonably be expected from traditional funding sources. Highway pricing might help to ease this budget shortfall. Possible options for HOT lane conversions in Northern Virginia include.

- **Convert the 28-mile stretch of HOV3 lanes on I-95/395 to HOT lanes.** This section of HOV3 lanes on I-95/395 south of the Beltway has considerable extra capacity. The infrastructure (barrier-separated reversible lanes, existing surveillance technologies) on I-95/395 is well suited to the enforcement and monitoring of traffic, thus facilitating experimentation with a HOT lane.

- **Convert the HOV lane on I-66 to an HOT lane outside the Capital Beltway.** The 17-mile stretch of I-66 west of I-495 has a single HOV lane that is not used to full capacity and can be considered for HOT lane conversion. HOV occupancy requirements for I-66 lanes inside the beltway could be raised from HOV2 to HOV3 if experimentation with highway pricing is accepted as a goal. Public resistance to additional capacity suggests such a change would not be politically feasible, though this needs to be studied further.

- **Consider the potential for a HOT lane in addition to BRT on the Dulles Airport Access Road.** The Dulles Airport Access Road has considerable additional capacity. BRT (running more frequently and priced lower than the current buses) to and from the airport would increase use of this road. Consideration should be given to allowing non-airport SOVs to use the Access Road, if they pay a toll that would vary according to the time of day and level of traffic on the adjoining toll road.

- **Introduce higher and dynamic tolls on the Dulles Toll Road.** The Dulles Toll Road has some spare capacity on the one lane that has HOV2 restrictions during morning and evening peak commuting times. The current occupancy restrictions could be increased and made free to HOV3, with HOV2 (and possibly SOVs) having to pay a toll. Another way of managing congestion would be to introduce dynamic pricing which would vary according to traffic conditions along the tolled portion of the highway. Motorists in this corridor are already accustomed to paying a toll and much of the necessary technology infrastructure for toll collection is already in place.

**Pricing of Truck Highway Use (see Chapter 4)**

Heavy-duty trucks are responsible for a disproportionate amount of road damage, traffic, pollution, and accidents. New plans to price trucks on I-81 in Virginia will divert more trucks to the Capital Beltway, making current traffic problems in this area worse. Of the 8,000 or more heavy trucks that use the Capital Beltway each day, peak use is at noon. There is no necessary reason for so many trucks to use the beltway during these hours. Many of the costs imposed on the Washington area by trucking could be reduced by pricing and managing truck use of highways to maximize road use benefits for all vehicles.
Besides reducing truck traffic, the unpaid social costs of trucking – including accidents, air pollution, and heavy road maintenance burdens – also make highway pricing of truck use desirable. Almost all interstate trucks already have GPS and EZ Pass technologies and thus it would be relatively easy to introduce new systems of truck charging. Truck pricing could improve traffic flow, increase incentives for more efficient transport of goods in general (including shifting of truck traffic to greater use of railroad “piggyback” services over longer distances), fund public transportation, and provide revenues for other purposes.

- **If and when Virginia institutes truck pricing on I-81, the Washington region should implement variable pricing for truck use of I-95 and the Capital Beltway.** If I-81 imposes significant charges for trucks, there could be a large diversion of truck traffic to I-95 in the Washington area, unless truck pricing is also imposed on I-95. Truck pricing thus will be required simply as a protective measure. The revenues from Beltway charges for truck use should be used to fund public transportation, inter-modal goods transport, and the use of priced lanes by lower income drivers.

**Highway Pricing on the Washington Beltway (I-495) (see Chapter 5)**

The Fluor Daniel Company submitted a detailed proposal to the Virginia Department of Transportation in October 2003 to expand 14 miles of the Capital Beltway in Virginia by two lanes in each direction, separate them with a barrier, and charge a toll using an electronic collection (ETC) system. Fluor Daniel estimates that construction will cost $693 million, but that the required public share will only be 13 percent of this total cost. Maryland has recently investigated pricing options on the beltway but so far there is no unified plan from the two states for all of I-495.

- **Virginia should reject the Fluor Daniel proposal pending further intensive study of full Beltway options.** The circular nature and preponderance of shorter trips on the beltway may not preclude the feasibility of toll lanes, but it does make design more problematic. Partial construction of new lanes for limited road segments might create large future bottlenecks. Unlike other roads in the Washington region, I-495 does not have excess capacity or an HOV lane that can be easily converted into a HOT lane. Under the Fluor Daniel proposal, collected revenues will therefore be dedicated toward bond repayment for the construction of new lanes instead of increasing transportation revenues for other purposes. Research has shown that creating HOT lanes from existing lanes can generate much more revenue; this option for the Beltway should be given greater study before deciding on any overall Beltway road pricing strategy.

The effects of adding more lanes as in the Fluor Daniel proposal are still uncertain as Virginia awaits the completion of the Environmental Impact Statement. The Fluor Daniel proposal does not address how drivers will access or exit the general-purpose lanes on the beltway, which could significantly increase the risk of accidents on the Beltway. Much further research is needed
to determine whether separated HOT lanes are feasible and appropriate on I-495, and how they might best be constructed.

- **If HOT lanes are built on the Capital Beltway, a BRT system should be implemented with them.** An effective HOT lane strategy in the long run for I-495 will probably have to incorporate the entire beltway to avoid bottlenecks. It should also support alternatives to driving such as the provision of a system of Bus Rapid Transit (BRT). Buses are already widely used in the region, carrying 45 percent of total Metro system users. A BRT system is designed to provide service qualities comparable to those of rail transit but at a cost that would be considerably lower. With the capacity to move far more people than light rail (possibly more than 50,000 per hour), a BRT system that travels on HOT lanes would be able to reliably move passengers and avoid the traffic congestion that currently makes the provision of public transit on I-495 impractical.

- **Further research by Virginia and Maryland is needed to assess tolling options on I-495.** Variable pricing on the entire beltway could generate substantial revenue for other transit options on the beltway and secure high-speed routes for a BRT network without separated HOT lanes. Before deciding on a Beltway strategy, regional leaders need to commission a high level study of the many Beltway options and their advantages and disadvantages for the Washington region – including highway pricing as a main element of many of these options.

**Potomac River Bridge Tolling (see Chapter 6)**

Another way to reduce congestion by the use of highway pricing is to charge tolls for use of Potomac bridges. In addition to reducing congestion on bridges, tolls can reduce traffic inside the city. A study performed by the Regional Plan Association of New Jersey, Connecticut, and New York found that adding tolls for the tunnels and bridges across the East River in New York would reduce traffic into the city by five percent. Placing tolls on one or more of the Potomac River bridges could help reduce congestion on the tolled bridges, on I-495, and in the District.

- **In the future, if and when traffic congestion on I-495 reaches a crisis point, consider tolling the American Legion Bridge and the Woodrow Wilson Bridge simultaneously during peak periods of Beltway use.** Charging a price for the use of the American Legion Bridge and the Woodrow Wilson Bridge simultaneously may be a way to reduce overall congestion on I-495. If HOT lanes are not implemented on I-495, tolling all lanes of these two bridges could reduce Beltway congestion considerably at peak hours. If HOT lanes are implemented on I-495, these HOT lanes should be extended onto and across these two bridges to avoid creating new bottlenecks.

- **In the future, if and when traffic congestion on the Potomac River bridges crossing into Washington, D.C. reaches a crisis point, one of these bridges should be tolled.** A variable toll for peak periods on one of these bridges—the
Arlington Memorial bridge is probably the most promising—could be set to allow traffic to flow freely on that bridge. By means of such a “HOT bridge,” commuters driving into D.C. will have the option of paying a toll for reduced travel time into the city. If this bridge toll is successful, the option of tolling all Potomac River crossings into D.C. should be explored. Tolling all of the Potomac River crossings into D.C. may reduce congestion in the core of the city and provide a significant source of revenue from the same commuters who are significantly responsible for creating this congestion.

Comprehensive Highway Pricing of all Roads (see Chapter 7)

Current highway pricing schemes in the U.S. have become feasible because of the emergence of greatly improved collection technologies. Expanding use of GPS technologies will enable even more sophisticated pricing mechanisms for the use of highways.

- **Educate the public about the recent developments and innovations in transportation technology.** Despite numerous successful examples of highway pricing in different countries and in some cities in the U.S., the public remains unaware or unreceptive to the latest developments and successes of highway pricing schemes. Highway pricing in general and the latest technological innovations in particular need to be discussed in the media to initiate public debate and discussion. The more the public knows about the benefits of highway pricing technology, the more receptive drivers will be to using highway pricing to address transportation problems.

- **Develop uniform highway pricing technology.** To ensure widespread and expeditious acceptance of highway pricing technology, these technologies should be uniform across states and localities, allowing motorists to travel from state to state and from one jurisdiction within a state to another with the same collection technology. The appeal of systems like EZ Pass has grown larger as highway-pricing technologies become more and more standardized, and as electronic toll collection (ETC) has eliminated waiting times at conventional tollbooths.

- **Address privacy concerns.** When EZ Pass was first introduced in the Northeast Corridor, the “big brother” concern was often mentioned as a reason not to buy into the system. However, not long after the introduction of EZ Pass, use of the system became widely accepted as motorists quickly realized the usefulness and convenience. A system of GPS-based tolling might become widely adopted as long as motorists see the benefits. The mapping capabilities of GPS-based Geographic Information System (GIS) technologies and theft deterrence are some of the additional benefits of such technology.

Highway Pricing and Air Quality (see Chapter 8)

Cars, trucks, and buses are the area’s leading sources of the precursors to the formation of ozone, an air pollutant that has prevented the Washington area from
attaining compliance with Clean Air Act requirements. Depending on how highway pricing is implemented, it could provide a precise and low-cost tool for reducing ozone formation and improving the region's air quality.

- **Any highway pricing system needs to consider impacts on air quality.** Any pricing system that reduces vehicle miles traveled will reduce emissions of ozone precursors. Therefore, the effects of any pricing proposal on VMT are critical. For example, pricing existing lanes and adding BRT (using only clean fuel buses) should reduce VMT and would be better for air quality than building new lanes and maintaining current levels of mass transit, which would only act to increase VMT. Reduced time waiting in traffic jams as a result of highway pricing may benefit air quality and should be taken into account.

- **If a HOT lane or FAIR lane system is implemented, it should incorporate higher prices for highway use on ozone alert days as an incentive to reduce traffic then.** Highway pricing may provide a means to reduce travel on ozone alert days. With comprehensive pricing, drivers who stay at home on ozone days would receive credits on their account, while drivers who travel would find road prices increased during the period of the ozone alert. Prices could be highest in the morning, when emissions have the greatest effect on subsequent ozone formation. Higher prices for driving as well as credits for staying off the roads would help keep VMT low on ozone days.

  Metro should continue to be free on ozone days. With highway pricing revenues used to improve and expand Metro and add BRT, area commuters will have more choices and additional free travel options on ozone days as well as on “normal” days. Extra revenues collected on ozone days should be pledged to cover the costs of free Metro use.

**Highway Pricing, Land Development, and Smart Growth Opportunities (see Chapter 9)**

The use of highway pricing should be an integral part of the development of a smart growth strategy for the Washington region. The transportation system is one of the leading influences on the patterns of growth that will occur in the Washington region. The growing traffic problems of the Washington region have been a main concern in stimulating demands for new patterns of growth. Changes in highway pricing thus could also have significant consequences for achieving smarter growth in the future. This report analyzes a number of the key considerations that will have to be taken into account by land and transportation planners.

- **Consider the potential effects of highway pricing on development patterns.** Highway pricing alone may not be the primary driver of development in the Washington region, but its potential to affect development should be addressed. The peak toll paid by a commuter will be a substitute for the economic cost of sitting in traffic in general purpose lanes. This may influence some people's decisions about where to live, but it is uncertain precisely how large this influence will be.
However, localities can take advantage of new transportation options (BRT service and pricing on highways) by implementing policies (such as rezoning, Transfers of Development Rights, or priority funding) to channel development into designated areas. In fact, many localities will not have the opportunity to implement smart growth policies without the creation of new transportation options that may require pricing of highway use.

Highway pricing and BRT are efficient ways of providing new transportation services because they can be implemented together and paid for by their users rather than through general government revenues. By channeling growth along transportation corridors, localities can implement some or all of the principles of smart growth to improve the quality of life of Washington area residents and preserve the natural environment.
INTRODUCTION

The U.S. population is growing and its demand for goods and services is rising even faster. From 1980 to 2000, total vehicle miles traveled (VMT) grew by 80 percent on the U.S. highway system. During the same two decades, the lane-miles of U.S. highways increased only four percent.\(^2\) Truck VMTs have grown at an even faster rate since 1994.\(^3\) As a result, as shown in Figure 1 below, the demand of car and truck users for highway space in the United States is rapidly outpacing the supply.

![Figure 1: The demand for U.S. highway space is rapidly outpacing supply.](image)

The Federal Highway Administration (FHWA) estimates that 46 percent of the national highway system will be approaching or exceeding capacity during peak periods in 2020; compared with 28 percent in 1998.\(^4\) This problem is already particularly acute in the Washington metropolitan region, where congestion periods have become longer and more intense for many people. The Washington area ranked third worst in the nation in the annual Texas Transportation Institute study of traffic congestion.\(^5\) The average person in the Washington region in 2000 experienced 33 hours of traffic delay, costing the region close to $2.3 billion, or $631 per person.\(^6\) Other costs of traffic congestion are imposed on businesses and individuals when employees are late for work and when traffic delays further disrupt normal routines of travelers. By 2020, traffic

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\(^2\) Ibid.


\(^4\) Ibid.


\(^6\) Texas Transportation Institute, Texas A&M, Mobility Data, 2000
volumes on the Maryland capital beltway are projected to increase by 31 percent in Montgomery County and 36 percent in Prince George’s County. Unless the Washington region acts now, the highway system will increasingly be incapable of moving goods or people in the future and the region will face longer and longer periods of highway gridlock.

![Traffic Trends Graph]

**Figure 2:** Traffic delays in the Washington area have increased dramatically in the past 10 years. Source: Texas Transportation Institute at Texas A&M

The high level of traffic congestion in the Washington region also contributes to its major air pollution problem. The Washington region has exceeded the one-hour federal standard for ozone every year since 1980. On April 15, 2004, EPA designated the Washington region in non-attainment for the new 8-hour ozone standard. The region must now submit a new air quality plan to EPA in 2007 and is required to meet the new 8-hour ozone standard in 2010.

The system of financing Washington transportation is in crisis. Voters in Maryland and Virginia have refused to accept new income or sales taxes to pay for large new investments in highways or mass transit. The ability of the Washington Metro system to pay for even routine maintenance and upkeep is increasingly in doubt. According to *Time to Act: The National Capital Region’s Six-Year Transportation Capital Funding Needs, 2005-2010*, the region does not have the funds to pay for critical transportation improvements in the next six years.

The present population of the Washington region is nearly 4.0 million people, and is projected to increase by 30 percent over the next 25 years. In addition, the current number of jobs is around 2.5 million and is also projected to increase by 30 percent in 25 years. According to *Time to Act*, growth in vehicle miles of travel is outpacing growth

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7 RK&K, LLP
in roadway capacity, and the Metro system is nearing capacity because of growth in public transit use. However, only $12.2 billion of the $25.4 billion in funding needed for critical transportation improvements over the next six years will be available from existing sources. Unless something changes, badly needed transportation improvements will not be made. The most urgent problem relates to the funding of the region’s transit authority, WMATA. Of the $4.1 billion that WMATA needs over the next six years, only $1.9 billion is likely to be available from current sources.

A POTENTIAL SOLUTION

In these circumstances, it is necessary to rethink the fundamentals of the financing and operation of the transportation system in the Washington metropolitan area. Fortunately, there is a new approach that offers the promise of helping significantly to improve the transportation of individuals and of goods and services in the Washington region. It may be possible to address some of the most severe transportation problems by pricing the use of Washington-area highways.

At present, the use of Washington highways—with the single exception of the Dulles corridor—is free to automobiles and trucks. Yet, demand for highway use greatly exceeds supply at many times of the day in many places. In economic terms, a traffic jam is an imbalance of supply and demand for highway use. In most markets in the U.S. economy, a system of pricing keeps supply and demand in balance. However, such a pricing system is absent from Washington highways, with the predictable results seen every day on the roads of this region—the demand greatly exceeds the highway supply and long waits in line are required to gain access to severely congested highways.

Historically, the solution for traffic jams in the U.S. has been to expand the supply and to keep the price of highways at the traditional price of zero. While this solution has often worked temporarily, the free price has usually encouraged increased traffic, and traffic jams have eventually returned. In any case, environmental concerns and resistance from taxpayers mean it is no longer possible to build major new highways in most metropolitan areas, including the Washington region. As a result, it is necessary to turn to a new approach, demand side management, rather than the traditional efforts to increase the supply of highways. The necessary instrument of demand side management is a system of highway pricing. Under such a system, the price varies with the place and time of day, according to road supply conditions and vehicle user demand (i.e., the potential for a traffic jam in the absence of a price charged).

Highway pricing holds not only the promise of bringing traffic loads into alignment with highway capacities, but also the possibility of generating large new revenues for meeting the region’s transportation needs. Indeed, in the current fiscal climate, highway pricing may well be the only available method by which the large revenues needed to supply funds for a high quality of future Metro service and otherwise meet the transportation needs of the Washington region conceivably could be generated. Road pricing has the additional advantage of putting the burden of paying for new
transportation improvements on the actual users of the transportation system, but it must seek to do so in a way that is not unfair to the poor.

Highway pricing has been proposed by many distinguished economists in the past. However, until recently highway pricing was mainly an academic economic theory because it was impossible to collect tolls without creating more delays. Technological developments in the past fifteen years have now largely resolved that problem. Transponder reading technology and/or automated cameras that read license plates can be added to existing or new lanes to collect tolls without delaying traffic. With the newest technology, vehicles will not need to slow down to pay a toll, allowing traffic to flow at a brisk pace throughout the most congested periods. In the future, the use of GPS technology—already used in other nations to price highway use by trucks—will allow for the close monitoring of vehicle locations and accurate pricing of any highways at any particular time. With GPS technology it has become possible in concept to charge for all road use according to the time of day and the traffic condition of the road—a comprehensive system of road pricing.

“HOT” LANES

The new collection technology was pioneered in the United States in the 1990s outside the Washington region to implement new systems of peak-load highway pricing. The Federal Highway Administration has funded a number of pilot projects including two that stand out in Southern California. A third project, implemented in Houston, Texas, also has received considerable attention. These projects have involved the conversion of HOV lanes to “High Occupancy Toll” or “HOT” lanes. Under this approach, single occupancy vehicles (SOVs) are allowed to use the HOV lane—along with the already allowed HOV car poolers—if they pay a toll at peak hours.

San Diego’s I-15 offers an example of underused HOV lanes that were converted to HOT lanes. This 8.5-mile stretch of tolled roadway consists of barrier-separated reversible lanes that can be used by SOVs for a variable price that responds dynamically to congestion levels. HOV vehicles continue to travel free. Motorists are notified before the single entry point into the HOT lanes of the price at that moment. After the lanes were converted, traffic increased in the HOT lanes by 140 percent and traffic decreased in the general-purpose lanes by 10 percent. The program, called FasTrak in its full implementation phase, collects tolls electronically via transponders much like Smart Tag in Virginia and EZ-Pass throughout the Northeast Corridor. Tolls currently range from $1 to $4 depending on the level of congestion in the general-purpose lanes and the level of remaining capacity in the tolled lane. The I-15 HOT lanes currently generate around $10,000 per day (17,000 vehicles) and near $2 million annually in revenue.

9 Ibid, 890
In Los Angeles, pricing the SR-91 Express Lanes came about through a public-private partnership in 1995. Unlike the I-15 HOT lanes in San Diego, the priced lanes were entirely new capacity, built in the unused median area of an existing expressway, SR-91, so the capital costs were much greater, approximately $126 million. As a result, most of the revenues have been committed to paying the operational and construction expenses. The toll for these Express Lanes also varies with the time of day. The lanes can be used at a reduced toll by HOV3 vehicles and at full price by HOV2 and SOVs. The priced Express Lanes now carry more than 40 percent of the total vehicles on SR-91 during peak hours and continue to maintain free-flow conditions, even though they comprise only one-third of the total freeway capacity. When a lane on a highway becomes congested, traffic not only is slowed but the total lane capacity is reduced by up to 25 percent relative to free-flowing traffic. Thus, the SR-91 prices lanes not only offer much more rapid highway speeds but each priced lane of SR-91 carries a considerably larger number of cars per hour, compared with the adjacent free lanes that remain highly congested.

California’s experiences with pricing on SR-91 and I-15 provide empirical confirmation of the claims made by advocates for highway pricing. When the prices are set properly according to the level of highway user demand at a given time and place, highway pricing eliminates traffic jams and delays. The new technology for revenue collection works and does not create its own traffic problems. I-15 and SR-91 have demonstrated that highway pricing may help alleviate traffic congestion, at least in the short term.

THE WASHINGTON POLITICS OF HIGHWAY PRICING

Many transportation experts agree that highway pricing could offer benefits in managing traffic and in generating public revenues in the Washington region. Resources for the Future (RFF) states that highway pricing “is a rare policy that can raise money and make people better off while doing so.”

Among the general public, however, there is still strong resistance to the idea of pricing the use of highways. For most Washingtonians, it is an unfamiliar idea, and it means paying for something that has been thought of as being free. Drivers argue they have already paid for the construction and maintenance of the road system through their gas taxes and do not want to pay a “second time.” (In fact, gas taxes pay only about 50 percent of total highway costs.)

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There is also an equity concern. Even though driver of all economic backgrounds will be able to use newly priced highways, their use will be more affordable to the more affluent. Some people—often with lower incomes—would rather pay a “time price” by sitting in traffic than pay a money price for using a highway. In effect, their time saved from reduced traffic congestion is worth less to them than the money that they will now be asked to pay for the use of the highway. They could be losers from highway pricing. Many other people see a highway-pricing scheme as a “regressive” system of taxation. For the same use of the highway, richer people will pay a much lower proportion of their income in highway use charges. Chris Bedford of the Sierra Club states “there is a nagging suspicion that ‘solutions’ like the HOT lane proposal are really solutions for a certain class of people.” However, people with lower incomes could benefit from traffic relief on general-purpose lanes or by occasionally using priced lanes. In fact, in San Diego, people with lower incomes (less than $40,000 per year) have a higher level of support (81 percent) for the HOT lanes than those with higher incomes (more than $100,000 per year) (71 percent). Sixty-six percent of those who do not use the I-15 HOT lanes support them, while 88 percent of users do.

In 2001, the Maryland Secretary of Transportation, John D. Porcari, announced that he planned to apply for $10 million in federal grants to test the idea of highway pricing on HOV lanes in Maryland. On one of the lanes under consideration, US 50, standard HOV use (two passengers or more) would have continued, but single drivers would have been allowed to use the HOV lanes on the payment of a monthly price. Following this announcement, the Chief Executive of Prince Georges County, Wayne Curry, expressed strong opposition to highway pricing on US 50, arguing that the proposal was racist because richer citizens (who were disproportionately Caucasian) would be able to buy their way out of congestion. In the face of this argument, Governor Parris Glendening ordered a statewide halt to any further study of highway pricing, declaring “Maryland is aggressively pursuing every alternative to reduce congestion and offer Marylanders better transportation and transit. I do not believe, however, that new toll lanes should be a part of this mix of options. It is unfair to link an easier commute with a person’s ability to pay; our goal is to ease congestion for all.” Thus, according to Governor Glendening, highways in Maryland should remain free to all users.

Governor Glendening's successor, Robert Ehrlich, appears more open to the pricing of highways. (Unfortunately, the Governor hopes to spend the revenue on additional roads, something this report does not recommend.) The Maryland Department of Transportation is exploring various highway-pricing options, as described in later sections of this report. In Virginia, there historically has been a greater

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15 Katherine Shaver, “Glendening Cancels Rte. 50 Toll Lane Study.” The Washington Post. (22 June 2001), B01.
willingness to employ pricing solutions, and Virginia is also interested in highway pricing. The difficulty of obtaining transportation revenues in Virginia from other sources, such as taxes, is an important factor in the growing willingness among Virginia leaders to consider highway-pricing options.

Politically, it may be desirable to introduce highway pricing through one or more limited experiments. Starting by pricing HOV lanes at peak times for single drivers—making them “High Occupancy Toll” or “HOT” lanes—appears to be the most likely form of highway pricing in the near term. Such an approach has two advantages: it gives the public the opportunity to become more familiar with the idea, and it gives the public the opportunity to see highway pricing in operation on a limited scale. This approach has the disadvantage, however, of potentially diverting traffic to other routes that remain free. As a matter of theory, and politics aside, it would be preferable to introduce a comprehensive highway-pricing scheme that would account for the interactions among all the elements of the Washington transportation system, rather than experiment with pricing that may induce diversions to “unpriced” roads.

CONCLUSION

Historically, Maryland has had a difficult time gaining support for highway pricing alternatives. However, as congestion worsens and traditional funding for transportation projects dwindles, public support may increase. If the public changes its mind, political officials should be prepared to act. Office-holders and public officials can help by developing campaigns to improve the public’s understanding of highway pricing.

Worsening congestion on the highways in the Washington region calls for a new approach to traffic demand management. A variety of possibilities are laid out in this report. They are based on the idea of charging for the use of highways that people have not had to pay for in the past. While this will be a difficult concept for some to accept, the increasingly severe traffic jams and absence of alternatives should direct the attention of everyone in the Washington region toward transportation methods that have not been considered previously.
CHAPTER 1 – THE ECONOMICS OF HIGHWAYS

The idea of pricing highways is at least 80 years old and derives from basic theories of economics. Economics is said to be the study of the allocation of scarce resources, and highways are becoming an increasingly scarce resource. In the ideal market system, prices are the means of allocating scarce resources. It is true that a highway system has elements of a monopoly – it does not make sense to build two competing roads from one place to another. However, there are other public monopolies such as water, sewage and electricity that have long been priced. The absence of highway pricing may be attributable to the practical difficulties of metering highway use and collecting the resulting highway charges. In the past 15 years, however, new technology has largely eliminated this obstacle.

HIGHWAY PRICING THEORY

Aside from John Maynard Keynes, the leading English economist of the first half of the twentieth century was A. C. Pigou. Probably the earliest statement of the case for highway pricing appears in Pigou’s (1920) classic *The Economics of Welfare*. Pigou hypothesizes there are two roads: one is wider with greater traffic volume capacity but drivers have slow driving speed on it; the other is narrower, but in the meantime road users can sustain a higher driving speed because of the higher quality of the road. Pigou argues that without highway pricing the traffic will be distributed so that the average travel time will be the same on either road – that is the equilibrium result. However, if a tax (a price) is imposed for use of the narrower and better road, excessive traffic volume would be diverted, total travel time for all drivers would be reduced, and the welfare of society increased. Those who pay the “Pigouvian tax” enjoy faster traveling speed and less travel time, and more related governmental revenues are collected to spend on public goods.

