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Mainstreaming Pricing Alternatives in the NEPA Project Development Process

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Abstract

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This paper discusses how pricing can be incorporated into alternatives being considered during the NEPA process for major highway improvements in metropolitan areas, and how the transportation performance and other impacts of pricing can be evaluated and compared to more traditional alternatives. The paper demonstrates, using a case study, that relatively simple analytical procedures may be used to estimate the impacts of pricing alternatives and generate information for use by local decision-makers. The case study also demonstrates that pricing alternatives can accomplish the purpose and need of a major highway project in a way that effectively competes with conventional alternatives that exclude pricing, while generating net revenue surpluses to make funding of transportation improvements financially feasible.

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1.0 INTRODUCTION

Transportation agencies will need to fundamentally rethink the kinds of solutions that make sense in highly congested metropolitan areas. Three forces will cause a change in conventional thinking. First, a precipitous increase in congestion levels will accompany travel growth. Second, public resistance to traditional major highway projects will continue due to their community and environmental impacts. And third, many States face funding shortfalls. Pricing solutions, although currently novel to members of the public and their elected and appointed governmental officials, will gain in acceptance as their real world performance becomes more widely understood. However, evaluation tools in current use in transportation decision-making processes are not well suited for evaluating pricing alternatives against more traditional highway construction alternatives. This paper introduces emerging evaluation tools that can address pricing, and demonstrates how they might be applied to a major transportation improvement being evaluated as part of the National Environmental Policy Act (NEPA) process.

The paper also discusses how pricing concepts can be incorporated into alternatives being considered during the NEPA process for major highway improvements in metropolitan areas, and how the transportation performance and other impacts of pricing can be evaluated and compared to more traditional alternatives.

As used in this paper, the term “pricing” includes a group of measures that all involve collecting a variable toll for highway use, with the primary intent of managing travel demand so as to reduce or eliminate congestion on the priced roadway facility, corridor or network. Specific examples and definitions are presented later in the paper.

2.0 THE NEPA PROCESS

2.1 Using the NEPA Process to Agree on a Transportation Solution

The NEPA process (1) is the forum for evaluating and deciding upon the key features of transportation improvements for which Federal funding or other Federal approvals are required. Successful completion of the NEPA process is in effect an agreement between the U.S. Department of Transportation (USDOT) and the project sponsor that the approved project is eligible for Federal funding. It is the culmination of a decision-making process that often involves a number of Federal, State, and local governmental decision-makers working together to specify in considerable detail what the improvement will include.

For major transportation improvements that have a high likelihood of having significant environmental impacts, USDOT is obligated by law to prepare an environmental impact statement (EIS). The process of preparing an EIS is highly regulated and is influenced by hundreds of judicial decisions interpreting the governing laws and regulations. Non-regulatory guidance provides a useful, but not fully comprehensive, roadmap for how to prepare an EIS. Considerable thought goes into how each EIS will address the fundamentals of transportation decision-making using a systematic, interdisciplinary approach. Each EIS requires a customized approach that is appropriate to the specifics of the situation.

The EIS process starts with one or more problems to be solved. The problem is framed as the "purpose and need" for the "action." Any given EIS may endeavor to address a number of transportation problems. For example, it may attempt to address current safety problems, current congestion and delays, anticipated congestion and delays, inefficient travel patterns due to gaps in the transportation system, etc. However, in major metropolitan areas, most major transportation improvements frame the purpose and need around attempting to achieve some desired level of personal mobility.

The purpose and need is finalized during preparation of the EIS, but in metropolitan areas the initial work is done as part of the Comprehensive, Coordinated and Continuing (3C) transportation planning process (1). As a result, the process of arriving at appropriate transportation solutions must consider the role of the 3C planning process in framing the problem to be solved. Often this involves looking at alternative ways of addressing broad policy goals and leads to more specific purpose and need statements for specific projects. The importance of the 3C planning process in framing the problem is critical to the eventual solution. Environmental advocacy groups often complain that an overly narrow framing of the problem inevitably leads to implementation of traditional highway construction solutions. Transportation agencies often complain that too broad a framing of the problem leads to such a complex problem that the process of deciding on an appropriate solution involves an unreasonably extensive evaluation of alternatives.

Some purpose and need statements include specific quantitative performance levels that must be attained in order for a project to be considered successful. Others use a more qualitative approach, relying more on a description of the outcome that is sought by the agency that is advancing a project.

