A New Multi-Modal Public-Private Partnership Approach to Restore Metropolitan Mobility

Patrick DeCorla-Souza, AICP[1]
Federal Highway Administration

Abstract: *Variable tolls can be used to manage demand in order to guarantee free flow of traffic on existing toll facilities. This can also be done on managed lanes such as High-Occupancy Toll (HOT) lanes, Express Toll lanes, and truck tollways, as well as on currently toll-free limited access highways. Concessions could allow for the efficient delivery of such roadway pricing systems. Various approaches have been developed to address challenges with regard to concessions on priced highways. This paper presents a new approach that employs outcome-based contracting systems and financial incentives to maximize public mobility goals.*

1.0 INTRODUCTION

Congestion pricing involves introducing variable tolls to keep demand and supply in balance. It may be implemented on existing toll facilities which currently have flat tolls, on HOV lanes by permitting use by toll-paying vehicles that do not meet occupancy requirements (a concept known as HOT lanes), on Express Toll lanes as well as on existing toll-free limited access facilities to manage demand during peak periods (DeCorla-Souza 2007a).

On such facilities, congestion pricing can prevent a spike in peak traffic demand from oversaturating the facilities and causing traffic flow to collapse. A breakdown in traffic flow can reduce vehicle throughput and force some motorists to seek alternative routes[2]. Pricing provides the mechanism to cost-efficiently reduce freeway congestion in the near term as well as the long term.

A broad, comprehensive congestion pricing approach would include elements that: (a) reduce high traffic demand at critical times to prevent breakdowns in traffic flow, by *increasing the price* motorists pay for highway travel during those critical time periods; (b) introduce complementary strategies that *improve the attractiveness of non solo-driving modes*; (c) *increase operational capacity* by managing and operating the system for maximum vehicle throughput; and (d) *increase physical highway and/or transit capacity* at the most critical locations in the longer term, continuing to manage the new capacity with variable tolls. This paper discusses how such a four-pronged approach may be implemented using public-private partnerships.

---

[1] *Disclaimer: The views expressed are those of the author and not necessarily those of the U.S. Department of Transportation or the Federal Highway Administration. This paper was presented at the Freeway and Tolling Operations Conference in Houston, TX in May 2007*

[2] The ability of congestion pricing to preserve vehicle throughput during rush hours is demonstrated on the SR 91 Express lanes in Orange County, CA. On these lanes, demand is managed by use of a variable toll This results in the Express lanes each carrying twice as many vehicles as the adjacent toll-free lanes during the peak hour, which occurs in the eastbound direction on Friday afternoon (US Department of Transportation 2005).

Elements (a) and (c) are discussed in Sections 2 through 5. Section 6 discusses element (b) and section 7 discusses element (d)

2.0 BOLD CONGESTION PRICING APPROACHES

Implementing a HOT Lane Network in the Short-Term

In a forthcoming paper (DeCorla-Souza 2007b), the author has presented a High-Occupancy Toll (HOT) network concept that could be implemented in a short period of time by converting some existing general-purpose lanes to priced lanes which would be managed using variable tolls. This concept has the potential to significantly reduce congestion in the near-term. Major new highway capacity improvements are not needed. A network of premium service lanes would be created by re-striping freeways with 6 lanes or more (i.e., 3 or more per direction) to convert the left general-purpose lanes into priced lanes during rush hours. On facilities with an existing HOV lane, the general-purpose (GP) lane adjacent to the HOV lane would be added to create a two-lane express section. Carpools and vanpools certified by employers or the ridesharing agency would use the network for free.