Frank Knight was a founder of the Chicago school of economics and included among his students two Nobel Prize winning economists, George Stigler and Milton Friedman. In 1924, Knight further explored and detailed the theory of highway pricing in his analysis of the theory of social cost. After that, however, development of the theory stagnated for nearly 30 years until the idea was picked up again by economists such as Walters in Britain and Beckman et al. Mohring and Harwitz continued the

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16 P27, K.J. Button, *The economics of urban transport*, Loughborough University, Saxon House
17 Crozet Y. & Marlot G. [2001], “Congestion and road pricing: where is the “bug”?”*, 9th World Conference on Transport Research
theory with a breakthrough—a time-dependent model of traffic congestion. Crozet and Marlot\textsuperscript{22} describe the implication of their theory advancement as “these models serve as a stepping stone toward the development and understanding of more complicated and realistic time-dependent models. They also serve as a basis to the analysis of the links between optimal pricing and investment.”

In 1969, another Nobel Prize winning economist, William Vickrey, published a paper proposing a tax system for alleviating congestion and accompanied social costs, which in many aspects followed the Pigouvian analysis. In “Congestion Theory and Transport Investment,” Vickrey\textsuperscript{23} first acknowledges that more and more transportation investment is being made for the purpose of congestion relief, either on existing roads or new capacities. For clarification, Vickrey divides different congestion situations into six types: “simple interaction,” “multiple interaction,” “bottleneck,” “triggerneck,” “network and control,” and “general density.”

Vickrey then shows that it is economically the same or better for average commuters to pay a fee for using a road at the time they want without congestion, and to get to work on time, instead of leaving home earlier or later to avoid a traffic jam. The payment of the road use price in effect substitutes for the “time price” in managing the demand for road access. Moreover, while waiting in line is a pure waste of time, the revenues collected from the highway price represent pure gain in public welfare. Vickrey’s article proved to be influential in stimulating further thinking concerning the possibilities for highway pricing in a real world setting.

Vickrey disputes claims that highway pricing is inequitable, arguing that highway pricing does not adversely affect the poor to a great extent because the poor only occasionally or even rarely have to use the road in peak hours when prices are imposed. And among those who are substantially affected by a pricing system, the poorest of them could be provided assistance, possibly in the form of benefits or transport credits from employers, or by other public expenditures derived from toll revenues.

**SINGAPORE – ELECTRONIC HIGHWAY PRICING (ERP)**

Although the theory long predated it, the first successful and lasting application of the idea of highway pricing appeared in 1975 in Singapore. The Singapore highway pricing system has experienced several phases of technology and management


\textsuperscript{22} Crozet Y. & Marlot G. [2001], “Congestion and road pricing: where is the “bug”?”, *9th World Conference on Transport Research*.

strategy. The first phase was characterized by the Area Licensing Scheme (LAS) in 1975. Under the LAS system, the city’s Central Business District (CBD) (a 720-hectare restricted zone (RZ) surrounded by a ring of road, encompassing about 1.2 percent of the total area of Singapore) was designated for pricing. Motorists entering this RZ would be tolled manually during daylight working hours on weekdays and half days on Saturdays. Motorists were tolled only when they entered the RZ.

Later in the mid 1990s, the government of Singapore extended the concept of highway pricing onto three major expressways with a new system called the Road Pricing Scheme (RPS). Since then, highway pricing in Singapore has been a combination of cordon pricing and expressway pricing. It is anticipated that all expressways will be tolled in Singapore eventually, though different kinds of vehicles may be tolled with different fees.

Since tolls were initially charged manually and separately (ALS and RPS were using different license systems), disadvantages became obvious. The Singapore government searched for alternative automated schemes until 1989 when applied electronic toll collection technologies became available. Finally, a system called Electronic Road Pricing (ERP) was implemented in September 1998. The ERP system has three components: in-vehicle units (IU) with prepaid smart cash cards; ERP control points (gantries) at the same locations of ALS and RPS toll stations; and a computerized control center. The ERP incorporates additional technologies such as the Global Positioning System (GPS), which assists in turning on and off the IU of each vehicle when it accesses a gantry; videotape monitoring of all incoming vehicles; and radio-based systems. Vehicles can access tolled expressways and the restricted zone without an IU but will be charged a fine within two weeks of violation.

The ERP system is working effectively — traffic volume has decreased in the toll period by 13 percent, from 270,000 to 235,100 vehicles in the CBD per day. EPR is successful in keeping an average speed range of 45 – 65 km/h for motorists on the expressways and 20 – 30 km/h on the major roads. In addition, the violation rate remains rather low, with a rate of 0.44 percent in the first months of ERP implementation and 0.26 percent in later months. The low violation rate is believed to be the result of campaigns to educate citizens on the new system.

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24 The earliest area pricing in practice may have been in the capital city of Malta, Valletta, where a system of licensing had been in operation for a few years prior to 1977 (Button, 1978). Both Malta and Singapore have some portion of their borders by the sea. This made it easier to control entry and to implement area pricing, especially without technologies like GPS.


The Singapore example proved influential and stimulated other efforts at highway pricing. Trondheim is the third largest city in Norway with a population of 140,000. In September 1991, Trondheim began to charge a fee for cars entering the city center (toll rings) to alleviate congestion. At that time, twelve toll plazas were opened on the major roads extending to the business center, with five toll stations added later. The basic toll is designed to be affordable – equal to $1.60. Trondheim doubles the toll for cars that weigh more than 3500kg and varies tolls according to traffic patterns. There is a premium toll for peak-time motorists, while roads are free on weekends and after 6 p.m. on weekdays.

The system has been running successfully for more than 10 years and the revenues are used only for building new roads, which seems to play a vital role in justifying the tolling policy in the minds of the public. Among those who stated that their behavior had changed because of the tolls, the most common change reported was the method of transportation, with time of travel next, and a change in destination and frequency of travel the third. From 1990 to 1993, overall traffic in priced hours decreased by 10 percent and traffic during unpriced periods increased by 8 percent, which contributes to an overall decrease of traffic by 4 percent. Use of public transportation during weekdays has increased by 7 percent.

The success of the Trondheim pricing system is built on a successful government campaign to garner public support. Professionals from the Country Road Office and local politicians began discussions of the Trondheim toll ring in early 1985. The initiative was followed by a two-year public debate, coordination and negotiations with other governmental agencies, designs of different toll systems, and proposals for use of future revenues. During this time the public was given a chance to understand the necessity and urgency of alleviating congestion, air pollution, and noise pollution by cordon pricing. In the end, the majority of Trondheim residents clearly expressed their support for implementation of highway pricing.

Toll rings are also being used in the cities of Oslo and Bergen, the first and second largest cities in Norway respectively, but they do not use disincentives such as a peak-time premium charge. Elsewhere in Scandinavia, Stockholm announced in April 2004 that during the summer of 2005 it would have a two-month trial period of area pricing for motorists entering the center of the city. Prices may vary in the range equivalent to $1.30 - $2.50 in the form of dynamic pricing.\(^\text{27}\)

\section*{LONDON – CORDON PRICING}

In 2001, a leading British left-wing politician, Ken Livingstone, was elected Mayor of London, partly on the basis of a campaign to implement a Singapore-type plan in

downtown London. Livingstone’s proposal initially met with strong political opposition; as a result, he was not able to implement it until February 2003. Many British opinion leaders, including the media, were deeply skeptical.

Under the London pricing scheme, motorists must pay a charge for entering the central area of London on weekdays between 7 a.m. and 6:30 p.m. This is a one-time £5 flat fee, equivalent to $8, for per day use — with exemptions for several types of vehicles, including motorbikes, licensed taxis, buses, emergency vehicles, and certain alternative fuel vehicles. Residents living in the restricted area also receive a discount of the flat fee as high as 90 percent.

There are various payment methods including buying tickets at selected retail stores, payment machines located in the area, or at Internet payment booths, and by cell phone messaging. Motorists can also choose to buy daily tickets, or weekly (£25), monthly (£110) and annual (£1250) passes. Payment is enforced using a surveillance system of more than 700 video cameras at entrance points to downtown London. The video cameras employ optical character recognition (OCR) technology to read license plates and take pictures of each entering car. Those cars that do not pay beforehand are identified and fined.

The cordon-pricing scheme in London has been successful in reducing weekday traffic volumes by 20 percent and improving travel time by bus or taxi. About 110,000 motorists pay to enter central London every day (as compared to 1 million people entering central London in the weekday morning peak hours). Annual revenues (charges and penalties) between 2000 and 2008 are expected to be about £160 million; £60 million more than the total cost.

As a result of the London pricing scheme, congestion in the restricted area has been decreased by 30 percent, and average speeds in the area have been the highest since the 1960s. Because of its quick and obvious improvement in traffic flow, London’s pricing system quickly won the approval of London residents. Within a month of its operation, support surged, city residents living in other areas of London began requesting to include their areas, and the opposition mayoral candidate became silent on eliminating the system. One survey found that 72 percent of respondents in the city believed the pricing system is working, and 58 percent of the citizens considered that it positively affected London’s image in the world. (Only 15 percent thought the opposite.)

Following the London success, Edinburgh and Cardiff are moving ahead with plans to charge cars for transportation investment within two years. Nottingham is also planning to implement a London style pricing system in the next few years if public opinion is positive.28 Sao Paulo, Brazil is also doing a feasibility study.

28 http://www.bbc.co.uk/london/congestion/cities.shtml
CONCLUSION

The Singapore, Trondheim, London, and other cases of highway pricing around the world demonstrate that traffic congestion can be significantly reduced, enforcement is feasible, and major revenues can be gained in those contexts. Worldwide, the current trend is for more metropolitan areas to use cordon pricing for congestion relief and revenues. The World Bank is trying to persuade developing countries to implement highway pricing in metropolitan areas where economic growth and increasing car ownership are creating traffic congestion problems.

In the U.S., Manhattan considered adopting an area-wide pricing system for car access into the lower part of the Island. Thus far, however, no pricing systems similar to those in Singapore or London have been adopted in the U.S. In this country, the practical applications of highway pricing have been limited to situations where existing highway capacity was under-used or where new capacity was being added. There is no example at this point in the U.S. of charging for highway use that previously was free.

Following the successful introduction of HOT lane pricing on I-15 in San Diego, and the construction of new priced lanes in the middle of SR-91 in Los Angeles, other states have shown an interest in similar approaches. Maryland and Virginia both have studies underway to assess the viability of HOT lanes in the Washington area. There are a number of other options for introducing pricing on area highways. As elsewhere, there is strong political opposition to pricing Washington highways, but there seems to be increasing professional and public interest and a greater willingness among the involved parties to discuss highway-pricing options for the future. This report explores a number of such options for the Washington region.

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PART I – HIGHWAY PRICING OPTIONS FOR WASHINGTON
Across the U.S., High Occupancy Vehicle (HOV) lanes have been built in many major cities to encourage carpooling and decrease congestion in peak periods. Since a majority of these HOV lanes are used at less than full capacity, many experts believe the lanes are a planning failure. As congestion increases, transportation planners are exploring ways to increase HOV use. Increasingly, HOT lanes are proposed as a way to increase HOV lane use and decrease congestion. HOT lane designation allows Single Occupant Vehicles (SOVs) to pay a fee to use the HOV lane at peak times (such as 6 to 9 a.m. and 3 to 6 p.m.), while HOVs continue to use the lane for free. It is crucial to keep the HOT lane free flowing, so dynamic pricing (raising and lowering the toll according to demand) is desirable. Most HOT lane facilities have the technical capabilities (cameras, sensors, monitors, etc.) to change tolls as the HOV lane becomes more or less congested. Other than monitoring and enforcement technology, HOT lanes do not require additional construction, thereby keeping implementation costs down.

By most accounts, HOT lanes are a win-win situation. Drivers in a crunch (those who are late for work, in an emergency, etc.) and drivers who value their time more than the toll price can pay to avoid congestion. Those drivers in the general-purpose lanes also benefit as some single drivers move to the HOV lane and decrease overall congestion. Equity concerns can be addressed if toll revenues are allocated to other public purposes such as transit funding which will benefit lower income citizens and further decrease congestion. The reallocation of HOT revenues is vital to long-term congestion solutions in the Washington region. Because of the benefits of HOT lanes, officials throughout the U.S. are increasingly interested in HOT lane pilot projects. The U.S. Department of Transportation provides funding for such projects.

**HISTORY OF HOT LANES IN MARYLAND**

At the request of the General Assembly, Maryland’s Variable Pricing Feasibility Study began in 1999,29 funded by the Federal Highway Administration’s Value Pricing Pilot Program. Maryland Transportation Secretary John D. Porcari wanted “to demonstrate, test, and evaluate a broad range of market-based approaches for reducing traffic congestion in Maryland.”30 The chosen corridors for study included I-270, US 50, and the Chesapeake Bay Bridge.

As far as transportation officials were concerned, the studies – while somewhat controversial – would be completed in a timely manner. However, in June 2001 Prince

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30 Ibid.
George’s County Executive Wayne Curry vehemently objected to the US 50 HOT lane study. The US 50 HOV lane between US 301 and the Capital Beltway (where the HOT lane would run) is located in Prince George’s County, a predominantly African-American community with a lower median income than surrounding counties. At the time, County Executive Curry did not like the fact that US 50 was the number one candidate for a HOT lane, while the HOV lane on I-270 was the second choice. I-270’s HOV lane runs through Montgomery County to the Beltway, a much wealthier area than Prince George’s County.

In June 2001, Secretary Porcari said that he planned to apply for $10 million in federal grants to test the idea of HOT lanes on parts of US 50 and perhaps I-270. But when Curry expressed strong opposition, Governor Glendening disavowed any idea of highway pricing and ordered a halt to further study. His successor, Robert Ehrlich, however, appears to be more supportive, although he hopes to spend revenue on building new roads, something this paper recommends against. As congestion in Maryland increases and funding for transportation projects decreases, political support for highway pricing might increase. This chapter examines the leading HOT lane possibilities for Maryland.

**US 50 HOT LANES**

HOT lanes on US 50 would run on the HOV lanes between 301 and the Capital Beltway, about 8 miles. The HOT lanes would be in effect 24 hours a day with the same HOV restrictions. The program would be implemented with minimal physical barriers (to reduce cost) and to minimize the disruption of the existing HOV facility. HOV2 vehicles could use the HOT lane for free, but single occupancy vehicles (SOVs) would pay a fee to travel in the lane. SOVs that want to use the lane would purchase an electronic tag that would be used for enforcement purposes.

The original proposal recommended that the HOT lane use the existing 10-inch wide, white dashed line and diamond pavement marking to separate it from the general-purpose lanes to avoid extensive barrier installation or lane reconfigurations. However, none of the four existing HOT programs in the U.S. use open access strategies because it is difficult to enforce and makes the HOT/HOV lanes less efficient. Nevertheless, because of funding shortfalls, 100 HOT proposals nationwide, including facilities in Washington State, Tennessee, California, and Maryland, will use concurrent-flow, open access lanes. In an open access strategy, vehicles enter the general-purpose lanes

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31 Katherine Shaver, “Glendening Cancels Rte. 50 Toll Lane Study.” *The Washington Post.* (22 June 2001), B01.
33 Ibid. 5
34 Ibid. 2.
35 Ibid. 2
and merge across those lanes to the HOT lane. An open access system reduces steady traffic flow because of the frequent movement of drivers in and out of the HOT lane. Open access will also increase the probability of traffic collisions, injuring many and snarling traffic.

During the trial period, the HOT tolls would be in force 24 hours a day to reduce public confusion. Prices would not vary according to the time of day. Experts, however, believe that peak variable pricing is the most effective way to reduce peak congestion. According to the 2001 Proposal design, a specific number of tags would be distributed and that number could be adjusted based on demand. The tags would cost $75 a month, based on previous projects and survey data. (Surveys conducted in the I-270 corridor indicated drivers would be willing to pay $1 to 2 per trip.)

US 50’s excess HOV capacity is approximately 300 drivers per hour during peak times. Therefore, US 50 could accommodate about 900 more drivers each peak period (three hours). However, to avoid overloading the system only 700 permits would be distributed. Annual revenue generated would total $630,000. With annual operating costs at $540,000, the pilot project would be net revenue generating. Assuming the HOT lane operates at capacity, 900 drivers per peak period will pay $.21 per mile (assuming drivers travel the entire length of the facility), for eight miles for 250 days per year (excluding weekends and holidays). Dynamic pricing should increase annual revenues to $756,000. If the HOT lanes are successful and demand increases, drivers may be willing to pay more per mile. At $.30 per mile, annual revenue would be over $1 million.

The US 50 2001 proposal is a step in the right direction, although officials appear to be tentative regarding actual implementation. A partial highway-pricing scheme that fails will make already skeptical Marylanders more so and could set back highway pricing for some time. If pricing is perceived as another tax, public opinion could plummet.

While the US 50 HOV lane is located in predominantly African-American Prince George’s County, studies indicate that 60 percent of the commuters on the HOV lane originate in Anne Arundel County which is primarily Caucasian and upper-middle class. Therefore, the argument that most drivers on US 50 are disadvantaged may not be accurate. More research is needed to determine the specific demographics of US 50 users, but anecdotal evidence suggests that HOT lanes would affect Prince George’s County residents and Anne Arundel County residents nearly equally.

Many officials believe that equity concerns represent a major problem for highway pricing projects; however equity concerns can be addressed by distributing the

37 Terrance Hancock, “Traffic Demand on I-270 and US 50.” E-mail communication. 30 Mar. 2004.
revenue to benefit those users who may be priced out of the HOT lanes. Less affluent users may be forced into public transit but highway-pricing revenue can be used to improve their transit options. In Prince George’s County 12 percent of commuters already use public transit and would benefit from increased transit funding. With Anne Arundel County residents using 60 percent of the HOV capacity (and presumably 60 percent of the HOT lane capacity when completed), a successful HOT lane would essentially transfer resources from Anne Arundel County to Prince George’s County.

Because of equity concerns about the US 50 proposal, a FAIR (Fast and Intertwined Regular) lane may be more appropriate than a HOT lane. FAIR lanes are essentially HOT lanes except that users who stay in the general-purpose lanes gain credits that can be used toward tolled lanes as needed. FAIR lanes ensure that less affluent commuters are not priced out of the newly priced lanes. Freeways are separated into fast and regular lanes; fast lanes are electronically tolled, with tolls set dynamically in real time to ensure that traffic moves at the maximum allowable free-flow speed. Users of regular lanes are eligible for credits if their vehicles have electronic toll tags. Admittedly, drivers who are more affluent use HOT lanes slightly more often than less affluent commuters, but FAIR lanes ensure that during a crunch (i.e., running late, or picking up children at daycare), anyone will be able to use the HOT lane.

Projected revenue from FAIR lanes would be less than projected revenue for the US 50 HOT lane proposal, leaving fewer funds available for mass transit. If, however, only residents with an income below $30,000 are allowed to accumulate credits (where say 25 trips in the general purpose lanes equal one HOT lane trip), annual revenues would not significantly be reduced. In addition, driver accumulation can be capped at 10 free HOT lane trips, ensuring that credits are not greater than revenues. If the FAIR lanes are managed properly and traffic on them flows freely, demand will increase and revenue will be generated.

I-270 HOT LANES

The proposed HOT lanes on I-270 are similar to those proposed for US 50. There will be no physical separation between the HOT/HOV lanes and the general-purpose lanes, except at select enforcement areas. Enforcement would consist of a combination of random stationary and in-stream patrols. Tolling devices would be placed on the existing HOV lanes between I-495 and I-70. Under the proposal, HOV2 would use the lanes at no cost and SOVs would pay a fee to use the HOV lanes at peak times. Both HOV and HOT lane restrictions would be in place at peak times only. Proposed I-270 HOT lanes may be more efficient than US 50 HOT lanes because of the

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39 DeCorla-Souza
policy of imposing restrictions only at peak times. The I-270 experiment is further along than the US 50 project because of county acceptance and interest. Officials are currently conducting focus group interviews and they expect to produce a final recommendation report by the summer of 2004.

One major concern for both projects is enforcement in the absence of physical barriers to prevent movement between the HOT and general-purpose lanes. Officials recommend that tubular markers be used to prevent enforcement problems on the corridor as soon as possible. However, tubular markers present a problem for snow removal. Recently, retractable lane delineators have been developed and installed at two test sites: I-5 in San Clemente, California and I-23 on the New York Thruway in Albany. These retractors are flexible posts housed in a self-contained cartridge recessed in the roadway, which can be raised or lowered from a remote location as needed.\textsuperscript{41} Currently, these retractors are expensive, but as the technology improves they may become less expensive.

I-270 has more excess HOV capacity than US 50. The southbound HOV lane during the morning commute could absorb 500 vehicles per hour without becoming congested.\textsuperscript{42} To generate 500 vehicles per hour, the Maryland State Highway Administration could conceivably sell 1,500 permits. To prevent overloading, however, fewer than 1,500 permits should be sold. The highway administration is proposing that 1,000 permits be issued; generating enough revenue to cover system costs and increase transit funding. In Montgomery County 13 percent of the residents use public transportation, so increased revenue for public transit would benefit a large portion of the community.

The I-270 experiment would select 1,000 volunteers who commute to Rock Spring Park by auto using I-270; Rock Spring Park was selected because of its compact location and maximum HOV benefits, the history of employer involvement in transportation, and a new HOV-only ramp onto I-270.\textsuperscript{43} Each volunteer will be equipped with a portable meter that uses smart card technology to record HOT lane usage. In the beginning I-270 will not have dynamic pricing; therefore the monthly volunteer permits will cost $75. These permits will allow volunteers to use the HOV lanes everyday. Assuming dynamic pricing is implemented on the nine-mile length of the corridor, annual revenue could be around $1.25 million (comparable to revenue under the pilot permit system).

I-270 exhibits fewer equity concerns than US 50 because of the relative affluence of drivers in the area. Focus group interviews have found it has considerable support. Forty-three percent of commuters in the corridor commute to Bethesda, Rockville, and

\textsuperscript{41} MDOT, 9
\textsuperscript{42} MDOT, 12
\textsuperscript{43} KCI Technologies and Maryland State Highway Administration. \textit{Feasibility Study of Experimental HOT Lane Project on I-270}. Presentation. (Maryland: KCI Technologies, 2004), 2.
Northern Virginia; only 8 percent commute to downtown Washington, D.C.\textsuperscript{44} About 84 percent of the commuters are destined for work and 80 percent travel alone; 14.6 percent travel HOV2; 2.5 percent travel HOV3; and 1.4 percent travel HOV4.\textsuperscript{45} These travel statistics indicate that 43 percent of commuters travel to similar destinations, yet 80 percent of commuters travel alone.

Since a majority of commuters travel alone and the I-270 project may not be implemented for several years, officials should actively encourage carpooling in the corridor. Northern Virginia has extensive carpooling amenities and programs that Maryland should replicate. For example, Northern Virginia has more park-and-ride facilities and a history of a successful “slugging,” or casual carpooling program.” (Chapter 3 describes slugging in more detail.) In stark contrast, there are few (three to four) park-and-ride facilities along I-270 and slug-lines are non-existent, making carpooling much less convenient. Studies have suggested that unless carpooling is \textit{extremely} convenient and efficient, drivers will not carpool. Since Maryland is known as the “smart growth” state it is surprising that carpooling initiatives are not a priority. Maryland officials should encourage carpooling on I-270 by undertaking a “pro-carpooling” marketing campaign, building more park-and-ride facilities, and encouraging slugging. Once further data is gathered on the origins and destinations of US 50 users, a similar initiative could be implemented there.

On May 4, 2004, Maryland’s Secretary of Transportation Robert L. Flanagan announced Maryland’s intention of considering a statewide system of HOT/toll lanes. Maryland officials are collaborating with Virginia’s Department of Transportation to determine if a region-wide system of HOT/toll lanes is feasible. At this stage, Virginia plans to allow HOV2 to ride for free in these HOT/toll lanes, while Maryland plans to require HOV2 to pay for the privilege. Unless Maryland officials want to discourage carpooling, they should reconsider this issue. Carpooling is a simple way to reduce roadway wear and tear and air pollution, as well as to reduce congestion — the overall goal of HOT lanes.

Currently, the I-270 HOT lane project is at a critical stage. One consultant reported, “The project is on indefinite hold while officials weigh the benefits of staging a small-scale, controlled demonstration at selling the concept and collecting valuable use data against the risk of having the demo fail by virtue of uncontrollable weaknesses in the technology, the lane configurations, or the enforcement.”\textsuperscript{46} If I-270 is the first highway-pricing project undertaken in Maryland, it must be done correctly so the demonstration does not fail, causing Marylanders to further doubt highway pricing initiatives. The I-270 project should be the model project that demonstrates the effectiveness of HOT lane technologies while accounting for equity and environmental concerns.

\textsuperscript{44} Michelle Martin, “Traffic Patterns on I-270 and US 50.” E-mail communication. 30 Mar. 2004.
\textsuperscript{45} Ibid
\textsuperscript{46} Rich Kuzmyak, “I-270 HOT Lane Implementation.” E-mail communication. 31 Mar. 2004.
To ensure project success, the following steps should be taken. Where possible, retractable pylons should be used to separate the HOT lane from general-purpose lanes to ensure maximum congestion alleviation. In addition, rather than relying on Maryland State Police enforcement, camera technology (similar to red-light technology) should be implemented to alleviate enforcement concerns. As soon as possible, the project should be expanded beyond Rock Spring Park. In addition, revenues should be recycled into local transportation alternative programs as soon as possible.\(^{47}\)

**CHESAPEAKE BAY BRIDGE**

Every summer, vacationers traveling to the Eastern Shore spend hours waiting in traffic to cross the Chesapeake Bay Bridge. Several alternatives to reduce delays have been studied including raising tolls at peak times to spread out demand. The Bay Bridge presents a unique situation in that most summer trips are discretionary and there are no viable alternatives for getting to Ocean City from the Washington area. (There are three alternate routes, but each requires considerable time, money, and mileage.)\(^{48}\)

The traffic delay occurs because the total eastbound Bridge capacity is 2,900 vehicles per hour while US 50 (the road that approaches the eastbound bridge) has capacity of 6,000 vehicles per hour.\(^{49}\) Most trips are bound for resort areas and occur on Friday evenings, Saturdays, and Sundays during the day. Currently, tolls are collected only in the eastbound direction.