No matter how planners arrive at a purpose and need statement, the legal standard is that USDOT evaluate "all reasonable alternatives" in its EIS. An alternative is considered reasonable if it meets the essential elements of the purpose and need statement, and is practical or feasible from the technical and economic standpoint and based on common sense. To satisfy the requirement for evaluation of all reasonable alternatives, USDOT must ensure that its EIS process evaluates the full range of alternatives and provides a logical rationale for winnowing down the selection to a single "selected alternative." Pricing strategies may appropriately be included among the alternatives to be evaluated, either by themselves as add-ons to the base case "No Build" alternative or in combination with alternatives involving roadway capacity enhancement. During the process the most promising short list of alternatives is evaluated in comparable detail in the draft EIS. The final EIS focuses on considering public and agency input to arrive at and present a single preferred alternative. The EIS process is concluded with a

Record of Decision. This finalizes the selection process by presenting the essential elements of the selected alternative.

Not all actions are advanced with an EIS. If USDOT is unclear whether an EIS is needed, it can first prepare an environmental assessment (EA) to assist in making that determination. The legal requirements for an EA generally correspond to those for an EIS, but are not as rigorous. If USDOT determines, after appropriate public comment and interagency coordination, that the action will have no significant impact, then it concludes the NEPA process by presenting the selected alternative in a Finding of No Significant Impact (FONSI).

2.2 The Scoping Process

Whether the NEPA process is done with an EIS or an EA, the process begins with an attempt to determine what issues and topics to address, and at what level of detail. This process is called scoping or early coordination. Ideally, the scoping process will carefully review previous and ongoing work that has a bearing on the particular action at hand. This would include a review of the 3C transportation planning process mentioned above, and other comprehensive or single topic plans, e.g., plans for transportation, land use, air quality, or water quality. Scoping should also look at transportation and related projects that could affect the decision for the action under study in the NEPA process. The goal of scoping is to nail down the scope of the analysis and coordination to be undertaken during the NEPA process. This includes developing or refining the purpose and need for the action, identifying the range of alternatives to be evaluated, developing a set of criteria for evaluating alternatives, determining which potential environmental consequences require the most study, identifying appropriate public involvement and interagency coordination opportunities, and deciding on analytical methodologies to be used in the course of the NEPA process.

The scoping process engages members of the public and representatives from other agencies and governments in addressing the items mentioned above. It is therefore an excellent opportunity to make suggestions that reflect on the viability of pricing alternatives in the NEPA process. For example, one might suggest that the purpose and need be framed as reducing traveler delay and variability in travel time rather than as building additional highway capacity. Such a suggestion would be strengthened by offers of specific evaluation criteria and performance measures to substitute for or supplement traditional measures such as volume/capacity ratios. In addition, one could specifically suggest that certain types of alternatives, including pricing, be studied in the NEPA process either by themselves as add-ons to the “No Build” base case, or in combination with roadway capacity enhancement. In cases where funding for capacity expansion alternatives is uncertain, pricing alternatives could be considered for study as interim solutions. Finally, one could suggest specific methodologies to use in evaluating such alternatives.

2.3 Evaluating Pricing Alternatives in the NEPA Process

As mentioned earlier, the term “pricing” includes a group of measures that all involve collecting a variable toll for highway use, with the primary intent of managing travel demand so as to reduce or eliminate congestion on the priced roadway facility, corridor or network. Other than conventional toll road alternatives, pricing has usually not been included among alternatives identified during the scoping process. Pricing measures to manage peak demand, such as time-of-day tolls or high occupancy toll (HOT) facilities, have not generally emerged from the scoping process, primarily because they were considered untested or politically unacceptable. Yet, there are examples of projects, such as the SR 91 expansion in Orange County, CA, where pricing has been shown to be publicly acceptable, while enhancing mobility, reducing environmental impacts, and generating new revenues to pay for highway construction or to provide for alternatives to solo-driving.