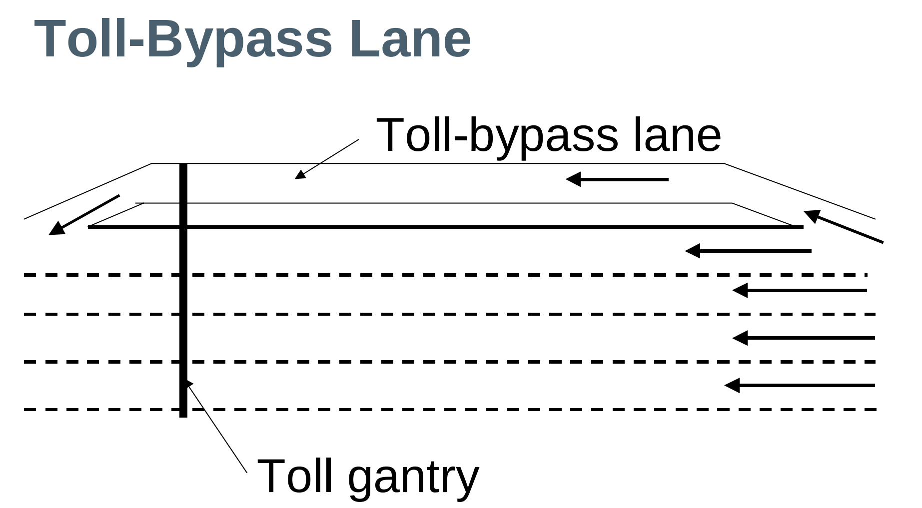
To gain public acceptance for the conversion of some GP lanes to restricted lanes, a limited allocation of toll credits would be made to all drivers in the metropolitan area for free use of the lanes during rush hours. Those not sharing the ride would have access to the lanes for free occasionally by using their toll credits. By pooling their credits, peak period commuters in non-certified HOVs would be able to use the lanes free of charge more often. After their credits are used up, motorists could purchase additional credits from those not needing their credits because they ride transit, commute in a non-certified carpool, or drive at off-peak times. Each driver's share of monetary credits would be determined by dividing the premium service value of the express lane network during peak hours by the number of drivers in the metropolitan area.

Credit charges for use of the express lanes would be set dynamically, and would vary to ensure that available lane capacity is always fully utilized, while ensuring the free flow of traffic. New and improved express bus service would be introduced on the network, and park-and-ride facilities would be enhanced.

Implementing a Fully-Priced Freeway Network in the Short-Term

In another forthcoming paper (DeCorla-Souza 2007c), the author has proposed a broader congestion pricing approach that could potentially be implemented in the near-term in U.S. metropolitan areas. The approach involves converting existing freeways (all lanes) into premium-service free-flowing highways that provide fast, frequent and inexpensive express bus service, charging all private vehicles a variable toll -- except for authorized buses and certified ridesharing vehicles. In order to preserve motorists' choice not to pay and suffer the same amount congestion delay as they did prior to implementation of pricing, toll-bypass lanes would be constructed at gantry locations (see Figure 1). Motorists could queue up in these bypass lanes and avail themselves of premium service on the freeway by paying a "time" price in the metered queue (similar to ramp metering).

FIGURE 1. TOLL-BYPASS LANE



This “full facility” pricing concept has several additional advantages over the lane-pricing approach. Since all lanes would be priced, there would be no need for additional rights-of-way and pavement for buffer separation and slip ramps between managed lanes and free general-purpose lanes. All lanes would be available for use by all vehicles. This would maximize motorists’ freedom to switch lanes and consequently maximize highway capacity. (A slower moving vehicle in a separated single lane causes a gap to build up in front of it, reducing vehicle throughput.) Additionally, vehicle throughput *per lane* is lower when fewer adjacent lanes are available for use by all traffic, since drivers of faster vehicles find it more difficult to switch lanes and overtake slower vehicles in order to occupy large gaps between vehicles.

Pricing all lanes would allow direct access to premium service lanes from *all* existing freeway entrance ramps. It would avoid the need for traffic to merge into and out of managed lanes from adjacent general-purpose lanes. Such weaving movements are inconvenient for buses and for motorists, cause extra delay for them, and reduce safety and highway capacity on the free lanes.

3.0 ISUES RELATING TO PUBLIC-PRIVATE PARTNERSHIPS FOR PROJECTS INVOLVING CONGESTION PRICING

A private concessionaire could operate congestion priced facilities, or even entire priced highway systems such as the lane-pricing and full facility pricing concepts presented above. A private partner’s skills would be valuable for deployment of the complex schemes and innovative technologies that would be needed. With a conventional concession agreement, a private operator makes the needed investments, and in return obtains the right to operate the system for a specified number of years and collect tolls. If the present value of expected toll revenue exceeds the present value of investment and operation costs (including return on investment), the concessionaire makes an up-front payment to the public authority. This is the public-private partnership (PPP) model that is currently used in toll road concessions.

However, transferring this model for use on road pricing projects presents a challenge. In the current toll road concession model, maximum toll rates that can be charged by the concessionaire are set in advance in the PPP agreement. This is not advisable on a road pricing project, because it is difficult to know in advance what the toll rates would need to be at various times during the day in order to ensure free-flowing traffic, throughout the life of the concession. Setting arbitrary toll rate limits would defeat the purpose of using pricing to maximize efficient use of the highway facility or lane(s).