The proposed timeframe for operational highway pricing is eastbound, 3 p.m. Friday to 7 a.m. Saturday, westbound 7 a.m. to 11 a.m. Sunday, and westbound 7 p.m. to 11 p.m.\(^{50}\) In one study, peak tolls were $8, shoulder peaks (two hours before and after peaks) were $4, and off-peak tolls remained at the current $2.50.\(^{51}\) This study found that this alternative would reduce peak congestion by 10 percent and shoulder congestion by 5 percent. However, the study report concluded that the bridge is not a good candidate for highway pricing because of the inelasticity of travel behavior. In addition, a high percentage of out-of-state travelers use the bridge and highway pricing would be largely ineffective for them because they will be less informed about local tolls.\(^{52}\) The peak traffic periods in the eastbound lanes extend for up to ten hours on the weekends and drivers would have to change their travel behavior significantly.\(^{53}\)

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\(^{47}\) KCI Technologies, 4

\(^{48}\) Maryland. Department of Transportation. State Highway Administration. *DRAFT Chesapeake Bay Bridge Implementation Plan.* (Maryland: Department of Transportation, 2000), 1.

\(^{49}\) Maryland. Transportation Authority. “Congestion Pricing and Other Congestion Mitigation Measures at the Bay Bridge.” *A Report to the Maryland General Assembly.* (Maryland: Transportation Authority, 2003), 5.

\(^{50}\) MDOT, 1

\(^{51}\) MTA, 7

\(^{52}\) Richard J. Gobeille, “Chesapeake Bay Bridge Congestion Pricing Study.” *Letter to Maryland Transportation Authority* (Resubmitted 10 Nov. 2003), 3.

\(^{53}\) Ibid.
A 10 percent decrease in peak trips is not trivial and officials should reconsider highway-pricing alternatives. If the peak toll were raised to between $10 and $15, demand might be reduced by up to 20 percent. In 2002, 25 million drivers used the bridge; 42.9 percent during peak hours; and 57.1 percent during non-peak hours. If 42 percent of drivers paid the peak toll of $8.00 (for a net addition of $5.50 per driver), an additional $60 million would be generated. If the toll climbed as high as $15, $130 million would be generated. Additional revenue could be generated from increased shoulder tolls as well, but those numbers are not available. In order to offset tourist strain in the ecosystem, most of this money could be dedicated to Chesapeake Bay restoration.

New revenues of $130 million would greatly benefit the Bay; project implementation would cost very little (some information dissemination is needed, but no construction is required). In addition, users may be less resistant to increased tolls if they know most of the revenue will benefit the Bay.

Further research on pricing the Bay Bridge is needed to confirm the findings of the study mentioned previously. If pricing is ineffective in reducing delays, it should not be implemented. One possible reason it may not reduce delays is a large proportion of out-of-state travelers who will be unaware of the pricing. If implemented, highway pricing could subsidize buses so those travelers who do not want to pay the toll have an alternative. Eventually buses may have their own lane, but until then they could receive priority in the queue to avoid congestion and encourage transit use. Officials should study highway pricing on the bridge with a subsidized bus/transit system across the bridge.

CONCLUSION

Studies suggest that HOT lanes on I-270 and FAIR lanes on US 50 will likely relieve some congestion in their respective corridors and generate significant public revenue that can then be dedicated to public transit. Allocating these funds to transit will likely resolve equity concerns for lower-income residents and further relieve congestion by shifting drivers to mass transit. Incentives to carpool may also generate significant congestion relief on both roads.

Additional tolls on the Chesapeake Bay Bridge have generated opposition because of inelasticity of bridge demand. While increasing tolls will likely generate more revenue, congestion will be relieved by pricing out vacationers who cannot adjust their schedules. Providing bus service from selected points to the Ocean City area would provide a lower priced alternative for travelers. These buses would have priority for crossing the bridge. Revenues collected on the bridge, if redistributed to ecosystem protection efforts, could benefit the Chesapeake Bay and all those who rely on it for

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54 MTA, 9
sustenance and income. Before highway pricing is implemented on the bridge further research is needed to determine its full effects.

CHAPTER 2 BIBLIOGRAPHY


CHAPTER 3 – HOT LANES IN NORTHERN VIRGINIA

In Northern Virginia, the major arterial routes into D.C. all have HOV lanes. Most of these HOV lanes have, through trial and error, ended up with restrictions that allow for the highest volume and speediest traffic flow. The major north-south route, the Shirley Highway or I-95/395, requires HOV3 during peak hours, while the east-west routes I-66 and the Dulles Toll Road (SR 267) require HOV2. Every day, HOV lanes carry nearly 40,000 commuters from Northern Virginia. In some cases, HOV traffic is greater than single occupancy. And in all cases, transit and car/vanpooling exceed SOV use of the major corridors in Northern Virginia, as shown in Figure 3-1.

Despite these well-utilized alternative modes, high levels of congestion persist. Virginia is therefore actively considering pricing as a way of better managing existing facilities and planning for the future. Currently, the Virginia Department of Transportation (VDOT) monitors traffic data on I-66 and I-95 to provide estimated time travel savings to motorists who choose to use the HOV facilities. This technology can be used to estimate the benefits of HOT lane facilities, although more extensive data collection will be necessary, including measures of flow, speed, delay, distribution, and travel times on both the tolled facility and a control corridor. VDOT is already beginning to install surveillance equipment that could collect this data on I-495. Presumably such technology could also assist in enforcing HOV restrictions; this would

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58 VDOT, 9.
be a significant benefit because enforcement now depends on physical monitoring and violation rates remain high.

This chapter considers the possibilities for HOT lane conversions on Northern Virginia’s existing HOV lanes. It briefly reviews the investment so far in transportation alternatives for the region and looks at the potential equity concerns associated with allowing SOVs to use Virginia’s well-utilized carpool lanes. Substantial revenue potential is presumed if pricing were implemented on the region’s HOV lanes.

**HOT PLANNING IN NORTHERN VIRGINIA**

The Federal Highway Administration’s (FHWA) Value Pricing Pilot Program provided a half million-dollar grant to VDOT to study the feasibility of implementing highway pricing in Northern Virginia in 2003, which was augmented by a state grant of $125,000. Under consideration in the preliminary study are I-66, SR 267 on the Dulles corridor, and 1-95/395, along with the Capital Beltway/I-495. A subsequent study conducted by VDOT includes the Hampton Roads region in its assessment of transportation alternatives. Initiatives to study the possibility of highway pricing result from the basic fact that gasoline taxes and other existing revenue sources do not provide enough funding for all of Northern Virginia’s transportation needs. A referendum to increase the regional sales tax for transportation purposes failed in November of 2002, forcing public officials in Virginia to think of alternate forms of financing.

One possible solution is the Fluor Daniel proposal, submitted in June 2002 through the Virginia Public Private Transportation Act, to add HOT lanes to I-495. (The Fluor Daniel proposal is discussed in more detail in Chapter 5 of this proposal.) Recent discussions of public-private partnerships have focused on extending Metro rail service in Fairfax County to Tyson’s Corner and Dulles Airport. A third option is the implementation of highway pricing on specific roadways, either as a public or public-private venture, with the prospect of establishing a comprehensive highway pricing system in Northern Virginia.

The Metropolitan Washington Council of Governments (MWCOG) has proposed a regional HOT lane network to be implemented by 2030. MWCOG’s transportation plan would apply HOT lane facilities on all 190 miles of existing HOV lanes in the region and double the amount of HOV lanes, creating a total of 385 HOT lane miles. This ambitious plan would need to be implemented incrementally. If the plan is pursued, it is likely that the first steps in providing HOT lanes for the region will be in Northern Virginia, given VDOT’s high level of interest in highway pricing and the current extensive Northern Virginia HOV network.

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Within Northern Virginia’s extensive transportation network there are many alternatives to driving alone. In addition to carpooling, commuters can participate in vanpools or take one of the many public transit alternatives into the city. Marrying highway pricing with public transit improvements and ridesharing facilitation should be given appropriate attention in Northern Virginia. Providing revenue for improving transit and ridesharing is one way to address the equity concerns raised by highway pricing schemes. Transit and ridesharing also can address the concerns that highway pricing can actually exacerbate environmental problems. (See Chapter 8 for more information on air quality and highway pricing.)

**PRICING ON I-95/I-395**

The two barrier-separated reversible HOV lanes in the median of I-95/395 were the first of their kind in the United States. Originally established as a rapid bus transitway in 1969, the lanes were opened in 1981 to van and carpools due to chronic underutilization and increased congestion in the general-purpose lanes. The 28-mile stretch of HOV lanes still has extra capacity and transit and HOV usage could be increased, despite the fact that among HOV lanes in the Washington area, the Shirley Highway lanes boast the most active carpooling. These lanes are the only HOV3 express lanes in the Washington area. Travel-time savings on HOV lanes are in excess of one minute per mile on I-95/395 as shown in Table 3-1.

<table>
<thead>
<tr>
<th>Corridor</th>
<th>HOV Lane Speed (mph)</th>
<th>Conventional Lane Speed (mph)</th>
<th>HOV Lane Travel Time (minutes)</th>
<th>Conventional Lane Travel Time (minutes)</th>
<th>Minutes Saved with HOV</th>
<th>Minutes Saved Per Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-95/I-395 (northbound)</td>
<td>61</td>
<td>29</td>
<td>27</td>
<td>58</td>
<td>31</td>
<td>1.12</td>
</tr>
<tr>
<td>From VA 234 (Dumfries) to VA end of 14th St. Bridge - 27.6 miles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I-66 (eastbound)</td>
<td>40</td>
<td>25</td>
<td>41</td>
<td>69</td>
<td>28</td>
<td>1.02</td>
</tr>
<tr>
<td>From VA 234 Business (Manassas) to VA end of T. Roosevelt Bridge - 27.5 miles</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>VA 267/I-66 (eastbound)</td>
<td>45</td>
<td>29</td>
<td>31</td>
<td>51</td>
<td>20</td>
<td>0.80</td>
</tr>
<tr>
<td>From VA 28 to VA end of T. Roosevelt Bridge - 25 miles</td>
<td></td>
<td></td>
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</tbody>
</table>

*Table 3-1: Travel-time savings on HOV lanes on I-95/395 are greater than one minute per mile.*

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61Safirova, et al., 5.

62VDOT, 4.
Traffic volume is high on this corridor as well. Average daily commuters and through traffic approximates 70,000, though at some sections daily flows reach 200,000.\(^{63}\) As HOV3 lanes, during peak hours, the two express lanes on I-95/395 carry as many people as the four adjacent general-purpose lanes combined.\(^{64}\) Table 3-2 shows the mode share in counts and percents.

<table>
<thead>
<tr>
<th></th>
<th>SOV</th>
<th>HOV(2+)</th>
<th>Bus</th>
<th>Metro rail</th>
<th>VRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-395 Passengers</td>
<td>15,900</td>
<td>17,000</td>
<td>3,500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Percentage</td>
<td>44%</td>
<td>47%</td>
<td>10%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>I-66 Passengers</td>
<td>1,900</td>
<td>7,600</td>
<td>700</td>
<td>10,600</td>
<td>1,800</td>
</tr>
<tr>
<td>Percentage</td>
<td>8%</td>
<td>34%</td>
<td>3%</td>
<td>47%</td>
<td>8%</td>
</tr>
<tr>
<td>SR 267 Passengers</td>
<td>6,700</td>
<td>5,800</td>
<td>3,300</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Percentage</td>
<td>42%</td>
<td>37%</td>
<td>21%</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3-2: 2001 Beltway Cordon Count Mode Share, Morning Peak Summary for Major HOV Corridors

Source: MWCOG/TPB Metro Core Cordon Count, A.M. Peak Period, 1999

A recent study looking into the feasibility of reducing the I-95/395 HOV3 restriction to HOV2 resulted in a recommendation to maintain the current requirement. Although the study was conducted because of additional capacity in the HOV lanes, objections from the carpooling community helped to discourage any pilot projects for HOV2 on the Shirley Highway. Highway pricing was not considered in the privately conducted study, but pricing may be an appropriate solution to expanding the capacity of the existing HOV lanes. Carpoolers tend to object to HOT lanes,\(^{65}\) but if any experiments with HOT lanes are initiated in Northern Virginia, the infrastructure on I-95/395 lends itself better to enforcement and monitoring of traffic flows. In fact, its infrastructure resembles that of the highways in the successful highway pricing projects in Southern California. It would be possible to introduce a HOT lane system on I-95 similar to the one on I-15 in San Diego, with prices for HOT lanes varying continuously with the time of day and traffic conditions.

**PRICING ON I-66**

While all the lanes of I-66 inside the Beltway have HOV restrictions, it would be difficult to argue that these facilities are under-utilized. Although physically there is more room for additional lanes, politically it would be difficult to move forward with any plans for new construction. Originally designed to be eight to ten lanes, the portion of I-66 inside the Capital Beltway was built as four lanes because of public outcry and a


\(^{64}\) See VDOT website [http://virginiadot.org](http://virginiadot.org).

resulting political compromise. In 2003, the Virginia Commonwealth’s Transportation Board abandoned research into the feasibility of widening this part of I-66 after three years of study, suggesting that new construction would face intense political resistance.\(^{66}\)

The inner portion of I-66 is unusual in that, during peak commuter hours, the road cannot, except in the most limited circumstances, be utilized by single-occupancy vehicles (SOVs).\(^{67}\) During peak hours, all lanes traveling eastbound in the morning and westbound in the evening are HOV2. As a major artery into the center of Washington, D.C., I-66 carries at some points as many as 200,000 vehicles daily.\(^{68}\) Per HOV lane, per hour, 3,200 people on average travel on I-66 inside the beltway.\(^{69}\) That means that during peak hours, assuming 1,600 to be the equilibrium number of vehicles per lane, per hour, \(^{70}\) the lanes are at full capacity. (Table 3-3 shows HOV flows in detail.)

<table>
<thead>
<tr>
<th>HOV Facility</th>
<th>Persons</th>
<th>Direction</th>
<th>Restricted Hours A.M.</th>
<th>A.M. HOV Lane Person Movement</th>
<th>A.M. Conventional Lane Person Movement</th>
<th>A.M. Persons Per HOV Lane, Per Hour*</th>
<th>A.M. Persons Per Conventional Lane, Per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-395 North of Glebe Road</td>
<td>HOV-3</td>
<td>Northbound</td>
<td>6:00 - 9:00</td>
<td>22,500 (2 lanes)</td>
<td>26,400 (4 lanes)</td>
<td>3,800</td>
<td>2,200</td>
</tr>
<tr>
<td>I-95 North of Newington</td>
<td>HOV-3</td>
<td>Northbound</td>
<td>6:00 - 9:00</td>
<td>12,200 (2 lanes)</td>
<td>16,500 (4 lanes)</td>
<td>2,000</td>
<td>1,400</td>
</tr>
<tr>
<td>I-66 - Inside Beltway East of I-495; HOV only</td>
<td>HOV-2</td>
<td>Eastbound</td>
<td>6:30 - 9:00</td>
<td>15,800 (2 lanes)</td>
<td>N/A</td>
<td>3,200</td>
<td>N/A</td>
</tr>
<tr>
<td>I-66 - Outside Beltway W. of I-495</td>
<td>HOV-2</td>
<td>Eastbound</td>
<td>5:30 - 9:30</td>
<td>9,100 (1 lane)</td>
<td>17,100 (3 lanes)</td>
<td>2,300</td>
<td>1,400</td>
</tr>
<tr>
<td>I-267- Dulles Toll Road West of Rt. 7</td>
<td>HOV-2</td>
<td>Southbound</td>
<td>6:30- 9:00</td>
<td>6,000 (1 lane)</td>
<td>13,600 (3 lanes)</td>
<td>2,400</td>
<td>1,800</td>
</tr>
</tbody>
</table>

*Table 3-3: Person Carrying Capacity Comparison for HOV and General-Purpose Lanes, 1999


\(^{66}\) See the Northern Virginia Transportation Alliance at [http://www.nvta.org](http://www.nvta.org).

\(^{67}\) Exceptions include motorcycles, vehicles with clean-fuel plates (hybrid cars), emergency vehicles, and traffic traveling to and from Dulles Airport. See [http://virginiadot.org](http://virginiadot.org).

\(^{68}\) VDOT, Average Daily Traffic Volumes.


\(^{70}\) This is widely accepted as the optimal traffic volume in transportation economics and engineering. See for example, Arthur O’Sullivan, [Urban Economics](http://www.thinkoutsidethecar.org/transit/hov_use/person_carrying_capacity.htm), (Boston, MA: Irwin-McGraw Hill, 2003).
Table 3-4 shows that for travel during peak hours the HOV lanes on I-66 provide one minute per mile savings on average compared to the best alternative route.

<table>
<thead>
<tr>
<th>Corridor</th>
<th>HOV Lane Speed (mph)</th>
<th>Convention Lane Speed (mph)</th>
<th>HOV Lane Travel Time (minutes)</th>
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<td>29</td>
<td>31</td>
<td>51</td>
<td>20</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Table 3-4: Time Savings on HOV Lanes in Northern Virginia (Mean A.M. Peak)\(^71\)

Inside the Beltway, the HOV lanes can save as much as two minutes per mile, as compared to parallel routes. \(^72\)

In terms of I-66’s potential for high-occupancy toll or HOT lane conversion on lanes inside the Beltway, Patrick DeCorla-Souza of FHWA suggests that “HOV occupancy requirements could be raised back to the original HOV3 requirement, and HOV2 and SOV use could be permitted with payment of a peak service charge.”\(^73\) This suggestion should be studied further because such a scheme probably would not cause a significant increase in vehicles on I-66 during peak hours, but it might get some of the traffic off the road during off-peak hours, when congestion can be at its worst. A model simulation conducted by Resources for the Future evaluates the effects of a $0.20 per-mile HOT lane policy in Northern Virginia and estimates that “a driver [currently] using only the general lanes of I-66 and side roads in the morning between the northwestern part of Fairfax County and downtown D.C. will save on average nearly four minutes a day, or 17 hours annually.”\(^74\)

Although congestion concerns may seem greatest on the inner part of I-66 because of the HOV2 restrictions and limited lanes, discussions to increase capacity on I-66 currently focus on the lanes outside of the Beltway. At its busiest sections, I-66...
outside of and around the Capital Beltway sees a total of 190,000 vehicle trips. Outer I-66 currently has a single concurrent HOV lane in addition to general-purpose lanes. The HOV lane is not used to full capacity and could be considered for HOT lane conversion on the 17-mile stretch of I-66 west of I-495. A Major Investment Study (MIS) for I-66 considers adding a general-purpose lane in each direction of I-66, converting the existing HOV lane to general purpose and adding two-barrier separated reversible HOV lanes from I-495 to US Route 15 in Prince William County. The MIS also includes plans for rapid bus service and extended Metro rail service. The new HOV lanes would provide an opportunity to implement highway pricing on I-66.

PRICING ALONG THE DULLES CORRIDOR

The 14-mile Dulles Toll Road (State Route 267) consists of local tolled facilities adjacent to toll-free lanes for motorists traveling to and from Dulles International Airport. Opportunities exist to increase the tolls on SR 267, to implement variable pricing on the tolled lanes, and/or to allow non-airport traffic to use the now-free lanes for a toll.\textsuperscript{75} Currently, motorists on the limited access lanes pay a modest toll (about $0.75) that varies slightly by distance traveled and by number of axles of the vehicle. Motorists can use the Smart Tag electronic toll program to minimize delay in toll collection. HOV2 restrictions exist on only one lane of SR 267 between the hours of 6:30 and 9:00 a.m. traveling eastbound and between 4:00 and 6:30 p.m. traveling westbound. Like traffic going to and from the airport on I-66, traffic traveling on the Dulles Access Road has no occupancy restriction. SR 267 is also a frequently traveled route in Northern Virginia, with the busiest sections seeing daily traffic of up to 60,000 vehicles.\textsuperscript{76}

Additional capacity is currently available on the carpool lane of the Dulles Toll Road with the current HOV peak-hour flow equal to 1,200 vehicles. The Airport Access Road has considerable current spare capacity as well. One of the alternative modes discussed in the Dulles Corridor Major Investment Study (DCMIS), currently underway, is to designate one of the lanes on the access road for buses. Bus rapid transit and extension of the Metro rail are the two major alternatives under consideration in the DCMIS, but attention is also being given to the spare capacity on the corridor for conventional vehicles. One lane on the Access Road could also be used to demonstrate a HOT lane project in addition to providing reliable trip times for riders of express buses to and from the airport. However, it may be preferable to introduce a variable pricing scheme along the tolled portion of the highway where motorists are already accustomed to paying a toll and where much of the necessary technology already exists for enforcement. The current carpool lane could be changed to HOV3 with free access, where HOV2 and SOV could be charged a higher toll to use the express lane over the adjacent tolled lanes. An increase in the toll rates as they already are on SR 267 would be necessary to provide greater incentives for carpooling if highway pricing were introduced on this route.

\textsuperscript{75} DeCorla-Souza, 2004; VDOT.  
\textsuperscript{76} VDOT, Average Daily Traffic Volumes.
Rough estimates of the revenue potential from a highway pricing scheme on all of the above mentioned roads, assuming a $0.30 per mile toll, are considered below. Using only existing capacity and converting HOV lanes to HOT lanes, the 17 miles of I-66 outside the Beltway could generate nearly $14,000 per day (1,600-1,150 vehicles x $0.30 x 17mi x 6 hours) or $3.6 million per year. If the average driver on I-95 travels 15 miles during peak hours, then a congestion toll could generate as much as $45,000 per day (1,600-700 vehicles x $0.30 x 15mi x 2 lanes x 5.5 hours) or $11.6 million annually. And finally, a HOT lane on both the Dulles Toll and the Airport Access Road running the full 14 miles could produce $17,000 per day (1,600-1,200 vehicles x $0.30 x 14mi x 2 lanes x 5 hours) or $4.4 million annually. A more sophisticated model may predict significantly more revenue. For example, in their study of a $0.20 per mile HOT lane policy on the existing HOV lanes in Northern Virginia (I-66 inside and outside the Beltway, I-95/I-395, SR 267), Resources for the Future estimates revenue in the amount of $34 million annually.\footnote{Safirova, et al., 7. They estimate $40 million in government revenue per year, but acknowledge that this does not include a 15% cost associated with toll collection.}

Table 3-5 shows potential revenue from pricing the three main highways in Northern Virginia would be nearly $20 million annually.

<table>
<thead>
<tr>
<th></th>
<th>Toll</th>
<th>Miles</th>
<th>Peak Hours</th>
<th>Lanes</th>
<th>Capacity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-66 (outside Beltway)</td>
<td>$0.30</td>
<td>17</td>
<td>6</td>
<td>1</td>
<td>450</td>
<td>$3.6 million</td>
</tr>
<tr>
<td>I-95</td>
<td>$0.30</td>
<td>15</td>
<td>5.5</td>
<td>2</td>
<td>900</td>
<td>$11.6 million</td>
</tr>
<tr>
<td>SR 267</td>
<td>$0.30</td>
<td>14</td>
<td>5</td>
<td>2</td>
<td>400</td>
<td>$4.4 million</td>
</tr>
</tbody>
</table>

*Table 3-5: Potential Revenue from Highway Pricing in Northern Virginia*

**CARPOOLING, PUBLIC PERCEPTION, AND EQUITY CONCERNS**

Although there is real potential for tolling spare capacity, the 70 miles of HOV lanes in Northern Virginia tend to be well utilized as compared to other carpool lanes. This raises the question of whether or not converting existing HOV lanes to HOT lanes would be the best option among the various transportation plans VDOT is considering. The 2020 Plan, the comprehensive plan forwarded by the Transportation Coordinating Council of Northern Virginia in 1999, makes no mention of highway pricing, and the FHWA-funded highway pricing pilot study currently underway has not identified priority roadways for implementation in Northern Virginia outside of the Capital Beltway proposal from Fluor Daniel. One equity concern that might arise if HOT lanes were to

\footnote{A $.30 per mile toll is considered as an average of what should be a variable toll by traffic conditions.}
be implemented in Northern Virginia is not primarily economic or geographic, but rather concerns those who have already invested in carpooling who may lose from HOT lane implementation. Carpoolers would lose if one of their members drops out, preferring to pay the toll instead of carpooling, or if HOT lanes cause increased congestion. This is of particular concern in Northern Virginia, where people carpool not only in the conventional manner in large numbers, but also in an informal but sophisticated carpooling program.

Slug lines, as they are affectionately named, involve specified pick up and drop off locations near park-and-ride lots (and work destinations) where people literally queue up to catch a ride from strangers. Also called slugging, this form of casual carpooling is unique to the Washington area. Supposedly, slug lines have existed as long as HOV restrictions have. The majority of slugging is still concentrated around the Shirley Highway, where the first HOV lanes in the nation were constructed, and pick ups occur at a large number of park-and-ride lots along the corridor. New lines are forming for motorists on the Dulles Corridor, including in the Herndon/Reston and Centreville areas. Researchers at Resources for the Future predict that “a HOT lane policy may pose a threat to slug lines by reducing the speeds on the HOT lanes and by reducing the number of drivers willing to pick up slugs, possibly leading to a complete deterioration of the slug line system.” Environmentalists who oppose highway pricing often cite decreased carpooling as one of their major concerns. Therefore, any analysis of the best candidate corridors for HOT lane implementation in Northern Virginia should consider the impact on motorists who use casual carpooling and the associated equity implications.

To overcome public resistance to highway pricing in Northern Virginia, much work must be done. Björn Hårsman, in reviewing the Norwegian experience with highway pricing, speaks of “the necessity of political negotiations across layers of government” and “a long process of actions and interactions” prior to implementation of a highway-pricing scheme that must be considered. Hårsman considers perceived effectiveness, the allocation of toll revenues along with equity, severity of congestion, and availability of alternatives. In designing a highway-pricing scheme in Northern Virginia, therefore, extensive communication with the public prior to any introduction of highway pricing will be of the utmost importance.

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79 Most commuters in Virginia are traveling from home to work within Virginia, according to the I-66 MIS. Also, the 2000 Census shows that Fairfax and Loudoun Counties are among the three richest in the nation.
81 Safirova, et al., 5.
82 “Specific attention will be given to the issue of who pays and who benefits so that equity implications can be adequately addressed.” VDOT, 10.
CONCLUSION

Northern Virginia’s successful HOV network puts it in a different position for the implementation of HOT lanes than in San Diego or Houston, where HOV lanes were more underutilized. As new lanes are constructed in Northern Virginia, highway pricing should be seriously considered. In the meantime, I-95, SR 267, and I-66 west of I-495 have HOV lanes that are not yet operating at their full capacity. All three of these highways should continue to be considered seriously for implementation of highway pricing by the Virginia Department of Transportation. At a time when the population of Northern Virginia is increasing and when transportation planners struggle for funding; the tolling of SOV and HOV2 on existing as well as new capacity becomes an attractive alternative to new taxes or serious deficits.