Given the growing number of real world experiences in evaluating and implementing pricing concepts, it appears that the time is ripe to give more serious consideration to pricing alternatives during the NEPA process. Under FHWA's Value Pricing Pilot Program (2), several feasibility studies have been funded to assess the role pricing can play in highway expansion projects. Among the pricing studies completed or underway are:

- US Route 101 corridor study, Marin and Sonoma Counties, CA
- I-25/US 36 Value Express Lane feasibility study, Denver, CO
- Feasibility study for extension of I-15 FasTrak Express Lanes, San Diego, CA
- Pre-implementation study for expansion of I-10 (Katy Freeway) with managed lanes, Houston, TX
- Feasibility study for expansion of C-470 with HOT Lanes, Denver, CO
- Feasibility study for HOT lanes in the median of US Route 1, Santa Cruz County, CA
- Feasibility study for expansion of US 217, Portland, OR
- Feasibility study for HOT lanes on I-40, Raleigh/Piedmont region, NC
- Feasibility study for HOT lanes on I-30 in Dallas, TX

While many of the above studies have been undertaken as separate studies with results feeding into the NEPA process, three studies (I-15 Express Lanes, US Route 1 and US 217) are being conducted as part of or in close coordination with the NEPA process.

The real world success of value pricing suggests that there is a need to mainstream such studies into the NEPA process. However, problems exist, such as:

- A lack of understanding of the range of pricing possibilities, both among professional planners and engineers, as well as stakeholders and the general public;
- Concerns of politicians about the prospects for public acceptance; and
- A lack of awareness of analytic and evaluation tools available to assist planners in developing information on the impacts of pricing alternatives, to help in decision-making.

The remaining sections of this paper attempt to provide guidance on how these issues can be addressed. We discuss:

- FHWA support of transportation agency efforts to achieve a broader public understanding of pricing possibilities.
- How barriers to public acceptance can be overcome.
- FHWA efforts to support transportation professionals in analysis and evaluation of pricing alternatives.

3.0 EXPANDING THE UNDERSTANDING OF PRICING POSSIBILITIES

FHWA has developed an information kit (available for downloading at www.valuepricing.org) to assist in increasing professional and public understanding of pricing concepts. The kit addresses four main types of pricing alternatives involving road user charges:

- Variable Tolls on Toll Roads
- HOT Lanes, i.e. High Occupancy Toll lanes
- FAIR Lanes, i.e., Fast and Intertwined Regular lanes
- Variable Tolls on Existing Free Roads

The rest of this section of the paper provides a summary of each strategy. It should be noted that under current federal law, pricing strategies applied to existing free Interstate facilities must obtain federal approval through FHWA's Value Pricing Pilot Program prior to implementation. Pricing strategies on free non-Interstate facilities may obtain federal approval under Section 129 of Title 23 of the U.S. Code.

3.1 Variable Tolls on Toll Roads

A variable toll refers to the fluctuation of a toll rate. Typically the toll is higher during peak travel hours and lower during off-peak or shoulder hours (i.e., the times right before and after peak hours). The toll may also vary by day of the week and by vehicle type. The fluctuation in toll generally follows a predetermined schedule. The primary intent is to encourage shifts in travel away from the peak periods. It may also encourage travelers to shift to another mode of transportation, or to change routes. With fewer people traveling during congested periods, the remaining peak period travelers will have decreased delays. Advances in technology, such as electronic toll collection, make the adoption of variable tolling easier to implement and allow traffic to flow even more freely. Vehicles are equipped with transponders, and transponders are read by overhead antennas. Ultimately, shifts in traffic will result in less need for roadway expansion on toll facilities.

This strategy has been implemented in New York, New Jersey, Florida and California. By reducing peak period travel demand through changes in travel behavior, introduction of variable pricing on toll roads can reduce the need for new highway capacity.

3.2 HOT Lanes

"HOT" is the acronym for "High Occupancy/Toll." On HOT lanes, low occupancy vehicles are charged a toll, while High-Occupancy Vehicles (HOVs) are allowed to use the lanes free or at a discounted toll rate. Tolls vary by time-of-day and are collected at highway speeds using electronic toll collection technology. There are no toll booths. Tolls may be set "dynamically," i.e., they may be increased or decreased every few minutes, to ensure that the lanes are fully utilized. Motorists are informed of the current toll rates through variable message signs placed in advance of the entrances to the HOT lanes.

HOT lanes can be introduced either by converting existing HOV lanes or by adding new lanes. They have been implemented in California and Texas. By maximizing the use of spare capacity on existing HOV lanes, HOT lanes can reduce congestion on general purpose lanes, and reduce the need for new highway capacity for unrestricted use. Variable tolls on new lanes ensure that new lanes will not get congested, and that spare capacity remaining after limited use by HOVs will be fully utilized.