On the other hand, allowing the concessionaire to charge whatever the market will bear could face issues. For example, the public may perceive that the concessionaire is being allowed to earn "windfall profits" at the cost of the motorist. The public needs to be assured that the best interests of the motorist are aligned with those of the operator. Elasticities of highway travel demand with respect to price tend to be relatively low. This means that revenue-maximizing toll rates may be higher than the toll rates needed to maximize use of the highway facility. Thus, profit-maximizing goals of a private operator could be in conflict with public goals to maximize highway usage and vehicle throughput during peak periods.

Table 1 illustrates the relative differences between total hourly revenue that might be generated from various toll rate scenarios, in a single direction on a freeway. First, estimates are presented for toll rates set at a level that maximizes vehicle throughput per hour. For convenience in calculations, a toll rate of $1.00 is assumed. Then, estimates are presented for toll rates that are 50% higher. Empirical evidence suggests that the elasticity of demand lies beneath -0.50 (HDR/HLB Decision Economics Inc., 2006). Short-term elasticities of -0.10 and long-term elasticities of -0.19 have been measured with respect to tolls (Lee, 2000). Table 1 suggests that under this range of elasticity assumptions, revenues generated by a 50% increase in tolls above the "throughput-maximizing" level would always be higher than that generated by the throughput-maximizing toll rate. At the same time, vehicle throughput would be reduced significantly, reducing public mobility benefits. Under these elasticity scenarios, a private operator would have an incentive to maximize revenue rather than vehicle throughput.

Table 1. Revenue and Throughput Consequences of Toll Rates

	Toll Rate	Elasticity	Vehicle Demand	Revenue
Maximum vehicle throughput	$1.00		6,000	$6,000
Alternative scenarios:				
Low elasticity	$1.50	-0.1	5,700	$8,550
High elasticity	$1.50	-0.5	4,500	$6,750

4.0 PUBLIC-PRIVATE PARTNERSHIP APPROACHES

Ways have been developed to deal with the above issues. One method, used in the 1995 concession agreement for the variably priced express lanes in the median of SR 91 in Orange County, California, is to specify a maximum rate of return, with toll revenues above that rate reverting to the public authority. This requires auditing, and after the maximum rate of return is reached, provides little incentive for the private operator to maximize vehicle throughput, or to innovate in order to run a more efficient operation.

A second method includes a revenue sharing clause in the PPP agreement for revenues above a specified level. The operator's interest in innovating to maximize operating efficiencies is thus preserved even after a specified level of revenue or rate of return has been reached. It also benefits the public partner, since it allows the public partner to share in those excess revenues. However, this method still provides incentives for revenue maximization at the possible cost of vehicle throughput, since the private operator shares in any excess revenues.

A third method that could perhaps reduce this incentive is used in the concession agreement for the Chicago Skyway, which allows for variable tolls for trucks at the concessionaire's option. Any peak period tolls above the maximum level specified in the concession agreement must be balanced with corresponding reductions in off-peak toll rates. It is unclear how this would be monitored.

A fourth method that could help ensure that the private sector will seek to maximize public mobility goals is suggested here. Under this approach, termed "Concurrent Real and Shadow Tolling," the operator would have freedom to set the toll rates needed to ensure free-flowing traffic during congested periods. However, all "excess" toll revenue above a "benchmark" flat toll rate (called a shadow toll) specified in the concession agreement would go to the public authority (see Figure 2). Concessionaires would be selected on a competitive basis, with their proposed "benchmark" flat toll rate being a prime criterion. High performance and orientation towards maximizing public goals would be encouraged through financial incentives and disincentives.