The fact that the HOV lanes on I-95/395 are currently barrier-separated rather than the concurrent flow lanes on I-66 and SR 267, along with their higher revenue potential due partly to current HOV3, suggests that this highway may provide the best opportunity for a demonstration highway pricing project in Northern Virginia. However, because of the impressive rates of carpooling, both conventional and casual, substantial marketing efforts will have to be made to overcome public aversion to such a project on this corridor. Focus group discussions, the engagement of key stakeholders, and positive media coverage can help generate public support for highway pricing, as experience with the projects in California and Houston attests. Such revenues might help to ease the budget shortfall expected in the 2020 Plan and the regional long-range transportation plan. The major investment studies underway in these corridors should seriously consider the feasibility of implementing highway pricing as a way of giving motorists more choice and of using the spare capacity that currently exists on Northern Virginia’s HOV lanes.

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Another way to begin using pricing to solve transportation problems in the Washington, D.C. region would be to price large trucks. Heavy-duty trucks are responsible for a disproportionate amount of traffic congestion, pollution, road damage, and harm to people. Of the 8,000 or more heavy trucks that use the Capital Beltway each day, peak use is at noon.\textsuperscript{85} There is no compelling reason that so many trucks need to share the road with cars during these peak hours causing pollution, delay, accidents, and death. It works poorly for truckers, poorly for commuters, and for the region.

New plans to price trucks on Interstate 81 in Virginia will divert many trucks to the Capital Beltway, making current problems worse. Without a change, the problems heavy-duty trucks cause on Washington area roads will only worsen in the years to come, as shown in Figures 4-1 and 2 on the next page, based on the latest projections of traffic by the Federal Highway Administration (FHWA). The width of the red lines in each of these two figures show the amount of truck traffic on roads in 1998 and the projected amount of truck traffic on the same roads in 2020.

\textsuperscript{86} Federal Highway Administration website. May 5, 2004. \texttt{http://www.ops.fhwa.dot.gov/freight/publications/state_profiles/Maryland/Maryland.html}
Figure 4-2: Estimated Average Annual Daily Truck Traffic: 2020

Many of the costs imposed on the Washington area by trucking are not fixed, and could be changed by policies which use pricing strategies for truck use of highways, and deliberate management of truck user demand to maximize the benefits of roads for all. This chapter offers a new pricing system for truck management. The unpaid costs of trucking make pricing desirable, and the fact that almost all interstate trucks already have GPS and EZ Pass technologies makes conversion to a pricing system easier. Truck pricing could reduce gridlock and danger, increase incentives for more efficient goods transport, and fund public transportation and highway pricing for cars to move our region’s transportation system into the 21st century.

WASHINGTON TRUCK TRAFFIC

The Capital Beltway Safety Team, a group of Washington area transportation public officials and experts, found trucks account for about 10 percent of all vehicles on the Beltway. While most “trucks” on the Capital Beltway may be local vehicles, most of the larger tractor-trailers are not. Indeed, 66 percent of tractor-trailer drivers on the Beltway were not based in Maryland, D.C., or Virginia.87

Trucks are larger, heavier, and less maneuverable than cars, and are therefore more likely to be involved in serious accidents. Trucks play a disproportionate role in the danger of highway driving. According to the National Highway Transportation Association (NHTSA), large trucks make up 4 percent of all registered vehicles and 7

percent of vehicle-miles traveled, but are involved in 11 percent of all crash fatalities. Approximately 450,000 car-truck accidents occur annually in the U.S.\textsuperscript{88} In 2002, 4,897 people were killed and 130,000 people were injured in truck-related accidents.\textsuperscript{89}

Today on the Capital Beltway, trucks, which account for 10 percent of all vehicles, are involved in about 20 percent of all accidents.\textsuperscript{90} A comparison of fatal crashes on 20 major metropolitan beltways in 1995 found that the Capital Beltway has more tractor-trailer crashes (18 percent vs. 9 percent) than comparable beltways.\textsuperscript{91} According to the Capital Beltway Safety Team, more than half (51 percent) of crashes involving tractor-trailers are sideswipe/cutoff crashes.\textsuperscript{92} These accidents are often the result of lane shifts at interchanges by cars and trucks sharing limited highway capacity.

The immediate costs of large truck accidents include the costs of emergency response, cleanup, and medical costs—estimated by the Federal Motor Carrier Safety Administration (FMCSA) nationwide to exceed $19 billion per year.\textsuperscript{93} Lawyers and insurance companies have attempted to quantify the present value of all costs over the victims’ expected life span that result from a crash: medically related costs, emergency services costs, property damage costs, lost productivity, and the value of the pain, suffering, and quality of life that the family loses because of a death or injury. According to one such analysis, large truck crashes cost the public more than $24 billion dollars each year in damages.\textsuperscript{94}

**ENVIRONMENTAL DAMAGE**

Still more social costs are attributable to trucks’ role in air pollution. About 127 million Americans, close to half of our national population, live in regions with air quality that fails to meet EPA’s standards for air pollutants.\textsuperscript{95} The Washington region is one of the areas that is out of compliance with federal law for air quality. For up to 38 days a year, air pollution levels in the Washington region violate federal health standards.\textsuperscript{96}

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\textsuperscript{91} Ibid.

\textsuperscript{92} Ibid.


Again, heavy trucks play a disproportionate role in the problem. The heavy-duty diesel engines that power big trucks release exhaust fumes that contain 100-200 times more small particles or “soot” than gasoline engine exhaust. The exhaust is a mixture of over 450 different components, including vapors and fine particulate matter coated by organic substances. Of these substances, over 40 are classified as toxic air contaminants by the state of California.

According to the American Lung Association, diesel engines create an estimated 26 percent of the total hazardous particulate pollution (PM 10) from fuel combustion sources and 66 percent of the total pollution from on-road sources. The American Lung Association also concludes from many studies that particulate pollution from diesel engines is linked to increased hospital admissions, chronic obstructive lung disease, pneumonia, and heart disease that result in up to 60,000 premature deaths annually.

Big trucks also often carry hazardous waste, intensifying the damage of any accident. Every day, nearly 500,000 shipments of hazardous materials are made, and highway shipments make up more than half of this total. When there is a truck accident involving hazardous material, major highways in the Washington area can be tied up or even closed to traffic for a day or more. No one has attempted to quantify the future costs of clean up.

ROAD DAMAGE

Along with accidents, pollution, and traffic, trucks also cause a disproportionate amount of damage to the highway infrastructure. According to the American Association of State Highway and Transportation Officials (AASHTO), a single truck weighing 80,000 pounds can cause as much damage to roads and bridges, as 9,600 passenger cars would. This results in large maintenance burdens for road repair and resurfacing. Heavy trucks do pay a variety of registration fees and tolls, along with fuel taxes, and are taxed more heavily than other vehicles. The U.S. Department of Transportation Combination estimates that trucks registered at less than 50,000 pounds pay 60 percent more in user fees than their share of highway costs. However, larger trucks, combinations registered at more than 80,000 pounds, pay on average only about

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98 Ibid.
100 Ibid.
60 percent of their highway-cost responsibility.\textsuperscript{103} In other words, bigger trucks are not paying their share of the damage that they do to the roads in the Washington region.

Pricing for truck use of the region’s highways can be justified not only as a traffic demand management device, but also as a socially appropriate charge for some of the other large social costs that trucks impose on the area. If trucks are unwilling to pay for the costs they impose, market forces will lead to diversion of some traffic to railroads, and to changes in industry production patterns to involve less intensive use of highway transportation. Trucks have been highly subsidized on American highways; it is time for them to have all their social costs internalized.

**PROPOSED TRUCK PRICING ON I-81**

For a variety of reasons, including the protests of District residents, highway planners stopped construction in the 1960s of I-95 within the Capital Beltway in Maryland and Washington, D.C. Interstate truckers have been left with two costly options: they can either take a short but high traffic detour around the Capital Beltway to the I-95 South interchange in Springfield, Virginia, or they can take a wider detour and use Interstate 81, about 100 miles west of Washington.

Despite the fact that I-81 is a huge detour, truckers have increasingly used the thoroughfare. From beginning to end, I-81 is 824 miles long and runs from New York to Tennessee. I-95 and I-81 run roughly parallel through Virginia. Although it was designed to carry 15 percent truck traffic, I-81 now carries 20 to 40 percent truck traffic.\textsuperscript{104} Reflecting its growing role as a main route from the Northeast to the Southwest, it has been christened by some as the “NAFTA Highway.”

Several major initiatives in the region would address the problems of I-81 related to trucking by separating trucks from cars. Fluor Solutions proposed adding two lanes to I-81 (which now has four lanes) for $5.9 billion by 2014, while STAR Solutions proposed adding four lanes for $6.3 billion by 2019. Both proposals would dedicate separate lanes for exclusive use by heavy tractor-trailers. Both would pay for the new exclusive truck lanes by pricing trucks: flat tolls of $55 to $70 are suggested in one proposal for a tractor-trailer to pass through the full length of Virginia.\textsuperscript{105}

Under the STAR proposal — which was recently accepted by the State of Virginia — trucks and cars would be separated by only rumble strips on all but 45 miles of the highway, with six spots where trucks could enter and exit the highway without


crossing car lanes. There would be eight other ramps where trucks would connect to the car lanes to access the highway's other 84 exits.\textsuperscript{106}

The American Trucking Association is skeptical of any tolling plan for I-81. It claims that a cost of as much as 20 cents per mile on the truck toll lanes on an expanded I-81 would divert and thus increase urban truck traffic by more than 225,000 per year on I-95 near Washington, D.C., and increase the use of rural roads as a diversion from I-81.\textsuperscript{107} A study commissioned by the state of Virginia found 50 to 60 percent of truckers would take alternative routes at a $120 toll. Even if the toll were reduced to the range of $65 to $80 that STAR officials hope to charge, the study found that anywhere from 30 percent to 50 percent of truck traffic would go elsewhere; most likely to I-95 and the Capital Beltway to the east, and I-79 to the west.\textsuperscript{108} This large diversion of truck traffic would magnify the problems the Washington region already faces with increasing heavy truck traffic. Any truck pricing of I-81 thus may have to be accompanied by corresponding truck pricing of I-95.

Opponents of both I-81 proposals argue that improvements in railroad transportation would be a better way to address the capacity problems in the region. The STAR plan called for more than $100 million in railroad improvements for the corridor, but many argue this isn’t nearly enough.\textsuperscript{109} According to the Sierra Club, the 30-year total benefit of railroad in the corridor has been calculated at $1.3 billion, and the STAR proposal, “means greater subsidies for the trucking industry instead of investments in rail that could get a lot of trucks off the roads entirely.”\textsuperscript{110}  A careful study might reveal that railroads and waterways would be less expensive and safer methods for transporting many goods that now travel by truck through the Washington region.

It is worth noting that increasing the use of these alternative modes would reduce jobs because rail requires less human interaction. Such a move would likely be opposed by unions. The International Brotherhood of Teamsters, Chauffers, Warehousemen, and Helpers of America (IBT) have an influential voice in national politics. More than 120,000 Teamsters are covered by the National Master Freight Agreement\textsuperscript{111} and the majority of its members are truck drivers.\textsuperscript{112}

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\bibitem{112} Teamsters’ website. May 11th, 2004. \url{http://www.teamster.org/}
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On the benefit side, trucking companies would see significant improvements from exclusive truck lanes on I-81. Their trips would be faster, more dependable, and safer. Shippers and carriers assign a value to increases in travel time, ranging from $25 to almost $200 per hour, depending on the product carried. The value of reliability for trucks is 50 percent to 250 percent higher, and congestion increases the cost of trucking significantly. Some truck companies thus might support the proposal.

TRUCK PRICING ON I-95

Interstate 95 stretches 1,907 miles from Maine to Florida with high speed limits and is the most direct route on the East Coast from the north to the south. I-95 runs through almost every major city on the East Coast without detour, with the notable exception of Washington, D.C. where north-south traffic must use the Beltway for 30 miles. In 1999, 7,000 tractor-trailers used the Woodrow Wilson Bridge on the Beltway every day. The average distance traveled by bridge truck shipments, both north and south, was 435 miles, indicating that much of the use was not local. The Bureau of Transportation Statistics estimates that the Woodrow Wilson Bridge carried 1.3 percent of the value of goods shipped by truck throughout the entire nation in 1993.

D.C., Maryland, and Virginia can improve the region’s transportation system by more wisely managing and pricing interstate truck traffic. The best policy would be a pricing method that would include the cost of extra traffic, accidents, and pollution, adjusted for the specific circumstances of the D.C. region.

To recover the unpaid costs of their highway use, large trucks could be charged a base toll at all entrances to the Capital Beltway. Currently, the Commerce Clause of the U.S. Constitution is used to argue against fees for interstate trucks. In fact, current policies use hidden subsidies to discriminate against local production and for interstate exchange. While the benefits of trucking through the region are distributed around the country, the costs are concentrated, and borne by local drivers and communities.

Highway pricing allows for a flexible approach to recover the social cost subsidy to the trucking industry. Most trucks that run the East Coast route already are outfitted with Global Positioning Systems (GPS) and EZ Pass technologies which allow for information exchange, systems monitoring, and tracking of trucks anywhere in the country, within seconds. In Germany, GPS technology is now being used to charge trucks according to the exact time and place of their use of that nation’s highways (see Chapter 7 for further discussion of truck tolling in Germany).

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Technological advances make it possible for individual trucks to be assessed a variable toll, without needing to stop, as they enter the Capital Beltway, and the toll could reflect traffic congestion and other social costs like accidents and higher charges for ozone days. IT methods could be used to give trucking companies advance warning about traffic conditions and current toll rates. This would meter truck traffic, and maximize the efficient use of road capacity. In response to the price schedule set for trucks, members of the trucking industry could choose to rework their hours and pay lower tolls, or choose to pay a significant toll that reflects their costs at a given time and place to the region.

Regional planners, especially in Virginia, would need to coordinate tolls on I-95 of the Capital Beltway and I-81 to get the best mix of truck traffic for the region. The goal would be to get the toll prices at the right level to discourage most truck trips at rush hour and to recover the greater costs of interstate trucks to the highway and society. In this highway-pricing scenario, truck-induced traffic would decrease, highway deaths and accidents would decrease, air quality would improve, and road wear and tear would be paid proportionately.

A PROPOSAL FOR I-95

Regional planners should build a separated toll truck lane on I-95 on the Capital Beltway to open at the same time as the truck-toll lanes open on I-81. In fact, for the purposes of interstate truck traffic, it would be necessary for only half of the Capital Beltway to have a lane for trucks, the connecting part of the Beltway between I-95 in Virginia and Maryland, as long as interstate trucks were required to use only that half. On the Virginia half of the Capital Beltway, one existing lane would be converted to a High Occupancy Toll (HOT)/Bus Rapid Transit (BRT)/heavy truck lane. To avoid an unwieldy acronym, this can be called a Commuter/Truck lane, or CT Lane.

The CT lane would be free for commuters in HOV2 cars and buses, but trucks would pay a variable fee to use the lane until it met capacity. Other drivers could opt to pay a variable fee when there was remaining space. Trucks would be required to use only this lane of the Beltway and to pay a charge — which would be very low at off peak hours but high at rush hour. The CT lane would need to be separated from the road, and have stops at every exit, allowing trucks delivering regionally to exit at any time. The largest construction cost would be rumble separation strips and ramps. Virtual tollgates, using GPS technology, could assess variable rates to trucks based on time of day and distance traveled.

Variable pricing could significantly alter truck behavior. At rush hour, the cost could be set so high that few trucks would use the Capital Beltway, even though they would continue to have the option. At other hours, trucks could share the lanes with carpoolers at a significant variable cost. The revenues could be used for public transportation, parking, rail improvements, and road maintenance.
Variable highway fees are better than flat tolls and registration fees, because they base cost on the time of day, level of use, and level of demand. A disadvantage of this method of pricing is that it could induce truck traffic in HOV lanes, creating dangerous driving conditions for current HOV users and deterring them from using these lanes. An advantage of this method of pricing is that it could adjust price to stop any induced traffic. The safety of the road system as a whole would still need to be improved.

The region needs to use revenues to increase support of public transportation, rail, and boat transport. These more sustainable and efficient methods for moving goods and people are currently underinvested in the Washington region. If the region uses 50 percent or more of the revenue from pricing of trucks to fund a conversion of an existing lane for trucks, buses, and commuters (CT Lanes), then users would pay for a more equitable system that leaves almost everyone in the region better off, even people who do not drive. It is critical that this CT lane be converted from a current Beltway lane rather than be an added lane because any new capacity might undermine the gains from CT lanes.

If trucks paid a charge for highway use that more closely reflected the social costs they impose on the nation’s highways, more long-distance truck traffic would be diverted to railroads and barges. Market forces would spur innovation and inter-modal transportation. Already, combinations of truck and rail are increasing, where truck trailers are loaded onto railroad flatbeds at their origin, taken off the flatbeds near the destination, and reconnected to a truck for final delivery. Trucks on the highways will still be needed, but increasingly focused on the regional deliveries that they do best.

CONCLUSION

Freight activity is increasing and exceeding the capacity of the road system, as shown in Figure 4-5. We will need to make a decision: keep the current system or make a fundamental change.
Truck pricing is an effective way to begin a new transportation system that serves people better. Trucks do more damage to people and roads than cars, and there is no reason for so many trucks to be on roads like the Capital Beltway at rush hour when they are most dangerous. Truck pricing could lead to a more efficient, safe, and sustainable movement of goods in and through the area while providing funds to improve public transportation and implement a highway pricing system to move people in cars more efficiently. Trucks are already almost universally outfitted with GPS, making conversion to a variable pricing system potentially fast and easy, and Virginia’s proposed truck pricing system for I-81 adds further justification.

There would be many challenges for implementing the ideas presented in this chapter. While a CT Lane might appear to be a “win-win” policy, some people would lose. The region should find a way to transition or compensate outlying regions and interstate trucking companies who would lose some of their advantages in the current system. With fewer people spending time in traffic, fewer accidents and traffic-related deaths, and a cleaner environment, the region would have additional of money for such purposes.

Another significant difficulty for a truck pricing system would be ensuring that prices reflect actual human, environmental, and infrastructure costs while taking into account the effects of other pricing systems like the STAR plan for I-81. A well-managed regional system would eliminate hidden subsidies for long distance trucking, and reduce truck trips at rush hour by internalizing real costs.

Building more roads will not solve the most significant transportation problems in the Washington area. There are many roads already, so supply is not the problem. Instead we need to do a better job of managing demand and using our capacity investments. The problem is that our roads are clogged with cars and trucks, which are very inefficient modes for using road capacity to move goods and people. Pricing systems that include social costs can use the power of the market to better manage our current capacity and induce a transition to more efficient modes of transport. We need to begin creating a transportation system that will keep us moving in the 21st century. A combination of highway pricing—including truck pricing—public transportation and inter-modal freight would be a good start and the nation's capital should lead the way.

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The Capital Beltway, originally called the Washington Circumferential Highway, was completed in August 1964 and covers 64 total miles – 42 in Maryland and 22 in Virginia. Originally a four-lane highway, the Capital Beltway underwent four major construction projects from 1972 to 1992 to widen it to its current eight lanes. Since its completion the beltway has added only two new interchanges bringing the total to 40.

Beltway usage has increased steadily since its completion, by 10 percent per year in the 1980s and 5 percent in the 1990s. Total vehicles carried in one day can reach as high as 240,000 in parts of the beltway in Northern Virginia. The growth in use of the beltway is not likely to slow down anytime soon. According to the U.S. Census Bureau, Maryland will add another 1.2 million people while Virginia will add 1.8 million people by 2025. Traffic volumes on the Maryland beltway are projected to increase by 31 percent in Montgomery County and 36 percent in Prince George’s County by 2020.

Since the beltway is circumferential and passes between many business and residential centers, it experiences segmented traffic patterns throughout the day. Some areas are congested on the inner loop while others are congested on the outer loop; these patterns typically flip-flop in the evening as people return home. Most traffic on the beltway occurs from 6 to 10 a.m. and 3 to 7 p.m. Under current trends, VDOT estimates that by 2020, rush hour may increase to 7 hours in the morning and 10 hours in the evening.

One solution would be to increase the capacity of the beltway in order to meet the rising demand. Simply adding lanes, however, cannot solve the Washington area’s traffic needs, according to the theory of “triple convergence” as espoused by Anthony Downs, Senior Fellow at the Brookings Institution. According to Downs, expansion will initially decrease congestion, but volume will increase as people who had previously avoided the highway reroute their trips back onto it, leading again to congestion but with shorter peak-periods that are commonly called “rush-hour.”

Pricing existing and additional lanes has been proposed as a means to easing traffic congestion, lowering vehicle emissions, and as a potential revenue source for mass transit. Achieving any one of these goals will be difficult, which has led to skepticism that pricing can relieve all of them. In essence, road pricing cannot achieve its congestion and equity goals without providing funds for alternative methods of transportation. The goal of road pricing cannot be to simply generate revenue but must incorporate a region-wide approach to solving congestion and automobile pollution while also solving the equity issues it creates.

117 NVTA website available at http://www.nvta.org/beltway495.html
118 RK&K, LLP
The Capital Beltway is not like other roads that have used toll lanes. SR 91 in California uses tolls on a 10-mile stretch where most through-traffic goes from one end to the other with few cars exiting in between. As a circumferential road around a major metropolitan area that is also surrounded by a technology corridor and satellite cities of Washington, D.C., the Capital Beltway experiences non-linear traffic patterns and high volumes of cars weaving between lanes to get on and off ramps at all points. This aspect of the beltway will pose complications for any use of HOT lanes on I-495. Most research concerning pricing on the beltway has revolved around HOT lanes but this chapter also analyzes and discusses the option of tolling all beltway lanes without any HOT separation.

**BELTWAY OPTIONS**

Using “quick-response tools,” Patrick DeCorla-Souza, team leader for highway pricing and system analysis in the Office of Transportation Policy Studies at the Federal Highway Administration, was able to model six options for the Capital Beltway in relation to a No Build base case scenario based on the VDOT Capital Beltway Study published in 2002. \(^{119}\) This study incorporated external costs into its cost-benefit analysis. Time spent in traffic was valued at $12 per vehicle per hour with an estimated average of 1.33 persons per vehicle. \(^{120}\) The study focused on the southern segment of the Virginia Capital Beltway, which has “medium” traffic in relation to the northern and middle segments.

**Alternatives Without Pricing**

- **Alternative 1:** Add one concurrent HOV lane in each direction.

- **Alternative 2:** Add one HOV lane in each direction, reconfiguring the cross-section in each direction to two local lanes and three inside Express/priced lanes (including the HOV lane).

- **Alternative 3:** Add two barrier separated HOV lanes in each direction, for a total of six lanes in each direction (four regular and two HOV).

**Alternatives With Pricing**

- **Alternative 4:** Divide the existing four-lane cross section in each direction into two sections of two lanes each, one local and the other priced with free access for HOV and transit vehicles. Provide toll credits to motorists using regular lanes, as in the FAIR lanes concept.

\(^{119}\) Available at [http://project1.parsons.com/capitalbeltway/](http://project1.parsons.com/capitalbeltway/)

\(^{120}\) Gas was assumed to cost $1.40 at the pump. Higher gas prices of approximately $2.00 dollars per gallon will increase per hour cost of traffic per vehicle up to $13.22.
Alternative 5: Add one concurrent lane in each direction. Using barriers, divide the five-lane cross-section into two sections – two regular lanes and three priced lanes, with free access on the priced lanes for carpool and transit vehicles.

Alternative 6: Add two barrier-separated priced lanes in each direction, with free access on the priced lanes for carpool and transit vehicles.  

Each of these alternatives generated results that maximized different objectives. Alternative 6 increased traffic volume by 30,000 person trips above the No-Build baseline. Alternative 4 resulted in the lowest beltway volume and negative estimates for induced travel, meaning people transitioned to transit or carpool. Although fewer people will use the beltway under Alternative 4 and delay hours will be reduced, Alternative 4 also reduced delay hours by the least amount; 68,962 person hours. Alternative 6 reduced delay hours the most, 2.5 times as much as Alternative 4 and 1.4 times as much as the next highest - Alternative 5. Figure 5-1 shows the net present value of each alternative.  

![NPV of Capital Beltway Pricing Options](image)

*Figure 5-1: Alternatives 4 and 6 have the greatest net present value.*

**THE FLUOR-DANIEL PROPOSAL**

The Fluor Daniel Company submitted a detailed proposal to VDOT in October 2003 to expand 14 miles of the capital beltway in Virginia by two lanes in each direction. The lanes would be separated by a barrier and a toll would be collected using an electronic toll collection (ETC) subsystem. This proposal is closest to Alternative 6 in the DeCorla-Souza study discussed above. The ETC would require patrons to establish and maintain a Smart Tag/EZ Pass account that would be limited to two-axle passenger and service vehicles, express buses, and emergency vehicles only.

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121 DeCorla-Souza, Patrick.
122 Ibid.
Fluor Daniel estimates that construction will cost $693 million, but that the public share will be only 13 percent of this cost. The rest, they estimate, will come from toll revenue bonds and a USDOT TIFIA (Transportation Infrastructure Finance and Innovation Act) loan of $246 million. Construction would begin in 2005 and end in 2009. For its study, Fluor Daniel assumed that tolls would reach a maximum of $5 by 2009 and $6 by 2015. Although other toll lanes do not charge for use of the lanes during non-rush hour, Fluor Daniel assumed a base price of $1 for 2009 and $1.25 for 2015. Detailed revenue projections from the Fluor Daniel proposal will be conducted following the release of the Locally Preferred Alternative by VDOT.

The Smart Tag/EZ Pass technology meets high standards and has been proven effective in other states. For this sort of tolling system, a majority or all of beltway users must have a transponder. The price of the technology does not seem to be a limiting factor. EZ Pass requires only a credit card account and asks for no deposit. A Smart Tag costs the user a one-time $15 deposit and then money for tolls is added to the Smart Tag and automatically deducted when passing through a toll sensor. This charge is significantly less than user fees for the I-15 Expressway in San Diego where fees have caused some “priced out” sensitivity. There, a $70 monthly pass has slightly decreased use but not “undermined support for the ExpressPass program.”

Critics such as Lon Anderson of the American Automobile Association (AAA) have criticized proposals to price existing roadways without adding capacity. Since the Fluor Daniel proposal seeks to add two lanes in each direction, the possibility of greater acceptance of groups like AAA may help to shift public opinion in its favor.