3.3 FAIR Lanes

The new value pricing concept called FAIR (Fast and Intertwined Regular) lanes was developed by FHWA to overcome equity concerns that sometimes surround efforts to implement variable tolls on previously untolled highway capacity (3). FAIR lanes involve separating congested freeway lanes into two sections, Fast lanes and Regular lanes. The separation may be done with methods as simple as using plastic pylons and lane striping. The Fast lanes would be electronically tolled, with tolls set dynamically, i.e., in real time, to ensure that traffic moves at the maximum allowable free-flow speed. Users of the Regular lanes would still face congested conditions, but would be eligible to receive credits if their vehicles had electronic toll tags. For example, if the current toll on the Fast lanes were $4.00, vehicles on the Regular lanes could get a credit amounting to $1.00, i.e., 25 percent of the current toll. The credits would be a form of compensation for giving up the right to use the lanes that had been converted to Fast lanes. Accumulated credits could be used as toll payments on days when a traveler chooses to use the Fast lanes, or as payments for transit or paratransit services, which would be subsidized using toll revenue from the Fast lanes.

FAIR lanes could increase vehicle throughput by as much as 50% on Fast lanes. The higher throughput occurs because freeway vehicle throughput under free flow conditions is significantly higher than when it is congested (4). FAIR lanes could increase *person* throughput even more with the provision of high quality transit and paratransit services. This in turn could lead to more efficient use of existing highway lanes, and thereby reduce the need for new highway capacity. A feasibility study of FAIR lanes is currently underway in Alameda County, California.

3.4 Variable Tolls on Existing Free Roads

By introducing tolls on existing toll-free facilities, such that tolls are higher when traffic demand is higher, traffic can be reduced and much or all of the congestion eliminated. With such pricing of existing free roads, commuters would shift to other modes, routes or destinations or may choose to travel before or after the peak times when tolls are higher. Present traffic volumes in metropolitan areas are so excessive that even a small reduction in traffic can eliminate much of the time lost because of congestion. And the revenue from tolls can be used to help pay for improvements to transportation -- both highway and transit. Improvements in transit service will increase commuter choice, and encourage even more commuters to abandon their cars leading to even greater traffic reduction, cleaner air, and safer and quieter streets.

While this strategy has not yet been implemented in the U.S., two municipalities – the Town of Ft. Myers Beach in Lee County, FL, and New York City -- are considering strategies to increase *person* throughput by tolling existing free bridges, and using the revenues to support alternative modes of travel. This in turn could lead to more efficient use of existing highway lanes, and thereby reduce the need for new highway capacity.

3.5 Lessons Learned from Implemented Projects

The SR 91 Express Lanes in Orange County, CA opened in December 1995 as a four-lane toll facility in the median of a 10-mile section of one of the most heavily congested highways in the United States. The toll lanes are separated from the general purpose lanes by a painted buffer and plastic pylons. There are eight general purpose lanes, four in each direction. As of November 1, 2001, tolls on the Express Lanes varied between $1 and $3.60 in the westbound direction and $1 and $4.75 in the eastbound direction, with the tolls changing by time of day to reflect the level of congestion delay avoided in the adjacent free lanes, and to maintain free-flow traffic conditions on the toll lanes. Traffic volumes for discrete time intervals during the day are monitored on a regular basis on the Express Lanes. When volumes approach levels at which free flow of traffic might be at risk, a new toll schedule is developed and published. To discourage additional traffic, tolls are raised for those time periods when volumes are close to the maximum volumes that can support free flow. All vehicles must have an electronic transponder to travel on the Express Lanes. Vehicles with three or more occupants pay a reduced toll. These vehicles go through a special toll collection lane for HOVs so that they can be identified as vehicles eligible for the discount.

Key findings from the SR 91 project are listed below:

- During heavy congestion periods, 40 percent of total vehicular traffic is carried on the express lanes even though they comprise only one-third of the capacity (5), because throughput is higher under free flow conditions (4). Due to higher HOV use on the lanes, the percentage of *person travel* on the lanes is even higher.
- Variable pricing successfully maintains free flow traffic conditions on the express lanes during peak traffic hours.
- Approval for the toll lanes in general was high (in the 50-75 percent range for most commuter groups) in surveys taken in 1996 and 1999.

In addition to SR 91, other pilot pricing projects have been implemented and are addressing many community concerns:

- *Mobility:* Revenues from pricing have been used to provide the traveling public with additional travel choices and to increase their mobility. Lane pricing has provided premium service for those willing to pay for it, and has provided for congestion-free movement of transit vehicles.

- *Productivity and Economic Efficiency:* By balancing supply and demand, pricing has promoted more efficient use of highway capacity and delayed the need for new capacity, thereby saving tax dollars. Pricing has decreased time wasted waiting in congestion and the uncertainty of delay times.