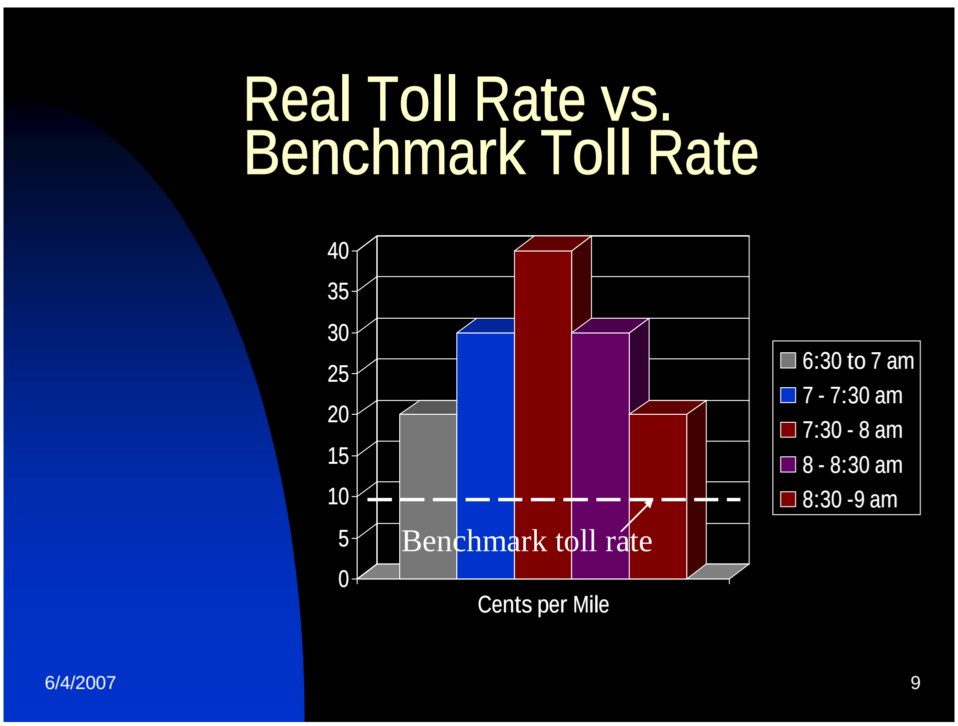


Figure 2. Real Toll Rate vs. Benchmark "Shadow" Toll Rate

Two examples of how such incentives and disincentives might work are discussed in the next section. The first example deals with cases where traffic is managed using "dynamic" tolls, i.e., tolls that vary in real time (as often as every 3 to 6 minutes) in response to traffic levels being experienced. The second example deals with cases where "pre-scheduled" variable tolls are used as in the case of the SR 91 Express toll lanes, e.g., when toll rates for each half hour time period are pre-set once every few months, based on traffic levels experienced over the recent past, to ensure that traffic flow does not break down due to high demand.

5.0 APPLICATIONS OF CONCURRENT REAL AND SHADOW TOLLING

Arrangements Involving Dynamic Tolling

Several operational HOT lane projects in the U.S. use dynamic tolling. However, in these cases, the revenue is wholly retained by the public sector, and where the private sector is involved, payments are made on a contractual "fee for service" basis. While PPP projects involving a private concession are currently under consideration in Virginia, it is unclear what type of concession approach might be used with the concessionaire to protect the public interest.

A "Concurrent Real and Shadow Tolling" concession approach would provide an incentive to the private operator to maximize vehicle throughput, since payments would increase with the number of vehicles served on the highway. In order to provide a greater incentive to take the risks and make the innovations necessary to maximize throughput, private operators who exceed a "threshold" vehicle throughput level could be provided a pre-specified bonus payment for each additional vehicle served. Thus, the operator is rewarded at a higher rate for the extra effort needed to fine-tune vehicle throughput in order to provide mobility for more vehicles than what can be achieved with conventional technology and methods.

If the private operator fails to provide the guaranteed level of service, it could be required to suspend charges and refund to toll-paying motorists any tolls already charged. The resulting revenue losses to the public sector could be limited if shadow tolls for those vehicles that did not get the guaranteed service level were subtracted from amounts owed to the concessionaire. Thus, the operator would be penalized for not meeting mobility standards agreed to under the terms of the contract, and would bear some of the financial risk for not meeting level of service standards guaranteed to the public.

Arrangements Involving Pre-Scheduled Tolling

The SR 91 Express toll lanes are an operational example where pre-scheduled variable tolls are used. In a PPP arrangement that involves pre-scheduled tolls, it may be possible to allow the concessionaire to keep the toll revenue, with certain conditions. This arrangement would increase the concessionaire's interest in reducing "revenue leakage," i.e., revenue losses due to non-payment of tolls. All expected excess toll revenue above the "benchmark" flat toll rate specified in the concession agreement would be required to be paid up-front to the public authority at the beginning of each month or quarter. One example of how such an arrangement might work is discussed below:

1. *Setting of toll schedules:* Prior to the beginning of each month or quarter, the private operator would set the variable toll schedule for each critical highway segment subject to a

breakdown of traffic flow during the peak periods. The estimates would be based on its estimates of toll rates that would be needed to efficiently use the highway's capacity during congested periods over the next monthly or three-month period.