PROBLEMS WITH THE FLUOR DANIEL PROPOSAL

The circular nature of the beltway may not preclude the feasibility of toll lanes, but does make design more problematic. The Fluor Daniel proposal does not appear to take adequate account of this irregularity of the beltway; it does not make clear how vehicles will enter the toll lanes once on the beltway or address the logistic difficulty of vehicles needing to traverse across four lanes to get off. The proposal discusses the possibility of having access to the toll lanes limited to on-ramps onto the beltway - making it impossible to enter the toll lanes once on I-495 – but also considers “slip ramps” throughout the system, allowing for entry and exit throughout the beltway. While the Fluor Daniel proposal discusses these alternatives, it does not provide a cost benefit analysis of the two very different options.

The addition of “slip-ramps” through the beltway system will dramatically alter traffic flow and may lead to increased accidents. According to a 1994 study by the National Highway Traffic Safety Administration (NHTSA), 4,447 traffic accident reports were filed by police between 1993 and 1994 on the Capital Beltway involving over 9,000 cars. About 36 percent of these crashes occurred because of “stop-slowing” where one

123 Virginia General Assembly LIS website, 3
car rear-ends another because of a negative change in velocity.\textsuperscript{124} “Stop-slowing” usually occurs in congestion. Another 18 percent occurred because of “sideswipe-cutoff,” whereby an accident is induced by a vehicle changing lanes. It is not clear how priced lanes will affect the number of accidents in the area. More people will be traversing more lanes, perhaps inducing more “sideswipe-cutoff” but perhaps lowering the amount of “stop-slowing.”

Traffic fatalities vary from year to year but averaged 14 deaths from 1993-1996.\textsuperscript{125} If current accounting practices estimate the value of a human life to be approximately $5 million dollars, then having at least rough estimates of induced traffic fatalities because of added lanes must be taken into account. If fatalities are increased by 1 per lane per year on I-495, this would subtract an extra $20 million (assuming the other deaths were already accounted for) from calculated benefits of adding toll lanes. DeCorla-Souza’s study takes crashes into account but does not explicitly account for fatalities. Five million dollars per life is the low estimate. Although the dollar value of a life is hotly debated, economists, government agencies, and insurance companies typically estimate it to be between $5 and $10 million. Calculated at this higher range, an equal amount of deaths will result in a yearly net loss of revenues in DeCorla-Souza’s fifth alternative and significantly reduce the net present value of the other pricing options. By 2015 Fluor Daniel estimates its toll lanes will generate $46 million in net revenues.\textsuperscript{126} In the higher range of life-value, net benefits only marginally outweigh net costs when compared only to the cost of lives lost.

The Fluor Daniel proposal has called for left lane exits that make exiting from the toll lanes, once on them, less troublesome to overall traffic. Getting onto the HOT lanes from the general-purpose lanes could still present the Capital Beltway with a serious safety hazard along with added delays on the road. The Fluor Daniel traffic relief estimates were made using a no-accident supposition, so actual time savings and cars diverted may be lower in practice. A more thorough examination of time lost because of accidents caused by additional lanes on the beltway ought to be undertaken to supplement the Fluor Daniel proposal.

According to Michael Replogle of Environmental Defense, the Fluor Daniel proposal also fails to incorporate environmental costs of increased highway capacity.\textsuperscript{127} Replogle cites DeCorla-Souza’s study and asserts that Alternative 5 where one extra lane is built will generate only an extra two percent of traffic, have significantly lower excess emissions and triple the toll revenues of building two priced lanes. Replogle calls for the consideration of buffer zones between the beltway and residents, design of transit-oriented development, Bus Rapid Transit (BRT) services and improved pedestrian and bicycle access, none of which are adequately addressed in the Fluor Daniel proposal. According to the DeCorla-Souza study that Replogle offers as

\textsuperscript{124} USDOT, 1996.  
\textsuperscript{125} NHTSA, 1999.  
\textsuperscript{126} Fluor Daniel Preliminary Plan of Finance, 2-o  
\textsuperscript{127} Replogle, Michael.
evidence, using a strict cost-benefit analysis, the social cost of one extra lane (the difference between adding one or two lanes) would have to equal or exceed $1.2 billion dollars, the difference in the two alternatives’ net present values.

FULL BELTWAY/TOLL NETWORKS

Expanding the capital beltway by four lanes on only one section of 14 miles, as proposed by Fluor Daniel, may cause traffic jams where it returns to its old dimensions at Rte 193 in the north and I-95 in the south. Beltway traffic in Virginia is currently highest in the northern section between Braddock road and the American Legion Bridge bordering Maryland. Assuming only “medium” increases in the number of person trips because of added capacity according to DeCorla-Souza’s model, already high levels of traffic from Rte 193 leading to the American Legion bridge will be burdened with more than 30,000 extra vehicle trips than it would under the No-Build scenario on top of expected volume increases through 2020.

To avoid this bottleneck altogether a toll network will have to be built on the entire beltway—only 8 more miles in Virginia, but 42 additional miles for Maryland’s portion. KCI Technologies is currently investigating Capital Beltway expansion for Maryland but no information on their result was available at the time of writing. However, by assuming proportional costs per lane mile similar to the Fluor Daniel proposal, Maryland can expect to pay approximately $2.1 billion for construction. This estimate has enormous room for error because of variations in right-of-way costs between different stretches on I-495 and discretion over how many toll access ramps Maryland may choose to build. Error is also introduced through a wide range of estimates on the actual cost of expanding I-495. VDOT estimates of adding two HOV lanes to its portion of the capital beltway by 2020 are more than double Fluor Daniel’s, reaching $1.7 billion for 15 miles. The Northern Virginia Transportation Alliance’s estimates are even higher at $3.2 billion to add two HOT lanes. If VDOT’s middle estimates turn out to be accurate, the cost to Maryland of adding toll lanes balloons to $4.8 billion, $1.7 billion more than Maryland’s entire 2004 transportation budget.128

One option not explored by DeCorla-Souza and not recommended by Fluor Daniel is total pricing of the Capital Beltway using standard EZ Pass technology, or perhaps further in the future, GPS. This plan could double the net revenues from DeCorla-Souza’s Alternative 4 without creating more dangerous, separated toll lanes. On the segment of highway studied by DeCorla-Souza, annual gross revenues could be as high as $56 million. If implemented on the entire beltway, annual gross revenues could reach $900 million. Without high construction costs, this money could go toward maintaining the beltway, relieving tax burdens, or providing desperately needed funds for public transit. Although a BRT system is well suited for HOT lanes, a variably priced beltway will be able to reduce traffic enough to ensure a speedy commute through the area without BRT or HOT lanes.

128 MDOT.
BUS RAPID TRANSIT (BRT)

A region-wide approach to solving congestion should also incorporate solutions using mass transit along with road construction or priced lanes. Washington’s Metro rail line and bus services have been critical in providing alternatives to car driving in and around Washington, D.C. Although “the core” of the area (the city limits and Arlington County) contains about 50 percent of Metro rail miles, only about 41 percent of ridership comes from these areas, meaning that the majority of demand for the rail service is outside the city. Given that these outlying areas will experience the greatest population increases, demand for mass transit will increase.

The cost of expanding the subway system is highly prohibitive, even for light rail. The Purple Line which would run from Northern Virginia, through Montgomery County and into Prince George’s County, less than half of a total circumferential system has been estimated to cost $1.2 billion dollars. Revenues from the system alone would not be able to pay for its construction; planners have stated that the federal government would have to assist with approximately half of the costs of construction. The Metro rail system as a whole has not been able to support itself through ridership fees, receiving 65 percent funding from the federal government annually. While some like Lon Anderson of AAA assert that this is because the fares on Metro rail have been kept artificially low to encourage ridership, others argue that an affordable rail system is essential for the capital city. Others argue that money for transit, like money for road maintenance, should not be considered a subsidy, nor should transit be expected to be self-sufficient. It makes sense for car riders—who benefit from keeping others off the roads—to help pay for this system.

Buses are already widely used in the region, carrying 45 percent of total Metro rail/bus users. A new bus system has been proposed to work in tandem with HOT lanes on the Capital Beltway and with the current rail system, connecting the spokes around the beltway. “BRT aims to provide performance and service qualities comparable to those of rail transit but at a cost that is considerably lower than that of light rail systems (an average of $9 million/mile for buses on HOV lanes versus $34.8 million/mile for light rail transit according to U.S. General Accounting Office estimates).”

Since HOT lanes would maintain throughput on the beltway, buses could reliably traverse its entire circumference unimpeded by traffic delays. BRT has the capacity to move far more people than light rail as well, possibly in excess of 50,000 per hour. Bogotá’s TransMillenio BRT system, the most used in South America, carries as many as 25,000 persons per hour in each peak direction. Other systems in South America

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129 Metro’s website defines “the core” as D.C. and parts of Arlington County; all of Arlington County is included in these calculations. This discrepancy slightly overestimates the percentage of miles within “the core” but since Arlington county only houses about 12 percent of total rail line; this should not greatly change the answer.


131 Poole, Orski.
carry as many as 11,000 to 20,000 persons per hour. Buses are also more flexible over time, able to adjust flows to match demographic and geographic changes.

The Virginia Department of Rail and Public Transportation (VDRPT) undertook a study of the costs of constructing a BRT system along the Dulles Corridor. Estimating year 2020 demand, VDRPT determined that the BRT system would cost $280 million for a 23-mile stretch including three stations with operating costs of $48.4 million annually. They calculated demand to be 23,000 average weekday boarders. The VDRPT found that BRT will provide “medium” improvements in mobility, “high” environmental benefits, and “medium” cost-effectiveness.\(^\text{132}\)

**PUBLIC PRIVATE PARTNERSHIPS IN MARYLAND**

If significant private involvement is sought for an extension of a Fluor Daniel approach into Maryland, one issue that will have to be addressed is that Maryland lacks an equivalent of the Virginia’s Public Private Transportation Act (PPTA) that has allowed Virginia to encourage private companies to submit construction and management proposals for state roads. Reliance on private companies to fund construction of any new highways in Maryland based on expectations of future toll collections would require new state legislation. In 1995 The Commonwealth of Virginia – after a year-long collaboration between the General Assembly, transportation agencies and private sector – passed the PPTA, which allowed the state to outsource the construction, repair, and operation of state-owned roads. Although the transportation service of construction, maintenance, and operation may be outsourced to a private company, that company must still comply with all state regulations. The PPTA agreement does not, however, privatize roads; it returns roads to full public ownership and control at some point in the future.

**EQUITY ISSUES**

Even though residents of all economic backgrounds will be able to use the HOT lanes, the lanes will be more affordable for the more affluent. Pricing schemes in other localities and those proposed for the Capital Beltway envision a price up to, but not above, approximately $10 per trip. If toll lanes are not allowed to represent a true cost of congestion and pollution, they could act as a license for the more affluent to move further from urban centers and increase overall vehicles miles traveled per car. Creative design of a fully tolled beltway will be necessary to alleviate equity issues. Lower income residents may be priced out of the beltway entirely if tolls get too high or if these residents are unable to adjust behavior and incur proportionately large financial losses. Full beltway tolling may require credits for lower income users. Additional research is needed to determine the magnitude and feasibility of these credits. For a discussion of the growth implications of transportation, see Chapter 9.

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\(^{132}\) Rating definitions are in accordance FTA’s *Technical Guidance on Section 5309 New Starts Criteria* for the 23 mile BRT system.
THE REGION AS A WHOLE

The beltway cannot be considered in isolation from other roads in the area. Any plans to refurbish, expand, or improve I-495 will also have to take into account the burden it might create for other roads. Any induced travel will generate its own costs by increasing throughput, road expansion, and routine maintenance, as well as creating additional social costs such as lowered air quality. While support for road pricing has been shown to increase once the toll lanes are implemented, opposition to expansion of the beltway may come from neighborhood groups and environmental groups who will see increases in local traffic and pollution.

The Northern Virginia Transportation Alliance (NVTA) has urged the state to consider options other than beltway expansion because of considerations of induced travel demand. These options include:

- Techway – New limited access parkway and Potomac River Bridge connecting either the Fairfax County Parkway or Route 28 in Virginia to I-270 near Rockville, Maryland.
- Dulles Corridor – Bus Rapid Transit between West Falls Church and Eastern Loudoun.
- Eastern Bypass – Four-lane limited access parkway.
- Fairfax County Parkway – Eliminate traffic signals, upgrade to throughway.
- I-66 Inside Capital Beltway – Add third lane in each direction.
- I-95 – Add fourth lane in each direction between Newington and the Occoquan.
- Inter-County Connector (MD) – Links I-270 with I-95.
- Loudoun County Parkway – Complete.
- Route 28 – Upgrade to eight-lane freeway (four lanes in each direction) between Route 7 and I-66.
- Tri-County Parkway – Complete as six-lane parkway and connect to Loudoun County Parkway.
- Western Transportation Corridor – Four-lane (two in each direction) limited access parkway.\(^{133}\)

\(^{133}\) NVTA
CONCLUSION/RECOMMENDATIONS

There is not yet adequate information to make an informed decision about whether or not to add priced lanes to the Capital Beltway. The Fluor Daniel proposal is currently under the NEPA process to determine its environmental effect. Michael Replogle suggests that a SEIS (Supplemental Environmental Impact Statement) also review DeCorla-Souza’s findings to determine the environmental impacts of adding beltway capacity. Without these findings, cost-benefit analyses are incomplete. How accidents and fatalities will affect these cost-benefit analyses is also uncertain. For these reasons the Fluor Daniel proposal should not be implemented without further detailed study including alternatives. The Fluor Daniel proposal EIS may be available to the public in the coming months and Maryland is set to unveil I-495 HOV options in early May.

Tolling the entire beltway through EZ Pass or GPS technology will generate the most revenue without increasing accidents. These solutions, however, are now only in the distant future and there seems to be little public support for such a plan. Nonetheless, further research is needed to determine the environmental impact of increasing throughput on the Capital Beltway, its effects on induced travel and how equity issues can be resolved.

Road pricing must be part of a wider solution to congestion in the Washington area. This solution should include improvements in mass transit, bicycle paths, and surrounding roadways. Pricing roadways can be a viable means of incorporating externalities like pollution and traffic costs more efficiently than gas taxes. By paying for highway use, people will have incentives to limit vehicle miles and locate their residences closer to town centers. HOT lanes on the entire beltway could generate well over $100 million in annual revenues that could go toward tax relief or funding for BRT and other transit options. Any pricing scheme for the area must dedicate funds toward alternative modes of transportation like Metro rail, buses and BRT. Without these earmarks, road pricing will not be able to reduce congestion in the long-term, nor will it be able to shift transport demand away from automobile use.

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CHAPTER 6 – PRICING THE POTOMAC BRIDGES

Bridges over bodies of water offer a good opportunity to implement highway pricing. Such bridges are often bottlenecks for traffic, and the pricing of the use of the bridge could be a valuable way of reducing or eliminating traffic jams on the approaches to the bridge. With pricing of bridges, the problem of diversion of traffic into alternative local routes may also be less significant. Indeed, if all bridges across a local water body impose charges, and alternative land routes are not available, there can be no diversion at all. The pricing scheme might be effective even with less than complete coverage, because in reality it may be difficult for an average driver to divert from one bridge to another distant bridge to avoid a toll. In the Washington region, the bridges over the Potomac River offer an opportunity for the creation of a highway pricing system with such purposes. According to a study by the transportation consultants, Smart Mobility, Inc. and Anita Kramer & Associates:

"Highway capacity on bridges is very costly to provide, both in dollars and in its effects on the environment. Therefore, bridge capacity will always tend to be a scarce good, compared with more conventional roadway capacity. Our region could better manage this scarce bridge capacity with far less congestion delay by making some or all of the lanes on these bridges toll facilities. Fully automated electronic toll collection, with off-peak discounts, and dedication of toll revenues to improved transit and incident management would improve both efficiency and equity of transportation in the region. The NY-NJ Hudson River bridges and tunnels offer automated time-of-day toll discounts that help finance transit and cut traffic congestion. Our region can do so too."

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There are a variety of options and locations for the possible tolling on bridges in the Washington area that might ease congestion and alleviate transportation funding problems, while possibly improving air quality. These locations can be grouped into two categories: tolling of bridges on the beltway (at the reconstructed Woodrow Wilson Bridge and the American Legion Bridge) and tolling bridges going into D.C. (at the Key Bridge, the Arlington Memorial Bridge, the I-395 14th Street/Rochambeau Bridges, Chain Bridge, and/or the Theodore Roosevelt/I-66 Bridge).

With current technology, bridge tolls can be collected through an electronic EZ Pass system. This fee can be either a flat-rate fee, or it can be dynamic (varying depending on the level of congestion on the road or bridge or on the time of day.) With congestion-dependant dynamic tolling, if the fee is not high enough to reduce traffic to a level of free flowing condition, the toll can be raised through a dynamic electronic toll

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collection system. As with other highway pricing, an appropriate fee structure can always be designed to eliminate any waiting in line by raising the cost of driving during peak congestion periods.

The idea of tolling bridges into a congested city has been studied for New York City. In November 2003, the Regional Plan Association of New Jersey, Connecticut, and New York published “An Exploration of Motor Vehicle Congestion Pricing in New York.” The study found that by tolling the East River bridges into the city, along with the tunnels, traffic flow into the city could be reduced by five percent. It looked at both flat-rate tolls and variable tolls. While both reduced overall traffic into the city, the variable tolls reduced peak period traffic levels to an even greater extent. The study also concluded that there would not be a significant loss in the number of trips into the city’s core business district. In addition, it stated that public transit ridership would grow as a result.137

New York City’s Mayor Bloomberg was exploring the idea of implementing tolls on the city’s East River Bridges. However, in the end, the long history of public opposition to the tolls, along with a decreasing amount of political capital, resulted in Bloomberg giving up on the idea. Although the East River bridge tolls were not implemented, the study performed by the Regional Plan Association can be used as a partial guide in helping transportation planners in the Washington area determine how tolling Potomac River bridges would work. If the study can be compared to the situation in the Washington area, then tolling all the Potomac bridges into D.C. would reduce congestion coming into the city. In addition, variable tolls on the bridges would reduce peak period congestion even further.

Nevertheless, it should be noted that there are some differences in the two regions. First, people in the New York City area have more experience with tolls. Second, a much greater percentage of commuters traveling into New York City have available and are used to taking public transit, as compared with commuters in the Washington area.

WOODROW WILSON BRIDGE

The Woodrow Wilson Bridge has been one area of particular concern because of the bottleneck of traffic that it creates during peak travel times. Referring to morning conditions on the Woodrow Wilson Bridge, Skycomp Inc. states on their website:

“During surveys in 1993 and 1996, a zone of severe congestion was found on the inner loop of the beltway (in Maryland) approaching the Potomac River at the Woodrow Wilson Bridge; the tail of this queue was typically located in the vicinity of MD 210


According to the Woodrow Wilson Bridge Center, the Woodrow Wilson Bridge creates “one of the worst bottlenecks in the country.” When the Wilson Bridge was built in 1961, it was designed to have a capacity of 75,000 vehicles per day, for twenty years. However, the bridge now has almost 200,000 vehicles traveling over it daily. It is predicted that there will be approximately 295,000 vehicles per day by the year 2020.\footnote{Woodrow Wilson Bridge Project Homepage. Website accessed March 2004 at: www.wilsonbridge.com.}

Because of congestion problems on the Wilson Bridge, the Federal Highway Administration (FHWA), the Maryland State Highway Administration (MSHA), the Virginia Department of Transportation (VDOT), and the District Department of Transportation (D.DOT) came together to plan and support the construction of a new Wilson Bridge. According to the \textit{Woodrow Wilson Bridge Project December 2003 Financial Plan Update}, the river crossing superstructures will be completed by early 2008.\footnote{Woodrow Wilson Bridge Project December 2003 Financial Plan Update. Submitted (Revised) March 2, 2004 by the Partnership of the District of Columbia Department of Transportation, the Maryland State Highway Administration, and the Virginia Department of Transportation.}

The reconstructed Wilson Bridge will have a total of twelve lanes, eight of which will be general-purpose lanes. In addition to the general-purpose lanes, there will be two merge/divide lanes. The last two inner lanes will be used for HOV lanes, Express Bus lanes, or rail transit lines. The new Wilson Bridge will create much greater capacity, so presumably there will be higher traffic flow on the bridge and it should no longer cause a bottleneck on the beltway.

While congestion would not result from the new bridge in particular, it will provide an ideal location to implement a new beltway bridge tolling plan. This beltway bridge tolling plan would involve the implementation of dynamic tolls on all lanes of the two beltway bridges that cross the Potomac River: the Woodrow Wilson Bridge and the American Legion Bridge. The goal of this plan would be to substitute the payment of a toll for the long waits in line that at present take large amounts of commuter time at peak hours. Prices, rather than traffic delays, would serve to spread out the use of the Beltway. Meanwhile, it could also create a significant revenue source for Maryland, Virginia, and D.C.

If tolls are charged on the Wilson Bridge, they should be dynamic rather than flat rates. With dynamic tolling, the toll rate varies either by time of day or by the current...
level of congestion on the bridge. Dynamic tolling would spread traffic use outside of peak period hours.

Tolling the Wilson Bridge could also be used to reimburse the transportation funds of Maryland, Virginia, and D.C. for laying out the money for bridge construction (the portion of the funding that was not provided by the federal government.) The idea of tolling the Wilson Bridge was suggested by Peter Samuel. He argued that a tolling system on the bridge would benefit Maryland taxpayers who are paying in part for the bridge. A toll would also benefit Virginia and D.C. residents since their tax money is also paying partly for the bridge.

While tolls might be a fairer way to pay for the new bridge, the federal government is actually funding a large portion of the project. So in this sense, the citizens of Maryland, Virginia, and D.C. may not be paying more than their fair share under the current financing plan. Despite this contradiction, tolling would result in a user-pays situation. Whoever drives on the bridge would contribute money to the transportation funds of those who already helped to pay for the bridge construction. In addition, the money that could be made in toll revenue would be relatively high. If a toll of $1 per vehicle per crossing were collected, this would roughly create revenue of $200,000 per day, or $70 million per year.

A second option for tolling on the Wilson Bridge is to have a truck-only toll. Currently, the government in effect subsidizes truck driving in the U.S., and heavy truckloads often add large costs to maintaining the bridges. (See Chapter 4 for more information about trucks and tolls.) If trucks had to pay a toll on the Wilson Bridge, they would be helping to contribute their fair share of financing for the bridge. Also, if trucks are charged a toll on this popular bridge—and similar policies are adopted for other bridges and highways—factories may eventually decide to transport their goods using barges or trains or at less congested times.

A third option for tolling on the Wilson Bridge is a HOT lane toll on one lane in each direction. With HOT lanes, drivers of single occupancy vehicles are allowed to use HOV (high occupancy vehicles) lanes as long as they pay a fee. Note that drivers have the option of driving in the general/non-toll lanes, or in the HOT lane. Since HOT lanes are normally used to reduce congestion in the location where the HOT lanes are placed (and there would presumably not be a congestion bottleneck on the new, wider Wilson Bridge) HOT lanes would not be necessary on the bridge for the sake of bridge congestion itself. However, if HOT lanes are constructed on the beltway in Virginia and reach the start of the bridge on the Virginia side, the HOT lanes should be extended onto the bridge. If HOT lanes are constructed on the beltway in Virginia, increasing traffic flow coming to the bridge, (and HOT lanes are not implemented on the bridge) then the bridge may be the cause of a bottleneck for the beltway HOT lane.

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141 Samuel, Peter. *Fresh Thinking on $s for Transportation.* April 23, 2003. Posted on the website of Maryland Taxpayers Association, Inc.
Despite the benefits tolling on the Wilson Bridge would provide, there are problems with political and technical feasibility. A political problem with pricing the Wilson Bridge is its multiple-state/federal government ownership. It may not be politically feasible to place tolls on the Wilson Bridge since it is being partially funded by the federal government. According to the Woodrow Wilson Bridge Project December 2003 Financial Plan Update, “Through September 2003, the project has received a total of $1.544 billion in special federal funds.” The total cost to complete the Woodrow Wilson Bridge Project, as of September 30, 2003, is $2.5 billion. Virginia’s share of the project budget is $1,120 million ($912.3 million is from Obligated Special Federal Funds and Obligated Regular Federal Funds); Maryland’s share is $1,291 million ($1,174.4 million is from Obligated Special Federal Funds and Obligated Regular Federal Funds); and the District of Columbia’s share is $16 million ($14.4 million is from Obligated Special Federal Funds and Obligated Regular Federal Funds). At this point in time, $672 million has been spent on the project. As a result, much of the project is being paid for through federal government funding.

The financial plan notes that the states will have the funding needed to complete the project. However, it also states “Based on current revenue projections, this project will consume a large portion of VDOT’s interstate funds. Every possible effort will be taken during program development to minimize statewide impacts and balance overall available funding with other statewide priorities.” If tolling were implemented on the new Wilson Bridge, Virginia’s transportation budget would not have to be consumed by the Woodrow Wilson Bridge Project, or it would be paid back in a short period. Maryland, along with D.C., could also receive toll revenues in proportion to the amount of money they contributed towards the Woodrow Wilson Bridge Project.

As well as political issues, there may be technical problems with implementing a toll on the bridge. A technical problem in regard to creating HOT lanes on the bridge is that it may not be feasible to separate local lanes from through lanes there, as would normally be done on a HOT lane facility. However, new ideas in lane division technology may be able to solve this problem. According to Poole and Orski, “electronic and video technology can assist with enforcement” of HOT lanes. These technologies have been used successfully in other places such as London and Singapore.

142 Woodrow Wilson Bridge Project December 2003 Financial Plan Update. Submitted (Revised) March 2, 2004 by the Partnership of the District of Columbia Department of Transportation, the Maryland State Highway Administration, and the Virginia Department of Transportation.

143 Woodrow Wilson Bridge Project December 2003 Financial Plan Update. Submitted (Revised) March 2, 2004 by the Partnership of the District of Columbia Department of Transportation, the Maryland State Highway Administration, and the Virginia Department of Transportation.