- *Environment:* By reducing congestion and increasing vehicle occupancy and transit use, pricing has also reduced air pollution and fuel consumption.

Projects implemented through FHWA's Value Pricing Pilot Program (see www.valuepricing.org for more information) have taught important lessons:

- Pricing *can* work – it can reduce congestion and change travel behavior, and provide additional travel choices.

- Pricing can provide much needed revenues for expansion of transportation services.

- Pricing can be politically and publicly acceptable. Surveys of motorists on SR 91 have repeatedly shown a high level of support from all income groups. A recently completed public opinion survey in San Diego (6) found that both users and non-users of the dynamically priced I-15 HOT lanes strongly support the use of pricing. Support is high across all income groups, with the lowest income group expressing stronger support than the highest income group (80% vs. 70%). While this appears to be counterintuitive, it may be explained by the fact that lower income motorists are more likely to have jobs which require them to be punctual at work, or they have child care arrangements which require them to be punctual in picking up their children from day care at the end of the day. This possibly explains their strong support for an option which allows them to bypass congestion on those days when they absolutely need it in order to be punctual and avoid severe consequences.

Implemented pricing projects have demonstrated that pricing makes sense in conjunction with added highway capacity, especially on freeways. It also makes sense where existing HOV lanes are either underutilized or overutilized, and where existing toll facilities are congested. The technology is not yet ready for general pricing of non-freeway type facilities, although advances have been made in using Global Positioning System (GPS) technology for pricing of trucks on all types of road facilities in European countries. In the U.S., one study (7) suggests that use of GPS technology for pricing passenger cars may be as much as 20 years away, due to the need to have the required technology incorporated into all vehicles at the time of manufacture.

4.0 OVERCOMING BARRIERS TO PUBLIC ACCEPTANCE

Conventional wisdom suggests that it is extremely difficult for the public to accept value pricing alternatives. These public concerns are discussed below, along with ways they have been addressed in existing or proposed value pricing projects.

4.1 Concerns About Paying New or Higher Tolls

Unless they get something in return, few members of the public are willing to pay higher tolls on existing toll facilities or new tolls on roads they currently use for free. For example, some freight transportation companies have expressed concerns with increased costs associated with pricing. Value pricing projects have overcome these concerns in two ways:

- *On toll facilities*, rather than raising tolls during peak periods, discounts have been offered during off-peak periods to vehicles using transponders. However, this could result in loss of revenue. In one case, in order to avoid loss of revenue, the "flat" cash toll rate charged during all time periods has been raised above that charged to vehicles with transponders in the peak periods. This has also provided an incentive for motorists to obtain electonic transponders, saving labor costs for toll collection staff and reducing toll agency operation costs.

- On free facilities, general purpose free lanes have remained free, with new tolls being charged only on new lanes or on previously restricted lanes, so that motorists always have a choice to travel free of charge. Trucking companies indicate that they like having the option to pay a premium price to bypass congestion, as long as a free (but congested) option is also available to them.

4.2 Concerns About Double Taxation

Tolls are often viewed as "just another tax increase" which will lead to bigger government. Many believe that pricing involves double taxation, once through gas taxes and again through the imposition of tolls. Another major barrier to public acceptance is the suspicion of some that politicians will divert revenues from any pricing scheme to their pet projects, instead of using the revenues to benefit those who contribute the revenues. These concerns have been addressed in two ways:

- Clear commitments have been made that toll revenue will be used strictly to support transportation services or facilities in the corridor where the revenues are collected.

- Some states have instituted rebates on state fuel taxes paid on tolled facilities. With transponder technology, it is possible to do this without excessive administrative costs, by providing mileage-based credits on the monthly bills that motorists receive.

4.3 Concerns About Equity

Some perceive tolls as being regressive since they can have a disproportional impact on low income groups, taking a larger share of their incomes. Pricing can be perceived as favoring high income travelers, offering them a higher level of mobility than those less wealthy can afford. These concerns can be addressed in one of three ways:

- The revenue generated by the pricing project can be used to mitigate the perceived inequity by financing transportation improvements such as new or improved transit services that benefit lower income travelers. However, the use of pricing revenue to support transit services presents a number of institutional challenges that have not been fully overcome. Support for use of toll revenue for transit is strong in some metropolitan areas such as New York, where even the local automobile club supports the use of toll revenue for transit, based on the understanding that more people riding in transit vehicles results in less congestion for motorists. However, this type of strong support may not prevail in other metropolitan areas.