2. *Calculation of anticipated peak period revenue:* Based on the proposed toll schedule and conservative estimates of expected highway vehicle throughput at the speeds guaranteed by the operator, total toll revenue that could be anticipated over the monthly or three-month period would be estimated. For example, toll revenue for each hour could be calculated as the toll rate times a "base" expected throughput of 1,600 vehicles per hour per lane.
3. *Calculation of "excess" revenue:* The anticipated toll revenue would be used to estimate the excess revenue that would be collected by the operator over and above the contractual "benchmark" toll revenue that would be owed to the operator, based on the benchmark toll rate in the concession agreement.
4. *Incentives to increase vehicle throughput:* If the operator is able to exceed the "base" vehicle throughput used in the calculations above, the operator would be allowed to keep the additional revenues collected. Thus, the operator would be rewarded at a higher rate for the extra effort needed to fine-tune vehicle throughput in order to provide mobility for more vehicles than the "base" number used in the calculations above.
5. *Penalties for poor performance:* If the operator fails to provide the guaranteed level of service, it would be required to suspend charges and refund to toll-paying motorists any tolls charged, thus reducing its own revenue and profit. Note that the operator would lose revenue at the actual toll rate, which would generally be higher than the flat "benchmark" toll rate per vehicle used to calculate its own compensation. Thus, the operator would be penalized for not meeting mobility standards agreed to under the contract, and would bear all of the risk of not meeting level of service standards guaranteed to the public.
6. *Safety mechanism:* In order to fine-tune demand and ensure that traffic flow does not break down when an entire limited-access facility is subjected to variable tolls, the operator could be permitted to meter entry of vehicles at highway entrance ramps using ramp meters, provided that those who wait at entrance ramps are compensated for their delay with toll credits. The credits would cut into the revenue received by the operator, who would thus be penalized for the delays caused to motorists at entrance ramps. Therefore, the operator would undertake a balancing act that would maximize highway efficiency and reduce overall delays.

The above performance-based incentives and disincentives could be built into the concession agreement. The concessionaire would have incentives to maximize vehicle throughput, and reduce the impacts of work zones, weather and incidents on traffic flow by using the most advanced and innovative techniques. The concessionaire would also have an incentive to provide travelers with the information needed to make travel choices that would maximize system efficiency.

The specific parameters, e.g., "base" vehicle throughput per hour per lane and guaranteed speeds, would be set in the PPP agreement. The public authority could set these parameters in their Requests for Proposals, and potential private contactors bidding on the contract could design their fee proposals to meet the objectives being sought by the public authority.

6.0 ENCOURAGING TRANSIT AND RIDESHARING

One potential enhancement to encourage a multimodal PPP approach might be to provide additional performance-based incentives based on the number of transit and vanpool riders carried during rush hours on the highway system. Incentive payments could be provided for each person served above pre-determined threshold levels, e.g., a level calculated based on existing transit and vanpool ridership and projections into the future. Transit ridership could be monitored electronically based on smart card usage, and vanpool participation could be monitored based on vanpool registration records. With incentive fee payments to private partners based on additional *person* trips by transit or vanpool on the highway, potential private partners would have an incentive to encourage greater *person* throughput during rush hours by promoting and/or providing incentives for use of transit and vanpool modes. They might work with other private and public partners to provide new vanpool or express bus services and collection and distribution services for express bus trips. They might market these travel options to the commuting public, and may even provide such services themselves to the extent they find it profitable.

Public agencies would need to be assured that public resources (including surplus toll revenue) would have a high probability of covering transit and vanpool incentive fee payments to the private partner. To protect the public agency from financial risk, the agreement with the private partner could set the maximum amount of total annual incentive fee payments, or limit this amount to the magnitude of surplus toll revenue returned to the public sector. Once that limit is reached, the private partner could reduce monetary incentives or other efforts to encourage transit and vanpool use, thus protecting itself from any reduction in profit. The limit could of course be increased by the public agency if additional public funds were to become available, and if the volume of additional person throughput could justify the additional payments to the private partner.