AMERICAN LEGION BRIDGE

Another bridge on the beltway that regularly has traffic backed up on it during peak travel periods is the American Legion Bridge. However, it is likely that the bridge is not the cause of congestion even though it is experiencing the resulting delays. While the American Legion Bridge is not the cause of backups on the beltway, a tolling strategy for this bridge needs to be in place if there is to be a toll on the Woodrow Wilson Bridge. If there is a toll on only the Wilson Bridge, some interstate drivers will divert from the southern to the northern part of the beltway to travel around Washington, D.C. As described earlier, a beltway bridge tolling plan (involving dynamic tolling of all lanes on the Woodrow Wilson Bridge and the American Legion Bridge) would reduce congestion on the entire beltway at peak periods. As fees for driving on the beltway bridges are imposed, the total time for vehicle trips on the beltway during peak hours will be reduced. Some people who now commute as single occupancy drivers and who do not want to pay the bridge tolls will switch travel modes to mass transit, carpool, telecommute, or avoid their trip entirely. As vehicle time spent on the beltway is reduced, traffic flow on the beltway will increase.

POTOMAC RIVER CROSSINGS INTO WASHINGTON, D.C.

Tolling the bridges that carry commuters from Virginia across the Potomac River into D.C. could reduce traffic congestion in D.C. and increase revenue for the District. Bridges crossing into D.C. that could be tolled include the Francis Scott Key Bridge, the Arlington Memorial Bridge, the I-395 14th Street/Rochambeau Bridges, Chain Bridge, and the Theodore Roosevelt Memorial/I-66 Bridge.

According to D.DOT, the Theodore Roosevelt Memorial Bridge carries around 100,000 vehicles per day on weekdays between Virginia and Washington, D.C. on Interstate 66. The Theodore Roosevelt Memorial Bridge, opened in 1964, is a seven-lane bridge with a center lane that changes direction during morning and evening rush hours. This bridge is one of the main passageways for commuters, as well as tourists, to cross from Virginia into D.C.

The Francis Scott Key Bridge, built between 1917 and 1923, crosses the Potomac from Rosslyn in Virginia to Georgetown in D.C. on U.S. 29. It carries around 60,000 vehicles per day. The I-395 14th Street/Rochambeau Bridges, completed between 1950 and 1971, carry approximately 250,000 vehicles per day. And, yet another bridge that crosses the Potomac River from Virginia into D.C. is Chain Bridge. It was built after a 1936 flood destroyed the previous bridge. This bridge carries around 24,100 vehicles per day. Finally, the Arlington Memorial Bridge, constructed between 1926 and 1932, carries around 73,000 vehicles per day.145 Table 6-1 shows average annual weekday traffic volumes on each of these bridges.

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Table 6-1: Average annual weekday traffic volumes on Potomac River bridges.

One idea to reduce the overall level of congestion in D.C. is for all of these bridges to have corresponding tolls. If all of the bridges crossing the Potomac into D.C. were tolled, this would deter any unnecessary trips into the city. In addition, some people who would otherwise drive alone would carpool, telecommute, take mass transit, or avoid the trip altogether. Tolling all the Potomac River bridges into D.C. would negate the problem of diverting traffic onto another bridge if only one of these bridges were tolled.

A “HOT BRIDGE”

Another option for implementing congestion pricing into D.C. is to charge a toll on just one bridge into the city. This would presumably be more acceptable to the public because those who cannot afford the tolls would have the option of changing their commuting routes to use a different (and non-tolled) bridge into the city. The most promising bridge for a HOT strategy would be the Arlington Memorial Bridge, because there is easy access to this bridge from many directions, and alternative bridges for non-HOV vehicles and drivers who do not want to pay a toll are readily available.

However, a toll on a single bridge would control congestion only on that bridge. While the traffic flow rate on the tolled bridge would increase, some commuters would switch to different bridges, and congestion in the city would not be reduced as a whole. It could even become worse if commuters take smaller roads, less able to handle the traffic volumes. But this situation may not happen frequently since drivers would first choose roads with greater capacity than roads that are narrow and crowded. The benefits and costs of tolling one Potomac bridge into D.C., compared with tolling all of the Potomac bridges, should be considered when deciding future tolling options.

In addition to improving congestion (on one bridge or in the city as a whole), tolling Potomac River bridges into D.C. would create a new source of revenue for the District. This could replace the commuter tax that District leaders wanted to charge workers who commute into the city from neighboring Virginia (and Maryland). This commuter tax could not be implemented because, in 1974, Congress declared it illegal.

\[146\] Ibid.
to tax commuters. As an alternative revenue source, toll revenues could raise nearly $38 million. This estimate is based on the assumption that the tolled bridge is the Arlington Memorial Bridge, that it is tolled at $2 per vehicle during the entire weekday, and that the bridge is not tolled on the weekends. Note that this is a relatively low toll compared to the $7 toll proposed in the Regional Plan Association highway pricing study for the New York City East River bridges.

EXAMPLES OF HIGHWAY PRICING ON BRIDGES

The use of bridge pricing has been studied in other metropolitan areas, although no peak load system of pricing has been adopted. The studies provide some useful advice on how to propose and implement highway pricing and how traffic volume might respond to pricing on Potomac bridges.

Golden Gate Bridge Study

Gifford and Talkington calculated the price elasticity of traffic demand using data from the Golden Gate Bridge in the San Francisco Bay Area. Their study used traffic volume data from 1979 to 1983 during which time the Friday and Saturday toll was raised to $2 from the weekday toll of $1. The study found that when tolls are increased during part of the week, overall demand during the entire week is lowered. This shows a “complementarity of demand instead of a substitutability of demand.” The authors suggest that their findings may be related to the effect of raising tolls during peak traffic hours on the traffic demand during the rest of the day.\textsuperscript{147}

SanFranciscoOakland Bay Bridge Study

In \textit{Bay Bridge CongestionPricing Project: Lessons Learned to Date}, Frick et al. describe how the congestion-pricing proposal for the San FranciscoOakland Bay Bridge was developed. Unlike the bridges in D.C., the San FranciscoOakland Bay Bridge already has a toll which funds bridge improvements and public transit, among other things. In addition, many people in the San Francisco Bay region already use alternative modes of transportation to get to work. Frick et al. estimate that nearly 68 percent of travelers use transit, carpools, or vanpools. They believe that “the overall challenge for congestion pricing is not technical feasibility but public acceptance.”

To solve problems related to equity issues, in terms of the poor, a “lifeline” toll discount was added to the proposal. This discount would incorporate a reduced toll for low-income solo drivers. In the proposal, the reduction in morning peak delay was estimated at 40 percent, while the reduction in afternoon peak delay was estimated at 47 percent. According to Frick et al., “this substantial reduction in delay would occur by

\textsuperscript{147}Gifford, Jonathan L. and Scott W. Talkington. “Demand Elasticity Under TimeVarying Prices: Case Study of Dayof Week Varying Tolls on Golden Gate Bridge.” Transportation Research Record 1558, pp.5559.
diverting approximately seven percent of peak trips to different times or modes of travel."

Public acceptance of highway pricing on the San Francisco-Oakland Bay Bridge tended to depend on how the toll revenue would be spent. The study argued that if toll revenue is spent only for funding transportation projects, the toll will be seen by citizens as a “thinly disguised tax increase designed primarily to raise money for cash-short transit agencies." The authors suggested that “some level of revenue neutrality will be essential—rebating to toll payers some or all of the revenue generated by pricing clearly would demonstrate that raising money is not the only objective of congestion pricing plans.” One way to have this “revenue neutrality” would be to rebate the balance of the increased rush hour tolls to drivers not using the tolled lane or using the bridge during non-rush hour periods.

While it may be hard to convince solo, rush hour drivers that highway pricing is beneficial to them, they may be won over once they are convinced of how traffic will flow faster, their commuting times will decrease, and how revenue can be spent on public transit. The authors believe highway pricing on the San Francisco-Oakland Bay Bridge and the New York City bridges will be particularly successful because there are so few opportunities for travelers to choose nearby routes, creating "spillover traffic."\[148\]

New York City Study

“An Exploration of Motor Vehicle Congestion Pricing in New York,” the November 2003 study performed by the Regional Plan Association of New Jersey, Connecticut, and New York, predicted the effects of four different tolling scenarios on New York City traffic and revenue, among other variables. It found that, while tolling all access points into New York City would be more successful than tolling just bridges and tunnels, having flat-rate tolls or variable tolls on the bridges and tunnels alone would reduce traffic coming into the city by 5%.\[149\]

Lee County Bridges Study

In Lee County, Florida, there is a systematic bridge tolling system. Midpoint Bridge and Cape Coral Bridge, which connect the cities of Ft. Myers and Cape Coral have been tolled two ways since August 1998. The standard toll for typical two-axle, four-tire cars is $1, with vehicles with more axles charged more and motorcycles charged half. Drivers who use the Sanibel Bridge onto Sanibel Island are tolled $3 per trip, and this tolling facility began much earlier in 1963. Drivers who participate in the prepaid programs are eligible for variable pricing during certain non-peak hours when

\[148\] Frick, Karen T., Steve Heminger, and Hank Dittmar. “Bay Bridge Congestion-Pricing Project: Lessons Learned to Date.” Transportation Research Record 1558, pp 29-38.

they use the Midpoint or Cape Carol Bridge. Studies show that pricing effectively reduced congestion problems during rush hours and drivers in this case were quite price-sensitive. Some surveys found that more than 71% of the drivers with vehicle transponders (who participate in the prepaid programs) change their travel time at least once a week for a toll reduction that sometimes amounts to only 25 cents.

CONCLUSION

There are a variety of tolling options that can be implemented on bridges in the Washington region. The options that would most likely be successful at reducing peak period congestion would be a beltway bridge tolling plan in which all lanes of the Woodrow Wilson Bridge and the American Legion Bridge have dynamic tolling and dynamic tolling of one or all of the Potomac River crossings into D.C.

Dynamic tolling of the Woodrow Wilson Bridge combined with dynamic tolling of the American Legion Bridge would reduce overall congestion on the beltway and would especially reduce peak period congestion. Dynamic tolling of all Potomac River crossings into D.C. would presumably reduce traffic congestion inside the city. Dynamic tolling of one of the Potomac River crossings into D.C. would reduce congestion on that bridge and would create an option for people to pay for a shorter travel time to work inside the city.

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CHAPTER 7 – A VIEW OF THE FUTURE: COMPREHENSIVE HIGHWAY PRICING

The options presented in the previous chapters represent partial forms of highway pricing, based in part on considerations of present political feasibility and the complexities and costs of introducing new technology to collect highway revenues. This chapter considers the more distant possibility of introducing comprehensive highway pricing in which variable prices would be set for every road in the Washington region. Comprehensive road pricing has the great advantage that it solves the problem of diversions from priced to unpriced highways.

New traffic technology applications, collectively known as Intelligent Transportation Systems (ITS), are quickly becoming practically feasible and available at low cost and little inconvenience to motorists. ITS, in the not-so-distant future, could offer attractive opportunities for comprehensive pricing of roads in the Washington region. Such a regional approach, however, would require that each car have a Global Positioning System (GPS) to keep track of its actual use of the Washington road network. Such an initiative could face political resistance from both auto manufacturers and motorists who may have privacy concerns. Electronic toll collection (ETC) mechanisms, such as Smart Tag and EZ Pass, offer promise because they can be applied in such a way as to allow drivers via transponders (or “tags”) to use HOT lanes or other tolled facilities without stopping at tollbooths. Such technology can also be used to inform drivers of the road conditions and charges associated with use of that roadway at any given place and time. ETC systems tie the tag to an established account that is either linked directly to a credit card or smart card, or associated with an intermediary account that is in turn linked to the tag.152 The wide scale application of GPS and ETC technologies has the potential to transform our current traffic management practices, and is already doing so in some places around the world.

GPS TECHNOLOGY

GPS is a network of satellites “providing 24 hours, all weather 3-dimensional positioning and timing all over the world.”153 GPS is owned and maintained by the U.S. Department of Defense and is available to any consumer with a GPS receiver.154 The GPS system can be used to collect complete information on the position, direction, and speed of a moving vehicle.155

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155 Ibid.
Current models of GPS receivers have built in or “uploadable” maps to allow users to view their current highway position on the receiver’s screen.\textsuperscript{156} Many GPS receivers have extensive mapping capabilities that include “a base map of all the Interstate roads, most of the state routes, railroads, rivers, and shorelines in the Western Hemisphere with seven levels of detail.”\textsuperscript{157} Currently GPS receivers are available in the price range of $150 to $1,200, depending on their specific features and mapping capabilities.\textsuperscript{158}

The applicability of the GPS system for locating and monitoring vehicles at all times does have some limitations. The GPS system is prone to “signal blockage,”\textsuperscript{159} meaning the GPS signal is unable to penetrate tunnels, bridges, buildings, large vehicles, and heavily wooded streets.\textsuperscript{160} The GPS system generates a stream of “second-by-second observations in which there may be some missed observations because of signal blockage,” but it is still possible to obtain an overall picture of the movement of a vehicle.\textsuperscript{161}

Currently, auto manufacturers install GPS systems only in luxury and emergency vehicles. Realizing universal installation of the GPS systems in all vehicles, as would be required for comprehensive road pricing, might require a congressional mandate.

\textbf{HIGHWAY PRICING APPLICATIONS}

The GPS receiver can be used in many different applications, “such as transport planning, management, control and scheduling, and hence can play a potentially important role in intelligent vehicle-highway system[s] (IVHS).”\textsuperscript{162} One application is to link the GPS system with different levels of geographic information systems (GIS) data files to provide a comprehensive scheme for navigation and traffic management.

Another potential application is expressed in the idea of distance charging, which presumes the use of the GPS and an odometer-monitoring device. At the center of this system is a simple on-board computer containing GIS data files, a GPS receiver, a record of actual road user charges, and a link to the vehicle’s odometer (for back-up data on distance traveled).\textsuperscript{163} The computer calculates road miles traveled, compares

\textsuperscript{156} Low Cost GPS Receiver and Moving Map PC Software Reviews, \url{http://gpsinformation.net/ot-20.htm}
\textsuperscript{157} Ibid.
\textsuperscript{158} Ibid.
\textsuperscript{160} Ibid.
\textsuperscript{161} Ibid.
\textsuperscript{162} Ibid., 193
\textsuperscript{163} David J. Forkenbrock, “A Mileage-Based Road User Charge Concept.” a paper presented at the 83\textsuperscript{rd} Annual Meeting of the Transportation Research Board, July 2003 (unpublished), 3
this mileage with the odometer's measurements, and then “applies appropriate user charge rates to the mileage traveled within each jurisdiction.”\textsuperscript{164} Periodically this record “is uploaded [electronically] and transmitted to a data processing or collection center.”\textsuperscript{165} The center would bill the vehicle owner and reimburse the states, counties, cities, and central business districts that operate and maintain the roads on which the vehicle has traveled.\textsuperscript{166}

A “smart card” system for collecting road user charges includes a credit card sized electronic memory device that connects directly to the GPS-GIS system. This integrated approach has several important benefits:

- A low cost of collection for both agency and user,
- A stable revenue stream,
- An ability to assess higher charges for users who impose higher costs,
- A low evasion rate,
- The ability to offer incentives for users to travel on appropriate roads and to spread their trips across time periods, and
- A procedure that is unaffected by the method of vehicle propulsion.\textsuperscript{167}

As new propulsion systems, such as electric hybrid systems and hydrogen fuel cells, become more common, the connection between the imposition of a gasoline tax and actual road use becomes more and more tenuous. As the traditional fuel tax becomes less useful, states will have to find new ways to assess road charges based on actual road use and corresponding social costs imposed on society. Many transportation experts agree that “GPS systems will become the accepted way to impose all forms of urban charging in due course, particularly since they can also provide other services such as driver information systems.”\textsuperscript{168} The physical proximity and economic interconnectedness of three separate jurisdictions in the Washington area form a unique mixture of transportation problems that, in the event of any regional approach to highway pricing, may be best addressed with GPS technology.

\textsuperscript{164} Ibid. 1
\textsuperscript{165} Ibid.
\textsuperscript{166} Ibid.
\textsuperscript{167} Ibid. 2
\textsuperscript{168} Road pricing taxonomy and description. Urban Road Charging. www.env.leeds.ac.uk/its/private/level2/instruments
GPS PRICING IN GERMANY

The use of advanced technology for highway pricing is being pioneered on German highways for trucks. Because of its geographical location in the center of Europe, German roads receive heavy commercial trucking traffic. The German federal government has decided to institute tolls as a means of redistributing the costs of rebuilding and maintaining the highways among domestic and foreign users. All freight trucks must pay this new distance-based toll on all German motorways.169 No distinction is made between a loaded and an empty truck – all freight trucks must pay the toll.170

Shortly after the passage of the new pricing law, the German government sought a contractor to establish the new ETC system, the first of its kind in the country.171 In the fall of 2002, Toll Collect GmbH was awarded the contract.172 Toll Collect is planning a “two-phase introduction of the satellite supported truck toll” system.173 The initial timetable of the project is to begin electronic toll collection at the end of 2004 with the complete implementation of the system by the end of 2005.174 Toll Collect’s technology is a combination of “advanced applications and systems based on mobile telecommunications, GPS, and infrared sensors.”175

Toll enforcement consists of mobile and stationary methods that complement each other. The stationary enforcement method relies on “control bridges with permanently installed infrared sensors that are activated when they detect an approaching truck.”176 The incoming data is analyzed and is compared to the data at the control center. If the truck is determined to be in violation of the toll, information can be sent to mobile enforcement units.

Toll Collect does not hinder the flow of traffic because it does not require vehicles to slow down, stop, or be restricted to certain lanes. Toll Collect’s system offers users three ways to access the toll system to make a payment:

- Automatic log-on via the On-Board Unit,
- Manual log-on at more than 3,500 toll station terminals, and
- Manual log-on via the Internet.

170 Ibid.
171 Toll Collect Press and News. Toll Collect: Truck tolls that don’t disrupt the flow of traffic. www.toll-collect.de/presseaktuelles
172 Ibid.
173 Ibid.
174 Ibid.
175 Ibid.
176 Ibid.
Automatic log-on requires that an On-Board Unit be installed in the vehicle. Authorized service partners throughout Germany will install, activate, and maintain the On-Board Unit. During installation, permanent vehicle information, such as vehicle registration plate number, is entered into the On-Board Unit, thus establishing a permanent link between the vehicle and its On-Board Unit.\footnote{177}

Approximately 3,500 toll station terminals are located throughout Germany to satisfy the first manual payment option. These terminals can be found at most rest areas and gas stations and also at border crossing points. Paying a toll at the toll station terminal is similar to the process of buying a ticket from a ticket vending machine.\footnote{178} The user enters all relevant information, including vehicle data, starting time, destination, and other route information. This process can be simplified for the registered users who have been issued a vehicle card. Using input data, “the toll station terminal calculates the shortest route within the toll road network and displays it on the screen. The user can accept this route or choose an alternate route by entering additional route information.”\footnote{179} Once the user selects a suitable route and makes a payment, a valid log-on receipt is issued which entitles the user to travel on the chosen route.\footnote{180}

Though the second manual payment option requires prior registration with Toll Collect, payment over the Internet can be made regardless of time and place.\footnote{181} The Internet log-on alternative shares the characteristics of the tolling stations procedure, but has the added benefit of allowing users to store frequently traveled routes.\footnote{182} The only requirements for logging on via the Internet are Internet access, a web browser, and registration with Toll Collect.

Tolling the trucking industry in Germany is the first example of the application of intelligent transportation technologies for allocating costs associated with the use of public roads. In this case one category of highway consumers and societal externalities produced by their daily activities is identified and compelled to internalize the external costs of their business operations. In addition, the German example has proven to be convenient, flexible, and cost-effective.

**PRICING TECHNOLOGY IN SINGAPORE**

Singapore has a long history of road pricing, as was described in Chapter 1 of this report. To improve the system, which was first implemented in the 1970s, the Singapore government announced plans to introduce Electronic Road Pricing (ERP) in

The technology used in ERP in Singapore includes a “complicated combination of radio frequencies, imaging and smart card technologies, optical detection, and cameras and computers working in unison.” The three main components of the system are:

- The In-vehicle Unit (IU) with the CashCard,
- ERP gantries located at the same points as the control points, and
- A control center.

Each IU is tied to the registration number of the vehicle to which it is attached. Different IUs are issued and varying tolls are charged for different classes of cars — such as personal vehicles, taxi, motorcycle, commercial vehicles, or trucks. To discourage illegal switching, IUs are color-coded and cannot be switched between different classes of vehicles. All vehicles registered prior to the introduction of the ERP were issued IUs without charge. In addition to issuing free IUs, the government of Singapore provided additional incentives to motorists by way of tax rebates. Foreign motorists (predominantly from Malaysia) may rent IUs or install permanent units.

The IU debits the CashCard for the toll every time a vehicle travels under a set of gantries. The IU has a liquid crystal display (LCD) screen that displays the balance on the card at the point of initial contact and after each transaction. The IU can also warn the driver when the cash balance is low. The CashCard is reusable and can carry a maximum balance of S$500 ($300 USD). The CashCard was launched in November 1996 “by a consortium of seven banks at a development cost of S$40 million ($28.4 million USD).” The CashCard is available nation-wide and, in addition to ERP tolls, can be used at some retail shops, for bus and taxi fares, telephone calls, and parking lot fees.

The Singapore Land Transit Authority (LTA) is the government agency in charge of the ERP scheme. According to LTA, by varying prices according to highway traffic

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183 Ibid.
184 Ibid.
185 Ibid.
186 Ibid.
187 Ibid.
188 Ibid.
189 Ibid.


conditions, “ERP has been effective in maintaining a speed range of 45 to 65 km/h (28 to 40 mph) for expressways and 20 to 30 km/h (12 to 19 mph) for major roads.”

Electronic Road Pricing in Singapore is one of the earliest and most successful examples of an application of road pricing in an urban environment. While road pricing in Germany applies only to a particular category of vehicle, road pricing in Singapore applies to all vehicles. In addition to the active role the government played to create incentives for ERP, the fact that Singapore is a densely populated island with scarce land resources factored into public acceptance of highway pricing.

INTELLIGENT TRANSPORTATION SYSTEMS AND PRIVACY ISSUES

Many ITS technologies and applications do not identify a particular vehicle and thus have no impact on privacy. However, technologies that generate and maintain databases about a vehicle and its driver might have serious privacy-related implications. Electronic toll collection (ETC) might have the most serious implications for the use and potential abuse of personal information. The development and proliferation of ITS, and ETC in particular, will provide massive amounts of detailed, cumulative, personal, and potentially real time location and identification data. This raises the prospect of real time and retrospective surveillance of the movement of vehicles and/or people.

Different groups of consumers may react differently to the use of personal information. For example, commercial vehicle operators, such as trucks, buses, couriers, and taxis may want to compile and maintain “both historical and real time location data for tags/vehicles which they own.” However, because of the possibility of real-time tracking, regular automobile users may be concerned that GPS systems, video cameras monitoring traffic, and electronic vehicle identification tags will be used to conduct “unwarranted and unwelcome surveillance on specific individuals.” When it comes to electronic toll payments there are several ways to address privacy concerns and to guarantee anonymity. One option is to link the tag to the smart card, thus limiting financial transactions to the card and the toll road operator’s account. Another alternative is to establish an anonymous account with the toll road operator. The user will be responsible for maintaining an adequate balance in the account and in return would be guaranteed anonymity. Privacy advocates stress that “it is the tag that

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190 Ibid.
191 Ibid. 3
193 Ibid. 126
195 Ibid. 127
196 Ibid.
needs to be identified, not the vehicle. For example, it is conceivable that the same tag might be shared among several cars in the same household. Privacy advocates insist that tag users need to provide only “the minimum amount of information which is necessary for the toll road operator to identify the right account and bill the correct toll.”

Further, the information generated and stored by an electronic toll collection system is not much different from the information reflected in credit card and cell phone records. Multiple databases already exist that track the daily activities of millions of Americans. Not all potential violations of privacy have negative societal impacts. For example, electronic road surveillance can be used for traffic enforcement and for tracking criminals. If all cars are equipped with a GPS receiver and electronic surveillance is widespread, knowledge of this information alone might discourage criminal behavior. It may be the case that a balance between individual privacy concerns and societal benefits is achieved through new technological innovation such as GPS and electronic toll collection.

CONCLUSION

Road pricing as a policy instrument holds great potential. Eventually, pricing all roads might have the most dramatic effect on the goal of improving traffic flow, enhancing highway efficiency, and reducing congestion. However, this process will take time. According to the U.S. Department of Transportation, because of the normal vehicle turnover rate, it would take 20 years to outfit the entire automobile fleet with a GPS system. Meanwhile, the focus should be on building public acceptance of intelligent transportation technology systems, which includes allaying the public’s privacy concerns. To ensure wider public acceptance, in the short term the objective should be to demonstrate the benefits and convenience of the system. In the long run the objective should be to bring the cost of this technology down so as to encourage auto manufacturers to install this technology in all vehicles.

Eventually, universal road pricing could be implemented down to the level of a neighborhood street. A commuter, once in his car, would plug a desired destination into the system with the computer feedback on possible areas of congestion or alternate and cheaper routes. Thus, a combination of ITS and a pricing mechanism can be used to divert traffic from congested streets by raising the price of traveling on those roads. Ideally, such a system would price a particular road or route based on actual congestion, by raising the price of traveling on a particular road as soon as some threshold number of cars accumulates on a stretch of road susceptible to congestion. Such a system could also be used to manage traffic by giving drivers real time information about accidents, congestion, road construction, and closures.

197 Ibid.
198 Ibid.
One of the main objections against pricing certain streets is the diversion of traffic into neighborhoods and smaller streets less equipped to handle a large volume of traffic. However with an omnipresent pricing scheme, the problem of diversion into residential neighborhoods and smaller streets would be resolved. To discourage drivers from cutting through neighborhoods, excessively high rates could be applied to those routes during peak-hour traffic. However, transportation experts seem to be in consensus that no road pricing scheme can be installed and introduced all at once in a large metropolitan area. A gradual phase in of any comprehensive road-pricing scheme is necessary and would, through phased implementation, afford an adjustment period for the public.

CHAPTER 7 BIBLIOGRAPHY


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200 Ibid. 54


PART II – HIGHWAY PRICING AND SMART GROWTH FOR THE WASHINGTON REGION
One benefit of reducing vehicle time spent idling in traffic jams is that it might help the region meet federal air quality standards. Cars, buses, and trucks are the area’s top sources of volatile organic compounds (VOCs) and nitrogen oxides (NO\textsubscript{x}), the two primary precursors to the formation of ozone (“smog” in common language). In 1990, cars, buses, and trucks contributed 58 percent of the total man-made VOCs and 44 percent of the area’s NO\textsubscript{x}. Air quality planners estimate that in 1990, cars, buses, and trucks produced 399 tpd (tons per day) of VOCs. The next highest contributor that year was lawn and garden equipment contributing 40 tpd. In the same year, it was estimated that cars, buses, and trucks contributed 380 tpd of NO\textsubscript{x}. The next runner-up was utilities and other sources at 361 tpd, with construction next at 62 tpd. This chapter explores the interactions between highway use (as it might be managed by pricing policies) and the air quality of the Washington region.