- Toll revenues may be used to provide "life line" toll credits to low income travelers.

- With lane pricing, all travelers in the regular lanes may be provided with small credits which can be accumulated and used to pay for transit fares or highway tolls (as in the FAIR lanes concept). Drivers from low income households could be provided with credits at a higher rate than that provided for middle and upper income households.

4.4 Concerns About Traffic Diversion

Possible diversion of traffic from tolled freeways to free surface streets is a concern for those who live in neighborhoods through which traffic is diverted. Traffic diversions to secondary roads caused by imposing pricing can have their own impacts on communities and safety that must be evaluated. However, if value pricing is used to pay for new highway capacity which might otherwise be delayed or not built, diversion of traffic from tolled freeways to free surface streets will be less of an issue. This is because, when freeway capacity is expanded, traffic could actually be diverted away from surface streets to the expanded freeway due to faster travel conditions. When value pricing is introduced without capacity expansion, as in the case of HOV lanes converted to HOT lanes, or FAIR lanes on existing right-of-way, diversions will actually occur from secondary roads *to* the freeway, because of the additional throughput of vehicles made possible, and the resulting reduction in congestion on general purpose lanes. Of course, nowhere in the U.S. is there any consideration being given to forms of pricing which involve pricing *all lanes* on existing freeways while secondary roads in the corridor remain free. Such a strategy *would* result in negative impacts on secondary facilities. That is one reason why such strategies are not under serious consideration in the U.S.

4.5 Concerns About Privacy

Some members of the public are concerned about their privacy, since they would be required to use electronic vehicle transponders allowing "Big Brother" to know where and when they travel. This issue has not been a big concern in the Northeast, where over 10 million motorists voluntarily use E-ZPass transponders. However, if privacy is a concern, those concerned about having their privacy compromised can be satisfied if the toll collection system allows use of anonymous smart cards with stored value, such as those in use in Japan. However, such systems are more expensive than the transponder systems currently used for toll collection in the U.S. Toll booths, another way to maintain anonymity, are not amenable to variable tolls, an essential feature of value pricing to manage demand.

4.6 Credibility as a Congestion Management Tool

Some question the ability of pricing to make a dent in the severity of congestion in metropolitan areas. It is true that the success of pricing solutions depends largely on traveler behavior changes, which in turn depend on availability of alternative modes and employer policies regarding work hours and telecommuting. Travel behavior changes are difficult to predict and may vary with economic cycles. Fortunately, evaluation data from several implemented projects are now available, and these data are being used to make a credible case for the magnitude of congestion relief and additional revenues for transportation that can result from pricing strategies.

5.0 ANALYSIS OF PRICING ALTERNATIVES

As indicated earlier, planners who would like to consider pricing in project studies are not aware of evaluation tools available to assist them in developing information on the impacts of pricing alternatives. This section of the paper discusses available tools and provides guidance on how transportation professionals can perform analysis and evaluation of pricing alternatives.

5.1 Available Analysis Tools

An analyst attempting to generate information on the impacts of pricing alternatives needs tools to:

- Forecast travel demand impacts (i.e., changes in modal shares for commuters, peak period and daily traffic on highway facilities in the travel corridor, HOV and toll-paying vehicle volumes, etc.)
- Estimate mobility impacts (i.e., changes in travel delays, vehicle and person throughput, user costs for tolls, etc.)
- Estimate environmental impacts, including the social costs or benefits of any changes in vehicular travel.

Based on the above information, an analyst can generate measures of financial feasibility (e.g., excess of costs above revenues), and measures of economic efficiency (e.g., excess of social benefits over public implementation costs).

Through the Travel Model Improvement Program (TMIP), FHWA has been developing and disseminating advanced travel demand forecasting techniques to estimate the travel effects of pricing alternatives (8). Four-step travel demand models are being used in many cases to estimate traffic impacts of pricing alternatives, e.g., a recent study in Portland, OR (9). When results from four-step models are available, FHWA's Surface Transportation Efficiency Analysis Model (a.k.a. STEAM) may be used to generate estimates of mobility impacts (10). STEAM can also be used to generate estimates of a variety of environmental impacts from vehicle operation on the highway. These estimates are generated at the system level, to ensure that only *net* effects are reported. A pricing study in the Twin Cities, MN, has used STEAM to estimate the mobility and environmental impacts of alternative strategies (11).