7.0 LONG-TERM PUBLIC-PRIVATE PARTNERSHIP ARRANGEMENTS TO EXPAND PHYSICAL CAPACITY

High rush hour toll rates on some highway segments would indicate the urgent need for highway or transit capacity enhancements at these locations. At the same time, excess revenue returned by the operator to the public authority would be much higher for these segments. The public authority responsible for managing the system and the surplus revenue could allocate the excess revenue collected at these locations for use in the corridor. Private proposals could be solicited to address expansion needs. Proposals could be evaluated on the basis of additional person throughput provided and public cost to provide it. The preferred proposal, which could be from the system operations (Phase 1) partner, could then be carried through the environmental review process with assistance from the winning private partner under a “Comprehensive Development Agreement” (CDA). A CDA involves the private partner in the early stages of development of the project so that it can be designed with the goal of maximizing construction and operation efficiencies.

After approval of the environmental document, the final agreement for expansion and operation of the facility could be negotiated with the winning private partner, and Phase 2 would begin. Funds allocated to the corridor could be used to support the investment’s financial viability. The private partner would proceed to finance, design and build the project, and would operate and collect tolls on the highway facility during the design and construction phase and after the expansion is completed. The flat “benchmark” toll rates that would be demanded by potential private investors would, of course, be much higher than those for Phase 1 (i.e., operation of existing system), because of the higher costs for highway, transit or Multimodal expansion. In cases where high costs for initial investment result in peak period tolls alone being inadequate to pay for these costs, candidate concessionaires could include in their bids “maximum” toll rates that they propose to charge for travel during off-peak periods. These lower, flat rate charges could provide the needed extra revenue. (Alternatively, highway or transit infrastructure expansion plans could be scaled back to ensure that the system is self-financing.) Benchmark shadow toll rates for off-peak travel could be the same as the real toll rate charged. The private partner could thus keep all off-peak toll revenue, reducing the need for public oversight and auditing of off-peak toll receipts.

In order to maximize revenue and profits, the private partner would safeguard against disruption of traffic flow during the construction phase. The performance-based incentives put in place in Phase 1 to maximize throughput during congested periods would, of course, continue.

Due to the high investment costs in Phase 2, “benchmark” toll payments owed to the concessionaire could exceed revenues in the early years of Phase 2. These deficits could simply be held on the books. In later years, when actual revenue from variable tolls exceeds the amount owed to the concessionaire based on the “benchmark” toll rate, the excess revenue could be used to pay (with interest) the deficits from earlier years. The risk that surpluses in later years would not be adequate to pay deficits from earlier years could be a risk allocated to the concessionaire. Surpluses in later years (over and above funds needed to pay benchmark shadow tolls as well as early year deficits) could be allocated to address travel corridor or area transportation needs.

8.0 SUMMARY

Congestion pricing on limited-access highway facilities prevents the collapse of traffic flow caused by recurring congestion. With pricing, existing highway systems would operate more efficiently. Multimodal public-private partnership approaches could employ outcome-based contracting systems and financial incentives to maximize public mobility goals and protect against “windfall” profits to concessionaires, both for short-term operations as well as for long-term multimodal infrastructure investments.

REFERENCES

DeCorla-Souza, Patrick (2007a). High Performance Highways. *Public Roads.* May/June 2007· Vol. 70, No. 6. Federal Highway Administration.

DeCorla-Souza, Patrick (2007b). Establishing a Metropolitan Network of HOT Lanes in the Short-Term. *Proceedings of the 2007 Annual Meeting of the Institute of Transportation Engineers.* August 2007. Institute of Transportation Engineers.

DeCorla-Souza, Patrick (2007c). The Near-Term Potential of Broad Pricing Strategies to Reduce Congestion in U.S. Metropolitan Areas. *Proceedings of the 2007 Annual Meeting of the Institute of Transportation Engineers*. August 2007. Institute of Transportation Engineers.

HDR/HLB Decision Economics, Inc. *Policy Analysis Framework for Road Pricing on a Regional Scale*. Prepared for U.S. Department of Transportation, Office of the Secretary. September 2005.

Lee, Douglas B., Jr. Demand Elasticities for Highway Travel. (Table C-6, page C-13). In *Highway Economic Requirements System, Volume IV: Technical Report, Appendix C*. Federal Highway Administration, Report DOT-VNTSC-FHWA-99-6; FHWA-PL-00-028. December 2000.

U.S. Department of Transportation. 2005. *Report on the Value Pricing Pilot Program through March 2004.* Available at: http://knowledge.fhwa.dot.gov/cops/hcx.nsf/All+Documents/AD276ECC2E3A077885257005006B5614/$FILE/March%202004%20Report%20of%20Congress.pdf