In April 2004, EPA designated the Washington metropolitan area in “moderate” non-attainment for the new 8-hour ozone standard. Now the region must submit a new air quality plan to EPA in 2007 and meet the standard by 2010. Two local government organizations play key roles in attaining air quality standards: the Metropolitan Washington Air Quality Committee (MWAQC) and the National Capital Region Transportation Planning Board (TPB). Each is housed in the Metropolitan Washington Council of Governments (MWCOG). The map in Figure 8-1 depicts the Washington area’s air quality region.
The Washington Metropolitan Air Quality Region is comprised of Washington, D.C.; Loudon, Arlington, Prince William, and Stafford counties in Virginia; and Frederick, Montgomery, Prince George’s, Charles, and Calvert counties in Maryland.

In spite of the fact that cars, buses, and trucks together contribute more VOCs and NOx to the area’s skies than any other single source, Traffic Control Measures

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(TCMs) are not primary targets at present for reductions in the Washington-area SIP. Ronald Kirby, Director of the Department of Transportation Planning at MWCOG explains the thinking of local air quality officials in a letter July 17, 2002 to the Senate Committee on Environment and Public Works:

“Transportation Control Measures (TCMs) play a very small role in the regional air quality attainment plan, accounting for only 0.2 tons per day of VOC reductions and 0.4 tons per day of NOx reductions in 2005. As you know, once TCMs are included in SIPs they can be changed only through a lengthy SIP amendment process. Because of this lack of flexibility, the only TCMs included in the Washington area SIPs are TCMs associated with capital projects that have already been completed. Such measures include park-and-ride lots, bus and rail transit vehicle replacements, and bicycle facilities. By comparison, emissions reductions of around 4.5 tons per day of VOC and 7.7 tons per day of NOx are being achieved through Transportation Emission Reductions Measures (TERMs) which are incorporated into the CLRP and annual TIP updates as they are needed to meet conformity requirements. These latter measures include employer outreach programs to promote increased carpooling and vanpooling, transit use and telecommuting, CNG buses, and bicycle facilities. ”

As this letter indicates, it appears that Washington air quality planners have not devoted serious study to the possible use of highway pricing as a possible TCM for improving air quality. This may have reflected an assumption that highway pricing would be politically infeasible and the absence of previous experience with highway pricing in the Washington region. However, for the reasons examined in previous chapters of this report, there is good reason to expect that highway pricing will play an increasing role in transportation planning in this area. In future SIP and other air quality planning, various options for highway pricing, including some of those explored in previous chapters, should be part of the planning process. This is especially important where highway pricing cannot only adjust to reflect the social costs but also the environmental costs of traffic.

TRAFFIC AND EMISSIONS

Mobile source emissions are determined by a variety of factors such as vehicle miles traveled (VMT), fleet mix, number of trips, number of vehicles, distances, and speeds. The figures below show how emissions models relate speed and vehicle types to emissions.
Figure 8-2: NOx emissions are higher at start up for all vehicle types. Chart data from “Emissions Factors for Automobiles, Trucks, Buses, and Motorcycles.”

NOx emissions are higher at start up for all vehicle types. After tapering off, NOx emissions increase even more than at start up after speeds of 65 mph. Maintaining a speed of 30 to 40 mph is ideal for reducing NOx emission. However, stop-and-go traffic for buses and heavy-duty diesel trucks appears to produce a maximum of NOx emissions.

Figure 8-3: VOC emissions are highest when vehicles start up. Chart data from “Emissions Factors for Automobiles, Trucks, Buses, and Motorcycles.”

Figure 8-3 shows that emissions of VOCs decrease with speed for most vehicles except for autos and light trucks whose emissions start to increase around 60 mph. The chart implies that stop-and-go traffic traveling from 0 to 15 or 20 mph (as occurs in congestion) produces the most VOC emissions.

Even though air quality planners mainly focus on VOCs and NOx, public health is also affected by particulate matter (PM). The following chart shows how different vehicles contribute to particulate emissions.

Figure 8-4: This chart shows PM10 emissions remain steady at various speeds for most vehicle types. Chart data from “Emissions Factors for Automobiles, Trucks, Buses, and Motorcycles.”

Figure 8-4 shows PM10 emissions remain steady at various speeds for most vehicle types. The exception is buses, whose emissions decrease until they reach about 45 mph. The chart also shows the magnitude of diesel emissions from heavy-duty trucks compared with autos and light-duty trucks. Only buses’ emissions of particulate matter are affected by speed in the emissions model, with PM starting at 0.57 grams per mile (gpm) at 5 mph and diminishing to 0.15 gpm at 60 mph. Autos and light duty trucks emit 0.02 gpm at all speeds, while heavy-duty trucks emit 0.96 gpm at all speeds.

HIGHWAY PRICING AND EMISSIONS

Some researchers predict that improving traffic flow in areas with NOx problems will exacerbate ozone formation by increasing vehicle speeds, while other models and empirical studies find highway pricing and other traffic control measures reduce emissions. Stop-and-go driving increases vehicle emissions, according to a California Air Resources Board report. The report estimated that hydrocarbon emissions tripled when an average 1987 auto traveled at 20 mph rather than at 55 mph on a 10-mile trip.

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According to this report then, highway pricing would reduce vehicle emissions per mile as traffic returned to a free flow. Emissions also would be reduced if pricing reduces the number of trips, causes people to switch to higher occupancy modes, or causes people to modify the timing of their discretionary trips. If highway pricing induces greater demand by increasing road capacity, or if drivers seek longer alternate routes, emissions could increase.

There are no general methods for quantifying improvements in air quality from any given TCM, but there are several interesting studies of individual HOT lane projects and their effects on vehicle emissions. UCLA transportation researcher Eugene Kim modeled the conversion of an HOV lane on a congested freeway to a general-purpose lane, a HOT lane, or a tolled express lane. “In almost all cases, HOT or toll lanes provided a greater degree of fiscal benefits, consumer welfare, and environmental benefits than any other expressway investments. But in almost all cases, converting to a toll lane produces greater benefits, primarily because doing so can preserve free-flow conditions as traffic continues to grow and freeway congestion worsens. Another benefit is that toll lanes generate substantial revenues for the transportation system.”

The difference between HOT and tolled express lanes is whether or not HOVs must pay. Kim’s model found that the tolled express lanes preserved the incentive to carpool and still reduced delay.

A 1994 study by the Puget Sound Regional Council (cited in “Opportunities to Improve Air Quality through Transportation Pricing Programs.”) found that roadway highway pricing fees set at 5 to 30 cents per mile, depending on the level of congestion, could decrease VMT in peak periods by 5 to 10 percent; NOx by 0 to 2 percent; VOC by 0 to 7 percent, and PM10 by 2 to 3 percent.

The I-15 FasTrak project in San Diego lets solo drivers pay a variable fee to use about 8 miles of the I-15 HOV lanes. A three-year study of the effect of these HOT lanes on vehicle emissions concluded that the pricing program moderated the increase of emissions in the I-15 corridor during a period when these levels were increasing along a matched control corridor. Because other factors such as job growth, home construction, and population growth would have affected travel and emissions in a study like this, it is not possible to attribute the lower emission to the pricing program with statistical certainty. However, the authors note these factors were present for both corridors and were more likely to adversely affect the I-15 corridor than the control

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The report concludes “No factors other than the FasTrak program were identified that could have reduced or mitigated emissions levels.”

The study data found the percent changes for both VOC and NOx emissions in the I-15 corridor remained lower than emissions for the control corridor and that these reductions were statistically significant. Figures 8-5 and 6 depict the percent change in emissions from one year to the next, and were generated from data tables in the I-15 study. All scales have been adjusted to show a maximum of 35 percent so that percent changes are visually equal from one chart to the next.

**Figure 8-5: The data show the percent changes for VOC emissions in the I-15 corridor remained lower than those for the control corridor.**

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Figure 8-6: The data show the percent changes for NOx emissions in the I-15 corridor remained lower than those for the control corridor.

CALIFORNIA AIR BOARD STUDY

A study done for the California Air Board modeled the effects of five pricing measures in four metropolitan areas: Los Angeles, the Bay Area, San Diego, and Sacramento. The authors found that combining “congestion pricing, employee parking charges, a 50 cent gas tax increase, and mileage and emissions fees, it would be possible to reduce VMT and trips by 5 to 7 percent and reduce fuel use and emissions by 12 to 20 percent, varying by region” 211

The study also used focus groups and feedback from public officials and private organizations to investigate public responses to transportation pricing. The report says, “First reactions were skeptical, but many were more favorably inclined after considering alternatives to pricing. Public acceptance would be increased by earmarking revenues for transportation improvements and providing independent oversight of revenue collection and expenditure.” 212 The study does not say what alternatives to pricing were presented to respondents. It also notes that some federal and state laws would need to be changed to implement some of the pricing strategies.


212 Ibid.
The highway-pricing model used in the California Air Board study assumes “that prices would be assessed on a per mile basis everywhere that congestion appears in the highway network, including on arterials and collector streets as necessary. A technology for electronic toll collection would provide information about tolls on upcoming segments, likely as part of a broader highway information system. Prices would … be set to reflect average conditions on each highway link during each period of the day, perhaps with seasonal adjustments. The results shown here are based on a reduction of congestion to level-of-service D/E, defined as a volume-to-capacity ratio of 0.9. Note that travelers would continue to experience some delay under this criterion, but that greater reductions in volume might not be justifiable in economic terms. This study did not discuss the costs of pricing measures or how they would be implemented. And the conclusion of the study may have been more positive about pricing if the volume-to-capacity ratio changes in a way that would justify a reduced traffic volume and greater speeds on the road.

The following table is reproduced from the study:

<table>
<thead>
<tr>
<th>Region</th>
<th>Averag e Price per mile</th>
<th>Change from 1991 Base</th>
<th>Annual Revenue ($millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VMT/PM10</td>
<td>Trip s</td>
<td>Time</td>
</tr>
<tr>
<td>Bay Area</td>
<td>$0.09</td>
<td>1.8%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Sacramen t o</td>
<td>$0.04</td>
<td>0.6%</td>
<td>0.5%</td>
</tr>
<tr>
<td>San Diego</td>
<td>$0.06</td>
<td>1.0%</td>
<td>0.9%</td>
</tr>
<tr>
<td>South Coast</td>
<td>$0.10</td>
<td>2.3%</td>
<td>2.2%</td>
</tr>
</tbody>
</table>

Table 8-1: According to these results a highway pricing project like the one described by the authors could reduce ROG emissions from 1.5 to 5.5 percent and NOx emissions from 0.7 to 2.5 percent. (ROG=Reactive Organic Gasses)

**SUMMARY OF RESEARCH**

Each of these studies anticipates reductions in mobile source emissions associated with highway pricing. Three of the four used emissions models to assess the effects of HOT lanes or highway pricing and estimate emission reductions. (The methodology for the Puget Sound study is unknown.) Although emissions models are

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213 Ibid.
improving, they tend to overestimate emission reductions. Because the I-15 study used field data, included a control corridor, and covered three years of data, its results are the most credible. However, it too, used a model to determine emissions. It is probably true that highway pricing can reduce mobile emissions by improving traffic flow in an area as congested as Washington, but it is difficult to say how much emissions reductions would reduce ozone levels or if these reductions could affect the area’s ability to achieve ozone standards.

One way to ensure lower ozone levels when traffic flow is improved is to use the highway pricing revenue to improve mass transit. A highway-pricing project should include setting aside funds for improving Metro, expanding bus service, or adding Bus Rapid Transit. Raising parking fees so that it is more cost effective to take mass transit could also improve the use of mass transit and decrease rush hour traffic.

**OZONE-DAY PRICING OF HIGHWAYS**

Another way to improve air quality is to use pricing to discourage driving during conditions conducive to ozone formation. Once technology is in place to implement highway pricing, it can be used to indicate when driving produces additional costs of creating ozone pollution and all its associated health implications.

If pricing consists of HOV/HOT lanes and free regular lanes, increasing the price of the toll lanes on ozone days could increase congestion and emissions on the free lanes. But if the pricing project includes a credit to drivers on the free lanes, then most drivers can be expected to have a transponder.

In this case, on ozone days, it would be possible to manage the pricing system in a way that would discourage individual drivers and encourage use of mass transit. People who drive on ozone days could be charged higher prices all around; while those who do not use their cars that day could have their accounts credited. This type of pricing, along with free Metro and bus transportation on ozone days could be used to significantly reduce traffic on ozone days. With technology that allows individual vehicles to be charged or credited, with improved mass transit, and with information provided to drivers as early as the night before, it could be possible to manage traffic demand to significantly diminish the harmful effects of air pollution.

From 1992 to 2002 the area exceeded the 1-hour ozone standard from 1 to 9 days; it would have exceeded the 8-hour standard from 10 to 52 days. Using pricing algorithms that raise variable congestion prices higher only when weather conditions are right for creating ozone could be a very precise and effective way to manage emissions in order to reach attainment of the NAAQS (National Ambient Air Quality Standards) for ozone and PM2.5. Because the mechanism for pricing would already be in place, ozone pricing could be a low-cost way to improve air quality.

For example, when the area expects sunny stagnant days to allow ozone levels to build, weather reports the night before typically forecast ozone days and remind people that Metro is free on ozone days. Forecasts could also include a notice that
ozone pricing during the ozone alert is in effect. Eventually most drivers will know to expect higher prices on ozone alert days, just as they now know that Metro buses and the subway are free those days. Ozone prices could be set to encourage postponing trips until later in the day or to encourage as little driving as possible. Prices could return to normal in the evening hours when ozone formation diminishes. Just as prices would be varied to mitigate congestion, they can be varied to mitigate air pollution.

Using ozone pricing to reroute or eliminate heavy-duty diesel traffic during the hours of ozone formation could be effective and have the added benefit of removing diesel particulate matter pollution from residential areas. Trucks produce from 10 to 20 more gpm of NOx than cars and light duty trucks and more PM (.96 gpm) than autos and light duty trucks (0.02 gpm). Reducing their number and/or rerouting them away from populated areas would improve public health as well as air quality.

Using ozone pricing to reduce traffic enough to prevent the ozone level from exceeding standards on specific days has a number of benefits, as long as it does not induce greater congestion in general purpose lanes. There would be very little cost to implement ozone pricing, since it would be a simple revision to the pricing algorithm already in place. It would be a politically palatable way to reduce ozone levels by “making the polluters pay.” It would produce reductions when they are needed and it would further inform drivers of the consequences of travel mode choices.

CHAPTER 8 BIBLIOGRAPHY


CHAPTER 9 – HOW TO GROW SMARTLY

Development patterns are a leading policy issue in the U.S. as more and more people are moving to cities and outer suburbs are growing rapidly. Existing patterns of development have contributed to increased traffic, air pollution, and other problems that may lower the quality of life in an area. Policy makers are searching for ways to mitigate some of the negative effects of current development patterns while still promoting economic development. Proponents of “smart growth” argue that transit-oriented communities are part of the solution, while opponents claim the costs of policies that promote smart growth are higher than the benefits. A combination of highway pricing and improved public transportation could satisfy both concerns. If land use and transportation decisions are considered together for the entire Washington region, it is possible to develop infrastructure and policies that will support development that respects property rights, preserve land for agricultural and environmental purposes, and allow for affordable housing within reach of several transportation alternatives.

HOW ARE TRANSPORTATION AND DEVELOPMENT PATTERNS INTERRELATED?

Transportation networks and development patterns are often highly interrelated. A quick glance at a map of the Washington area will illustrate this point. Almost all major communities in the metropolitan area are serviced by a major highway or transit network. The automobile is the principal means of commuting in the region. In suburban Maryland, close to 80 percent of commuters drive to work and most of these commuters are driving alone. Any significant shift in traffic patterns could have a significant effect on development patterns.

Studies have shown that the physical form of cities is highly dependent on the transportation infrastructure. The difference is evident in the divergent development patterns of cities that grew before the automobile became common, such as Boston or New York City, or after, such as Houston or Phoenix.

Some cities are beginning to consider transportation, land use, and development decisions together. Los Angeles has included an integrated planning process called Planning for Integrated Land Use and Transportation (PILUT) as part of its 2004 Regional Transportation Plan called Destination 2030. Various PILUT scenarios were modeled, including infill development or development on the outskirts of the metropolitan area. The models demonstrated that integrated land use and transportation planning helped to reduce annual delay and VMTs.

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214 U.S. Census 2000 data; http://factfinder.census.gov/servlet/BasicFactsServlet
Integrated planning is beginning to be considered on a smaller scale in the Washington region. The National Capital Region Transportation Planning Board (TPB) is conducting a Regional Mobility and Accessibility Study (RMAS) to “evaluate alternative options to improve mobility and accessibility between and among regional activity centers and the regional core.” The RMAS will examine six land-use and transportation scenarios for outcomes such as traffic, commuting distance, land use, and vehicle emissions. One of the scenarios includes a highway-pricing scheme in the form of HOT lanes.

**HOW WILL HIGHWAY PRICING AFFECT DEVELOPMENT PATTERNS?**

Implementation of highway pricing could have a significant influence on the relationship between transportation networks and development patterns. Upon first glance, some may be concerned that highway pricing could be too successful by promoting undesirable growth in distant areas. However, the issue is more complicated. If highway pricing is implemented, commuters will pay for the ability to save time. In San Diego, the cost of using the HOT lanes on I-15 during peak hours is about $0.50 per mile. If this price were implemented on I-66 in Virginia and the District of Columbia, the price of commuting from Haymarket to downtown Washington (over 35 miles each way) would be about $35 per day in addition to typical driving costs such as gasoline and maintenance. If a Haymarket commuter used the priced lanes daily, that person would add over $8000 per year to their commuting costs, obviously a prohibitive amount for most people.

Currently, commuters are paying these costs in the form of traffic delays. If highway pricing were implemented, commuters would pay the toll instead. It is uncertain how the public will view this economic tradeoff when they determine where to live. Some may decide that the tradeoff is even, and their decisions of where to locate will not change significantly. Others may decide that the price is too expensive and may move closer to their workplace to avoid traffic delays, or that the value of their time is high and they will move farther from their workplace since they can pay to avoid traffic.

It thus remains uncertain how highway pricing alone will affect development patterns. Indeed, Chris Fiscelli of the Reason Public Policy Institute points to highway pricing as a way to “truly mitigate traffic congestion without preference for a specific land use pattern.” In other words, he believes that the economic incentives for people to change their location preferences are neutral; a monetary price will be substituted for the value of time that commuters currently waste in traffic. This is an important

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217 National Capital Region Transportation Planning Board, “Proposed High Occupancy Vehicle/High Occupancy Toll (HOV/HOT) Lane Alternative Transportation Scenario for the TPB Regional Mobility and Accessibility Study”, Draft of March 8, 2004

218 San Diego Regional Planning Agency I-15 FasTrak website, http://argo.sandag.org/fastrak/

characteristic of a successful pricing scheme – the price must be set where the demand for toll lane usage equals the capacity of the lanes.

However, this does not mean that a highway-pricing scheme has no impact on development patterns. In fact, highway pricing could provide the free-flowing capacity necessary for an effective express bus or Bus Rapid Transit (BRT) service. Revenues from congestion tolls could be used to help pay for other transportation options that could allow communities to change their development patterns in ways that would help to improve the quality of life of their citizens. Even if highway pricing does not directly alter development patterns, the revenue it generates may allow decision makers to implement policies that promote the type of development that communities desire.

GROWTH AND TRAFFIC

Growth is an important aspect in any community. Economic development helps improve a region’s economy, improving the quality of life of its citizens. Population growth is one important driver of development. However, population growth can also lead to more traffic and more congestion on a region’s roadways. This problem is especially troublesome in the Washington region. As can be seen in Table 9-1, the population of the Washington area increased 13 percent in the decade from 1990 to 2000; in the current decade it is projected to increase another 9 percent; and by 2025 it is expected to be 22 percent above 2000 levels.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Percent difference from 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>6.7 million</td>
<td>−13 %</td>
</tr>
<tr>
<td>2000</td>
<td>7.6 million</td>
<td>---</td>
</tr>
<tr>
<td>2010</td>
<td>8.3 million</td>
<td>9%</td>
</tr>
<tr>
<td>2025</td>
<td>9.3 million</td>
<td>22%</td>
</tr>
</tbody>
</table>

Table 9-1: Washington Metro Area Population History and Projections

This increase in population has had and will continue to have dramatic effects on traffic and development patterns in the region. Data from the 1990s show that population growth in the Washington area is being fueled by the outermost of the suburbs. As seen in Table 9-2, population increases in the outlying suburbs such as Loudoun County in Virginia and Calvert County in Maryland are dramatic, while areas closer to downtown Washington have grown modestly (the District actually decreased in population during the 1990s).

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<table>
<thead>
<tr>
<th>County</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loudoun County, Va.</td>
<td>97%</td>
</tr>
<tr>
<td>Manassas Park, Va.</td>
<td>51%</td>
</tr>
<tr>
<td>Stafford County, Va.</td>
<td>49%</td>
</tr>
<tr>
<td>Calvert County, Md.</td>
<td>45%</td>
</tr>
<tr>
<td>Howard County, Md.</td>
<td>33%</td>
</tr>
<tr>
<td>Prince William County, Va.</td>
<td>31%</td>
</tr>
<tr>
<td>Frederick County, Md.</td>
<td>30%</td>
</tr>
<tr>
<td>Manassas, Va.</td>
<td>27%</td>
</tr>
<tr>
<td>Fairfax, Va.</td>
<td>19%</td>
</tr>
<tr>
<td>Charles County, Va.</td>
<td>19%</td>
</tr>
<tr>
<td>Arlington, Va.</td>
<td>15%</td>
</tr>
<tr>
<td>Anne Arundel County, Md.</td>
<td>15%</td>
</tr>
<tr>
<td>Montgomery County, Md.</td>
<td>15%</td>
</tr>
<tr>
<td>St. Mary’s County, Md.</td>
<td>14%</td>
</tr>
<tr>
<td>Fauquier County, Md.</td>
<td>13%</td>
</tr>
<tr>
<td>Arlington County, Md.</td>
<td>11%</td>
</tr>
<tr>
<td>Prince George’s County, Md.</td>
<td>11%</td>
</tr>
<tr>
<td>Falls Church, Va.</td>
<td>10%</td>
</tr>
<tr>
<td>Fairfax, Va.</td>
<td>8%</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>−6%</td>
</tr>
</tbody>
</table>

Table 9-2: Percent Change in Population, 1990 – 2000

This distribution of housing is having major effects on traffic since most of these people are commuting to work. The Texas Transportation Institute publishes annual statistics on mobility in the Washington area; some of this data is shown in Table 9-3. These data show that population is expanding; however, from 1990 to 2000, population density actually declined (although the base area may have changed). This is further evidence of the rapid growth of the outer suburbs, which is increasing traffic on the region’s roadways. While population grew 16 percent, freeway vehicle miles traveled increased 93 percent, leading to 57 percent more annual delay per person. Congestion cost to the region is greater than $2 billion dollars, and the congestion cost per capita doubled during the 1990s.

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<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>2,700</td>
<td>3,100</td>
<td>3,600</td>
<td>+ 16%</td>
</tr>
<tr>
<td>Population density</td>
<td>3,395</td>
<td>3,690</td>
<td>3,495</td>
<td>– 5%</td>
</tr>
<tr>
<td>Daily freeway VMTs (000)</td>
<td>15,200</td>
<td>17,860</td>
<td>34,535</td>
<td>+ 93%</td>
</tr>
<tr>
<td>Annual delay (person-hours)</td>
<td>27.0 million</td>
<td>66.1 million</td>
<td>120.1 million</td>
<td>+ 82%</td>
</tr>
<tr>
<td>-per capita</td>
<td>10</td>
<td>21</td>
<td>33</td>
<td>+ 57%</td>
</tr>
<tr>
<td>Delay saved by transit</td>
<td>10.7 million</td>
<td>32.2 million</td>
<td>47.8 million</td>
<td>+ 49%</td>
</tr>
<tr>
<td>-per capita</td>
<td>4.0</td>
<td>10.4</td>
<td>13.3</td>
<td>+ 28%</td>
</tr>
<tr>
<td>Congestion cost</td>
<td>$307 million</td>
<td>$942 million</td>
<td>$2,271 million</td>
<td>+ 141%</td>
</tr>
<tr>
<td>-per capita ($)</td>
<td>114</td>
<td>304</td>
<td>631</td>
<td>+ 108%</td>
</tr>
</tbody>
</table>

| Table 9-3: Mobility Data for the Washington Area |

Development patterns are likely contributing to the explosion in the number of vehicle-miles traveled (VMTs). Commuters are locating farther away from their place of work, and outlying residential areas are often separated from grocery stores and shopping centers. Spreading the population over a larger area might have mitigated delay in isolated cases, but expansion of the urban area has likely contributed to the significant increases in total traffic delay. Per capita delay has more than tripled in the Washington area since 1982.

Traffic would be even worse if billions of dollars had not been invested in public transportation. Public transportation benefits commuters who use private transportation, but also those who do not. Without public transportation, delay on the highways would increase by about 40 percent. However, the number of public transportation trips increased by just two percent during the 1990s, much less than the rate of population growth. Commuters living in the outlying suburban areas are less likely to use public transportation, contributing to the decline in the percentage of people who use the transit system. The current system needs to adjust to new development patterns.

The congestion cost for the average area resident was $631 in 2000, and it was likely much higher for many individuals. However, the cost of traffic delays has not yet caused any dramatic shift away from the current development pattern that is creating growth in outlying areas. There are many factors that determine where people wish to live. Delay and congestion costs are currently providing economic incentives to live close to work; however, current development patterns demonstrate that people are moving away from employment centers. Since current levels of congestion do not seem

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\(^{222}\) Texas Transportation Institute Mobility Data. This data is for the Washington area and defines the area differently from the Census, hence the different population estimates.
to be dramatically affecting development patterns, it is uncertain whether reducing it will have any significant effect on development patterns.

**SMART GROWTH**

Current growth and development patterns are leading some planners to promote the principles of smart growth. Dr. Sam Staley of the Reason Public Policy Institute notes that the term *smart growth* is difficult to define and is often used for several different purposes.\(^{223}\) Before discussing smart growth in more detail, it would be useful to define the term. According to Dr. Staley, the EPA definition of smart growth is specific relative to other definitions, and EPA looks for communities implementing smart growth to:

- Reduce the amount of land used for housing as a matter of policy;
- Strive for a specific urban form—namely, one that is compact and transit focused.
- Make development decisions political decisions.