However, the above procedures tend to be complex and often expensive to implement. Therefore, at initial stages in a study, when it is desirable to evaluate a wide range of alternatives, use of these tools may be cumbersome. Quick-response sketch planning procedures are a feasible solution for initial evaluation or "screening" of reasonable alternatives, especially in areas that do not have the resources to implement complicated four-step modeling procedures to evaluate a broad range of pricing strategies early in the study process.

FHWA has developed quick-response sketch planning tools which can assist in travel demand and impact estimation at the screening stage. FHWA's IMPACTS model (12) provides for estimation of impacts for pricing alternatives. Other tools developed by FHWA, such as its Sketch Planning Analysis Spreadsheet Model (a.k.a. SPASM) (13) and its Spreadsheet Model for Induced Travel Estimation (a.k.a. SMITE) (14) may also be modified for use in evaluation of pricing alternatives. FHWA's SMITE model was modified for the case study analysis presented below. The modified model is called SMITE-Managed Lanes (SMITE-ML), and may be downloaded with case study project data from www.fhwa.dot.gov/steam (go to the Related Links page).

5.2 Case Study Alternatives

The case study presented below demonstrates application of screening analysis techniques using a typical major freeway widening proposal in a large metropolitan area. A detailed description of the analysis is provided in a companion paper (15). Data were obtained from the draft EIS document. The proposed project is 14 miles long. The existing freeway facility has 8 lanes, and the alternatives evaluated involved expansion to 10 lanes or 12 lanes. The purpose and need statement identified four main purposes for the project:

- Improve access to activity centers
- Preserve the link in the transportation system which sustains the regional economy
- Meet the transportation needs of a growing population
- Upgrade the region's transportation infrastructure

Three conventional Build alternatives were evaluated for the EIS. In addition, a No Build alternative was evaluated in the draft EIS for comparison purposes. The conventional alternatives included:

- 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 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).

Three pricing alternatives which address the purpose and need statement were developed for the case study analysis, in addition to the above conventional alternatives evaluated in the Draft EIS. These pricing alternatives were variations on the No Build alternative and two of the three Build alternatives. Note that the pricing alternatives were not identified in the scoping process for this EIS and were therefore not evaluated in the EIS. The case study is simply intended to illustrate how pricing alternatives could have been evaluated.

In each pricing alternative, tolls would be charged only during peak hours (6-10 am and 3-7 pm) on priced express lanes and would vary dynamically, to ensure that traffic flows freely at all times, including the peak hour of each peak period. This would ensure premium delay-free service for transit and paratransit riders, carpools and toll-paying vehicles. It is important to understand that the primary intent of pricing is not to reduce mobility or freedom of travel, but to *increase* it by providing funding and uncongested travel conditions for better quality, cost-efficient alternative modes while instituting financial incentives to encourage use of these modes. In the alternatives developed, pricing revenues would fund high quality alternatives to solo-driving, including demand-responsive paratransit services, express bus or Bus Rapid Transit (BRT) services, and non-motorized options. And solo drivers willing to pay would enjoy a higher level of mobility.

The physical configurations for each of the three pricing alternatives developed for this case study are described below:

- 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 express with free access for HOV and transit vehicles. Provide toll credits to motorists using regular lanes, as in the FAIR lanes concept. This is essentially the 8-lane No Build alternative with a pricing add-on.

- Alternative 5: Add one concurrent lane in each direction. Using barriers, divide the new 5-lane cross section into two sections - two regular lanes and three priced express lanes, with free access on the express lanes for carpool and transit vehicles. This is essentially the 0-lane Alternative 2 with a pricing add-on.

- Alternative 6: Add two barrier-separated priced express lanes in each direction, with free access on the express lanes for carpool and transit vehicles. This is essentially the 12-lane Alternative 3 with a pricing add-on.

Note that a pricing add-on to the 10-lane Alternative 1 was not evaluated. Barrier-separated priced lanes on a 10-lane cross-section are evaluated under Alternative 5.

5.3 Forecasting Traffic Impacts of Alternatives

A "pivot point" mode choice model (16) was used to estimate impacts of the alternatives on peak period mode shares, pivoting off of estimated No Build mode shares in the year 2020. Table 1 presents the results from this analysis for one of three segments into which the project was divided for analytical purposes. The results are for the southern segment which had mid-range traffic levels. For this segment, the model estimated:

- An additional 3,400 transit person trips for conventional Alternatives 1, 2 and 3.
- An additional 21,000 to 24,000 transit person trips for pricing Alternatives 4, 5 and 6.