The EPA states that smart growth will help communities simultaneously achieve healthy communities, economic development, strong neighborhoods, and transportation choices.\(^{224}\) EPA’s 10 principles of smart growth are:

1. Mix Land Uses
2. Take Advantage of Compact Building Design
3. Create a Range of Housing Opportunities and Choices
4. Create Walkable Neighborhoods
5. Foster Distinctive, Attractive Communities with a Strong Sense of Place
6. Preserve Open Space, Farmland, Natural Beauty, and Critical Environmental Areas
7. Strengthen and Direct Development Towards Existing Communities
8. Provide a Variety of Transportation Choices


\(^{224}\) EPA Smart Growth website: http://www.epa.gov/smartgrowth/about_sg.htm
10. **Encourage Community and Stakeholder Collaboration in Development Decisions**

By following these principles, the EPA states that communities will be able to achieve environmental benefits in addition to the community benefits discussed above. Air quality should improve by lowering the number of vehicle miles traveled. Less acreage of developed land (because of the increase in housing density around transit centers) will improve water quality because of less runoff. Open space will be preserved more effectively and brownfields will be redeveloped, which could reduce environmental contaminants.

Still, there is no consensus around the principles of smart growth. Many oppose the idea in principle, stating that promoting growth in certain preferred areas will restrict the freedom of individuals to choose where they wish to live. Others oppose smart growth for functional reasons. While smart growth proponents claim that increased walkability and transit use will help lessen the traffic load, opponents of smart growth claim that the increase in population density that smart growth promotes will lead to increased traffic congestion.

A U.S. Department of Transportation study shows that for every 1.0 percent increase in population density, vehicle-miles traveled will increase by 0.8 percent. Both sides of the issue can point to this statistic as proof that they are correct. Smart growth advocates note that the VMTs per person decreases with increased population growth. Opponents state that this increase isn’t enough to make a significant difference and the increased density of vehicle use will make traffic worse. They also note other reasons that smart growth policies are undesirable – higher traffic densities could lead to increased air pollution in locations where more people live and property prices will increase.

Can highway pricing resolve this debate? As was previously mentioned, highway pricing alone may not dramatically change development patterns. If development patterns are changed, it is impossible to tell whether they will be more or less concentrated. In San Diego, when the single occupancy vehicles were allowed to pay to use the high occupancy lanes, the number of carpools using the lanes actually increased. This increase may be because residents realized how much the freeflowing capacity was worth economically or possibly because commuters can still drive to work if their carpool partner is unavailable. The same effect could occur when people realize how much money a short commute is worth to them, which could even cause

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development patterns to become more concentrated. Results such as these are often unpredictable.

HIGHWAY PRICING COMBINED WITH PUBLIC TRANSPORTATION CHANGES DEVELOPMENT PATTERNS:

One of the key aspects of smart growth development is the availability of different transportation options, including transit. This is where the possible effects of a highway-pricing scheme can have a significant effect on development patterns. Highway pricing, when properly implemented, can create free flowing highway capacity. The revenue from a network of congestion priced lanes throughout the Washington region should allow for a network of Bus Rapid Transit (BRT) service throughout the area.

BRT can be designed for comfort and simplicity for the user. Instead of paying for the service on the bus (as in standard buses), there could be enclosed stations with bus-level platforms where fares are paid upon entry, similar to the Metro rail system. These platforms are at the same level as the bus floors for stair-free handicap accessible entry. Transfers could be accomplished at enclosed stations as well. The BRT system could be coordinated with the Metro and local buses as a one-fare system with combined stations for convenience and simplicity. The Reason Public Policy Institute 229 has proposed a HOT lane network, shown in Figure 9-1, for the Washington area that they argue could make a base for an effective BRT system. Additional links from the beltway in Maryland to the downtown district would also be useful for creating a simple BRT commute from every radial corridor into Washington.

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According to “A Network of Livable Communities,” a joint publication of the Chesapeake Bay Foundation and Environmental Defense, transportation in its current form perpetuates sprawl. The paper notes that “hidden subsidies” make other forms of transportation less competitive than the automobile. It states that the cost of driving is artificially cheap because of the social costs such as air pollution and traffic. Even the cost of building and maintaining roads is subsidized by the general fund. It is also notes that the value of free parking and other employer-provided driving to work subsidies in the District of Columbia are worth about $240 million – about the same as Maryland, Virginia, and D.C. spend on the Metro system each year. The paper states that transportation and land use decisions are generally not coordinated. A coordinated effort between transportation and land use across county boundaries could help promote transportation friendly communities. According to the Thoreau Institute, an organization that promotes environmental solutions without regulation, bureaucracy, or central control, highway pricing is an important part of a comprehensive land-use policy that would slow sprawl without using command-and-control regulation.

Highway pricing combined with public transportation could satisfy environmentalists and libertarians. One of the tenets of smart growth is to maximize transportation options. While this may include walkable communities and efficient public transportation, it should also include the option to drive to work. Highway pricing will help alleviate peak hour congestion and would therefore be an important way to provide transportation options to community residents. If BRT service were included in a highway pricing scheme, the availability of public transportation would help allow land-use decision makers more flexibility in how they structure future communities.
BRT and highway pricing are excellent options for providing transit opportunities for communities because of their efficient pricing. Although revenues from a highway pricing system are very project-specific, we can obtain an estimate by examining the Reason Public Policy Institute paper on potential HOT networks in the nation’s largest cities.\textsuperscript{230} RPPI’s HOT network proposal for the Washington, D.C. area is shown in Figure 9-1. While they assumed BRT would be part of the HOT network, BRT revenue was not included in their revenue estimates. The assumptions by RPPI were maximum peak tolls of $0.37 per mile and average peak tolls of about $0.25 per mile (compared to San Diego’s I-15 maximum of $0.50 per mile and average of $0.33). The throughput is estimated at 1350 vehicles per lane per hour. This amounts to revenue of more than $400 million per year on the 610-lane-mile network (including two lanes in each direction on the beltway). The estimated cost to construct the HOT network described above is greater than $8 billion, and millions more would be needed for annual maintenance.

Revenue bonds based on the highway toll revenue could cover about 51 percent of the construction cost of the proposed network. It is possible that a portion of the HOT network with the highest demand could be constructed with revenue bonds that would pay the entire construction costs. Revenue that is not required for the bonds could be directed at several different priorities. This money could help extend the HOT/BRT network to other locations in the Washington area and could be used for projects that cannot fully fund the construction using revenue bonds. The revenue should be used to subsidize the BRT system on the HOT lanes and to help fund Metro and other transit. Revenue could also be used to promote transit-oriented development or a non-transportation priority, such as improving other government services or lowering taxes. Unless it is explicitly earmarked, the revenue could be diverted almost anywhere. If new capacity is constructed rather than conversion of current lanes, the revenue will probably be used almost entirely to fund the construction of new capacity. However, the congestion toll revenue would help the government raise money to pay for transportation projects by consuming less of the general fund compared to free capacity.

Highway pricing is more efficient than free highway capacity at allocating economic costs and benefits to peak-hour highway users. BRT is also an efficient use of funds. It is much less expensive than a rail system, but can provide similar services. Using the data from the RPPI study and GAO data on the cost of BRT (shown in Figure 9-2), investing about 10 percent of the revenue from a HOT lane pricing system could pay to construct about five miles of BRT per year. More realistically, the revenue could support revenue bonds that could pay for around half of a 100-mile BRT system. Revenue from fares on the BRT system will likely be able to pay for the operating costs of the system.

\textsuperscript{230} Poole, R., Orski, C.K., “HOT Networks: A New Plan for Congestion Relief and Better Transit”, Reason Public Policy Institute, February 2003

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According to the Texas Transportation Institute, without public transportation the Washington region would experience 40 percent more delay, which would amount to a congestion cost of close to $1 billion. If a BRT system helps relieve congestion, as public transportation currently does in the region, then it would be economically efficient for highway users to help pay for the system and relieve their own congestion. Additional funding of $40 million per year could help complete the potential 100-mile BRT network discussed above, and if it is successful it could be expanded in the future.

As can be seen from Figure 9-2, BRT is a cost-effective way to provide public transportation compared to rail, especially when combined with an HOV or HOT system.

![Figure 9-2: Capital Costs of Light Rail and Bus Rapid Transit](image)

The Texas Transportation Institute (TTI) mobility data shows that transit is not a trivial issue for anyone who uses highways in the Washington area. This is also displayed in a study called “The Impact of Urban Spatial Structure on Travel Demand in the U.S.” It is noted that a 10 percent reduction in distance to the nearest transit stop reduces the chances of a person driving to work by 1.6 percentage points. If BRT is successful and simple to use, this could lead to a significant shift in road use. Because of the current high levels of congestion, a few percentage points can make a significant difference – the TTI mobility data states 129,000 additional daily transit users or carpoolers are required to prevent congestion from worsening without adding capacity, a relatively small percentage (about 3 percent) of the current population in the study.

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Highway pricing can provide opportunities for jurisdictions in the Washington area to promote smart growth policies. Highway pricing alone will probably not lead to a change in development patterns. However, if BRT is implemented (in part using revenues from highway pricing) and local and county jurisdictions wish to tailor their development policies to the transportation opportunities provided by highway pricing and BRT, communities can be built that truly take advantage of the transportation opportunities available while preserving the area’s natural environment, clean air, and clean water.

The I-66 corridor outside the beltway in Virginia is an area that would significantly benefit from an effective combination of HOV and BRT. Haymarket, Virginia is about 35 miles from downtown Washington. It is about 10 miles from the nearest VRE rail station in Manassas, which is over an hour by train from downtown Washington. Driving can be difficult because of congestion on I-66, and although the Vienna/Fairfax metro stop is on I-66, it is 22 miles from Haymarket and it is still a 30-minute metro ride to Metro Center. If HOT lanes were implemented successfully and the tolls were set to properly allow traffic to flow at highway speeds, an express route BRT could allow a commuter to get to central Washington in just over a half hour. Additional stops would add a few minutes. Connections could be made at other stations for commutes to other parts of Virginia or Maryland. With this access to efficient transit, local citizens and decision makers could help create a community that has many transportation options and is not dependent on the automobile. If the citizens decide higher densities around transit centers and other smart growth principles are desirable, they can institute policies to promote this. Highway pricing would help keep the automobile as a viable option, and the combination could help insulate the area from traffic today and in the future. Without highway pricing and BRT, the community will have a difficult time if it wishes to use policies to promote smart growth ideas.

CASE STUDY: LAND USE PLANNING IN MONTGOMERY AND ANNE ARUNDEL COUNTIES, MARYLAND

When trying to determine the effects of highway transportation options on a community, it is useful to observe some examples of how highways have affected growth in the Washington region. To do this, we can examine the effects of I-270 in Montgomery County and I-97 in Anne Arundel County. Both have land development plans in place to accomplish different goals with land near these respective highways. Montgomery County has decided to promote policies that promote growth in the I-270 corridor while Anne Arundel County has tried to limit growth along the I-97 corridor between Annapolis and Glen Burnie. Both counties have been successful in accomplishing their goals.

Montgomery County is often considered a national example for their county land preservation policies. Its general goal has been to preserve the rural land in the north

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and west parts of the county while promoting growth in the southeast suburbs of Washington and along the I-270 corridor. These areas provide transportation opportunities (although I-270 is now consistently congested and lacks good public transit) and this is where the county decided growth should occur.

In 1964, Montgomery County first implemented its Wedges and Corridors plan, where development was encouraged along transportation corridors (such as I-270) and discouraged on rural wedges by requiring at least five acres per dwelling. When this didn’t prevent large lot suburban development, the zoning was increased to 25 acres per dwelling in the rural wedges. To compensate rural landowners for the potential loss in value of their property and to promote higher densities along transportation corridors, rural landowners could take advantage of a policy called Transfer of Development Rights (TDR).

Through a TDR, a rural landowner can sell “development rights” at a rate of one dwelling per five acres to increase allowable development densities in Receiving Areas, such as transportation corridors. To see the areas where Montgomery County is channeling its development through various policies see the pink areas in Figure 9-3. Notice the stripe of pink along the I-270 corridor and the emptier spaces in the northern and western parts of the county. Today, about 105,000 of the county’s 317,000 acres are protected from development because of TDRs, easements, and government ownership. Economic development has prospered in Montgomery County as well; it is currently the fourth wealthiest county in the nation.

234 Maryland Department of Planning and Maryland Department of Natural Resources data, Grant Dehart, January 2003
The goals of Anne Arundel County were quite different from those of Montgomery County when developing a land use plan for the I-97 corridor. I-97 connects Annapolis to Glen Burnie and Baltimore, and at 17 miles it is the shortest two-digit interstate in the nation. The southern portion of I-97 runs through a rural part of Anne Arundel County, in and around areas designated by the county as greenways. Officials decided to implement policies to prevent significant development along I-97; the capacity will be primarily to carry traffic between Annapolis and Glen Burnie/Pasadena. They have done so principally through open space zoning, easements, and private and government owned conservation lands.

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In Figure 9-4 on the next page, you can see the southern portion of the I-97 corridor, which begins west of Annapolis north of the South River, continues northwest and turns northeast at the intersection with MD-3 and begins to run into the more developed areas of Pasadena and Glen Burnie. The corridor passes almost entirely through areas of rural or natural area zoning. The preservation is enhanced by the lack of consistent exits on I-97 through the rural and natural areas of Anne Arundel County. The county has done a good job of keeping development away from regions that it is attempting to preserve. Of the 72,000 acres it has identified as part of the greenway system, it has preserved over half of the acreage.
There have been unintended consequences of the development policies in counties such as Montgomery and Anne Arundel. Housing prices have increased
dramatically, partly because of the constraints on new development. Development restrictions in some areas have led to additional development in other areas. While counties have tried to channel the growth into certain areas of the county, additional development in other counties (further from the employment centers) has occurred.

**CASE STUDY: BRT IN SOUTH AMERICA**

While counties will approach their growth goals individually, it is important for the Washington area’s development patterns and growth to be coordinated, particularly for a united BRT system. BRT has been successfully implemented on a large scale in Colombia and Brazil. In Curitiba, Brazil, authorities have used land use policy to encourage high-density development on radial corridors of the city. There are five main corridors, and each corridor has two express bus lanes between the regular traffic lanes.

The corridor development strategy was begun in 1965 as part of a master plan. Express bus service was added to the local bus service in the mid 1980s. Express buses operate in the dedicated lanes at an average speed of 18 miles per hour, which is twice that of the private automobile traffic along the corridors. One can board the busses at large end terminals, or smaller terminals approximately every two kilometers, where transfers can be made to local buses. The system has been highly successful, as evidenced by the fact that three-fourths of the city’s commuters use the BRT system. This amounts to more than 1.3 million passengers per day, about the same number as the Metro system in Washington, D.C.

Bogota, Colombia implemented a BRT system called TransMilenio, inspired by the Curitiba system. Just three years after it was designed in 1998, the system carried 800,000 passengers per day. TransMilenio operates like a rail system without the high cost. Passengers board the buses at enclosed stations and purchase tickets at the stations, similar to the Metro. The bus platform is level with the station floor, making boarding safe and simple for handicapped people. Some buses offer express service, while others make stops at all intermediate stations and make connections with local buses. TransMilenio cost about $8 million per mile; however, this includes the construction of lanes that are dedicated to bus service. The private service covers all of its operating costs and makes a small profit as well.

**CONCLUSION**

A well thought out transportation system gives communities an opportunity to implement development plans effectively. In Montgomery County, I-270 allowed the county to channel its development onto that corridor and preserve rural areas in other parts of the county. Anne Arundel County determined it preferred not to use the opportunity to develop the I-97 corridor because it was important to residents to preserve this area. Each county determined for itself how to use its transportation corridor.
However, it is important to consider regional impacts of these policies. If a policy in one locality will affect development or housing costs in another, there should be some mechanism for the affected county to participate in the policy formation. Brazil and Colombia have shown that BRT systems can be successfully implemented in a region the size of D.C., and a network of radial corridors of development would be an example of cooperation among localities that might accomplish smart growth goals.

Highway pricing alone may not have a significant effect on development patterns in the Washington region. The peak toll paid by commuters will be a substitute for the economic cost of sitting in traffic in general purpose lanes. This may influence some people’s decision of where to live, but it is uncertain what effect this will have on a large scale, if any. However, with a new transportation option and BRT service, localities can take advantage of these options and implement policies (such as rezoning, TDRs, or priority funding) to channel development into designated areas. Highway pricing and BRT are efficient ways of providing new transportation options, since they can be implemented together and are paid for principally by their users and not by government subsidies. If land use and transportation decisions are considered together for the entire region, it is possible to develop infrastructure and policies that will support development that respects property rights, preserve land for agricultural and environmental purposes, and allow for affordable housing within reach of several transportation alternatives.

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As traffic congestion worsens in many American cities, policy makers are searching for new policies to address this problem. Pricing the use of highways is one such strategy that is receiving increased attention. However, highway pricing must also be coordinated with other appropriate urban policies. Congestion pricing is not a silver bullet; it must be implemented in concert with improved public transportation.

American public transportation is mostly inconvenient, under-funded, and underutilized. Highway pricing revenues, if dedicated to public transit, could be used to improve current transit systems. Ideally, Bus Rapid Transit (BRT) would be implemented in the Washington region as part of a highway-pricing scheme. BRT is relatively inexpensive, politically more feasible, and user-friendly. With its train-like characteristics, it avoids some of the problems associated with buses. Compared with light rail, it is less expensive to build, and more flexible over time as population and land use changes from area to area.

Why is there a reluctance to use public transit? Some policy makers may say that, “It is just the American way, Americans love their cars and cars provide us with a certain lifestyle that they are unwilling to give up.” However, public policy has also favored automobile use. Still, this could change in the future. Policies are usually implemented in an ad hoc manner, but transportation funding shortfalls and increased gasoline costs at present may provide a “window” in which a rethinking of the role of public transit (and BRT) may take place.

Building more roads will not solve the Washington area’s transportation problems in the long run. The area needs to rethink how it moves people and goods and transition to a transportation system that will work in the 21st century. A combination of highway pricing and public transportation would be a good start, and the nation’s capital should lead the way in considering these possibilities.

Metro is proposing the second consecutive fare increase in two years. Metro officials admit that, once fares increase, ridership will most likely decrease. As the third most traffic congested region in the nation, steps should be taken to increase Metro ridership, rather than decrease it. WMATA is experiencing severe tremendous pressures, which could be partially alleviated through highway pricing revenues. This revenue could help to lower Metro fares, improve and expand service, and increase ridership. Currently, annual ridership on Metrorail and Metrobus equals 300 million trips. If the fare increases result in only a 5 percent decrease in the number of trips, as many as 15 million annual trips could be added to the region’s roadways. In the future, highway revenues should be used to maintain the Metro system in order to reduce fares and keep millions of vehicles off the roadways.

One pricing option in which there is great current interest is truck tolling. Many believe that interstate truck pricing would be an early priority for introducing the concept of highway pricing to the Washington region. Trucks do more damage to people and
roads than cars, and it is not necessary for as many trucks to be on the Capital Beltway at rush hour when other demands are at a peak. Trucks are now almost always outfitted with GPS, making conversion to a pricing system easier. If the Washington region dedicates 50 percent or more of the revenue from pricing of trucks to fund a separated lane for trucks, buses, and commuters, then truck users of highways would help to pay for a more equitable system that leaves almost everyone in the region better off -- even many transit users who don't drive.

In addition to truck pricing, several roads in the region have excess HOV capacity that should be converted to HOT lanes shared with BRT. Studies suggest that HOT lanes on I-270 and FAIR lanes on US 50 can relieve some congestion in their respective corridors and generate significant public revenue that can be dedicated to public transit options. Allocating these funds to transit will likely resolve equity concerns for lower-income residents and further relieve congestion by inducing some drivers to shift to mass transit. Incentives to carpool may also generate further congestion relief on I-270 and US 50. Virginia has a vibrant carpooling community and Maryland should seek to replicate its success. Currently, Maryland is proposing that HOV2 users pay to utilize the HOT lane, while Virginia is proposing to allow HOV2 to continue to drive for free. Maryland officials should not discourage carpooling by forcing HOV2s to pay for their use of HOV lanes.

Northern Virginia's successful HOV network will facilitate implementing HOT lanes. If any new highway lanes are constructed, they should also be priced. In the meantime, I-66 west of I-495, I-95, and SR 267 have HOV lanes that are not operating at full capacity. All three of these highways should be considered for implementation of highway pricing through HOT lanes. At a time when the population of Northern Virginia is increasing and when transportation plans struggle to find necessary funding; tolling single occupant vehicles on current HOV lanes and thereby adding new capacity is an attractive possibility.

The fact that the HOV lanes on I-95/395 are currently barrier-separated, rather than the concurrent flow lanes on I-66 and SR 267, along with their higher revenue potential (due partly to current HOV3), suggests that this highway may provide the best opportunity for a demonstration HOT project in Northern Virginia. However, because carpooling on I-95/395 is so popular, substantial marketing efforts will be needed to overcome public resistance to such a project.

HOT lanes on the Capital Beltway present a more difficult proposition. There is not yet adequate information to make an informed decision about whether or not priced lanes would be effective on the beltway. The Fluor Daniel proposal is currently in the midst of the NEPA process to study its environmental effects. The environmental study also needs to review the environmental impacts of adding beltway capacity. Without these findings, cost-benefit analyses are incomplete and a decision cannot be made. If tolls on the beltway are found to be feasible (in terms of logistics and environmental impacts), the HOT lanes could at some point generate well over $100 million in annual revenues to fund BRT, Metrobus, and Metrorail.
The Washington region must consider a long-term plan for its future transportation system. In the long run, a variety of tolling options might be implemented on Potomac bridges in the Washington region. The options that appear most likely to be successful at reducing peak period congestion would be: 1) a beltway bridge tolling plan in which all lanes of the Woodrow Wilson Bridge and the American Legion Bridge have dynamic tolling; and 2) dynamic tolling of one or all of the Potomac River crossings into D.C. Dynamic tolling according to levels of Beltway congestion of the Woodrow Wilson Bridge, combined with dynamic tolling of the American Legion Bridge, would reduce overall congestion on the beltway and would especially reduce peak period congestion. In addition, dynamic tolling of all Potomac River crossings into D.C. would reduce traffic congestion inside the city.

Another heavily congested bridge in the region, the Chesapeake Bay Bridge, experiences severe congestion during the summer months. Higher tolls on the Chesapeake Bay Bridge – set for peak times -- have been proposed but they have generated opposition because bridge demand is inelastic. While increasing tolls will likely generate more revenue, it may also prevent some vacationers from visiting the beaches. Public transit options over the bridge (i.e., buses) should also be examined to provide an option for those that might lose with higher bridge tolls. If higher tolls were implemented, revenue could be dedicated to Chesapeake Bay restoration. Further research is needed to determine if congestion pricing on the Bay Bridge could succeed.

In the distant future, pricing all roads might have the most dramatic effect on the goal of improving traffic flow, enhancing highway efficiency, reducing congestion, and increasing Washington area livability. Pricing all roads will require GPS technology in all vehicles. According to the U.S. Department of Transportation, because of the normal vehicle turnover rate, it would take 20 years to outfit the entire automobile fleet with a GPS system. Meanwhile, the focus should be on building public acceptance of intelligent transportation technology systems, which includes allaying privacy concerns. To ensure wider public acceptance, the short-term objectives should be to demonstrate the benefits and convenience of the system. The long run objective should be to lower the cost of this technology to encourage auto manufacturers to install it in all vehicles.

Eventually, comprehensive road pricing could be implemented down to the level of each neighborhood street. A commuter, once in his or her car, would enter a desired destination into the system; the computer would supply information on possible levels of congestion on the most direct route, and on alternate routes. Thus, a combination of Intelligent Transportation Technology and a pricing mechanism can be used to divert traffic from congested streets by raising the price of traveling on those traffic-filled roads. Ideally, such a system would price a particular road or route based on actual congestion, by raising the price of traveling on a particular road as soon as some threshold number of cars accumulates. Such a system could also be used to manage traffic by giving drivers in their cars real time information about accidents, congestion, road construction, and closures.

Universal highway pricing could also be used to improve air quality. Since the Washington region is in non-attainment for ozone, pricing should be used to discourage
driving during conditions conducive to ozone formation. On high ozone days, highway prices could be raised to discourage individual drivers and to encourage use of mass transit. People who drive on high ozone days could be charged higher prices all around; while those who do not use their cars could have their accounts credited. This type of pricing, along with the current practice of providing free Metro rail and bus transportation, could be used to significantly reduce traffic on high ozone days.

Another broader goal that highway pricing can help to address is the need to promote smart growth and reduce sprawl. Several examples of smart growth in the region demonstrate that effective transportation corridors give counties an opportunity to implement development plans. In Montgomery County, I-270 allowed the county to channel its development onto that corridor and preserve rural areas in other parts of the County. Anne Arundel County determined it would not develop the I-97 corridor because it was important to residents that this area be preserved. Each county was able to determine for itself how to use its transportation corridor. This strategy of channeling growth can be applied anywhere in the Washington region where improved, more efficient transportation corridors are located. Pricing has the potential to improve the efficiency of corridors, allowing officials to plan growth around movement within these corridors.

Overall, it is important to consider the full regional impacts of these policies. If a policy in one area will affect development or housing costs in another area, there should be some mechanism for the affected areas to participate in the policy formation. If land use and transportation decisions are considered together for the entire region, it is possible to develop infrastructure and transportation policies that will respect property rights, preserve land for agricultural and environmental purposes, and allow for affordable housing near several transportation alternatives. The region might seek, for example, to create a network of radial corridors of development.

Highway pricing alone may not have a significant effect on development patterns in the Washington region. The peak toll paid by commuters will be a substitute for the economic cost of sitting in traffic in general purpose lanes. This may influence some decisions of where to live, but it is uncertain whether the effect will be large. However, with the provision of new transportation options and BRT service, the Washington region can act to channel development into preferred areas. Highway pricing is just one part of a larger solution for easing congestion in the Washington area. A full vision should include improving and expanding mass transit options, adding bicycle paths, and improving surrounding roadways. Pricing of roadways can be a viable means of creating incentives to reduce external pollution, inefficient land use, and high traffic costs – and doing so more efficiently than gas and motor vehicle taxes. By pricing automobile trips, people will have financial incentives to limit unnecessary vehicle miles and perhaps even live closer to town centers. No one wants to sit in a long line of cars and these steps should reduce the time that is wasted in traffic jams. The lives of Washington residents are not enhanced by time spent in our isolated polluting cars, and regional policy makers must take the necessary steps to reduce that time to a minimum. Americans today have more and more leisure time but too much of that leisure time is now on congested roadways?