As shown in Table 1, carpool use estimated by the model ranged from an increase of about 14,000 person trips for the conventional alternatives, to smaller increases of 8,000 to 12,000 person trips under the pricing alternatives. Note that pricing does not generate as much carpool use as conventional alternatives because some would-be carpool commuters are attracted to transit due to the superior transit services under pricing alternatives provided with funding from toll revenues.

The pricing alternatives tend to reduce vehicle demand relative to the base case No Build alternative. However, the reduced vehicular demand and reduced congestion will cause diversions of traffic *to* the freeway from other routes and destinations, and may even induce additional development and consequent new trips in the corridor. FHWA's SMITE-ML model was used to estimate increases in traffic from these sources. Table 1 presents estimates of the induced vehicle trips under each alternative for the southern segment of the travel corridor. Due to the larger amount of new capacity available and used in peak periods with Alternative 6, diverted and induced traffic is significant, increasing vehicle volumes daily by almost 30,000 above the No Build volumes for that segment of the freeway, and 12,000 above No Build volumes for the whole corridor. On the other hand, with pricing Alternative 4, vehicle volumes are *reduced* by more than 30,000 vehicles daily on the freeway. This occurs because Alternative 4 shifts many peak period trips to carpools and transit, and shifts a small number of vehicles to arterial roads (amounting to about 1,000 vehicles, or 2% of the total No Build arterial traffic volume). And it actually dis-induces about 550 vehicle trips from using the corridor, because no capacity increase is involved.

6.0 EVALUATION OF PRICING ALTERNATIVES

6.1 Delay Reduction

SMITE-ML produced estimates of average daily speeds for each alternative. The speed estimates were then used to estimate delay reductions relative to the base case No Build alternative. Table 2 presents the resulting estimates (in person hours) for each of the six alternatives. The pricing alternatives reduce significantly more delay than alternatives with the same physical configuration but no pricing. Table 2 suggests that pricing Alternative 4, which does not increase capacity, is still able to reduce delay significantly. Delay reduced amounts to more than 75% of the delay reduction with conventional Alternative 1, which *does* increase capacity by one lane in each direction. Thus, if funding is not available in a timely fashion for capacity improvement alternatives, this alternative could be a very good interim solution. Alternative 5, which involves the same amount of new capacity and the same configuration as conventional Alternative 2, reduces delay by about 50% more than Alternative 2. Similarly, Alternative 6, which involves the same amount of new capacity and the same configuration as conventional Alternative 3, reduces delay by almost 50% more than Alternative 3.

The bottom line of Table 2 also presents the cost of each alternative per hour of delay reduced. As the table shows, the most cost-effective alternative with regard to delay reduction is Alternative 4. It costs only about $3 per hour of delay reduced. On the other hand, the conventional Alternatives 1, 2 and 3 and pricing Alternative 5 are the least cost-effective. They cost about $9 to 13 per hour of delay reduced.

6.2 Financial Impacts

The average toll rate per mile was estimated using average time saved per mile by vehicles in the priced lanes, and converting it to a monetary value. This value would roughly be equivalent to the toll that those ineligible for free service would be willing to pay. Note that peak period toll rates would actually be much higher than suggested by this methodology, because peak period speed differentials are much higher than the average daily speed differentials estimated by SMITE-ML. Table 2 summarizes the resulting estimates of gross annual revenue. Toll revenue is relatively lower for Alternative 6 because toll rates are lower, since the four regular lanes are less congested and travel time saved by taking the priced lanes is correspondingly lower. For Alternative 4, approximately 25% of the revenue will be needed to pay for credits to motorists in the regular lanes, assuming a credit payout of 25% of the toll rate.

Estimates of new transit trips were used to calculate new transit subsidies that would be needed to support service for the new trips and provide discount fares. Table 2 shows the resulting transit subsidy estimates. Transit use under the pricing alternatives is about two and one-half times its use under the conventional alternatives. This results in a need for new public subsidies for transit which are about eight times the new subsidies needed for the conventional alternatives.

Despite the very conservative assumptions that were used in estimating toll revenue, the pricing alternatives bring in gross toll revenues estimated at about 70-75% of the new public subsidy needs for transit under Alternatives 4 and 5, and about 25% of that needed for Alternative 6. Total annualized public costs, including capital costs for highway facilities, is higher for the pricing Alternatives 5 and 6, relative to the comparable "no pricing" Alternatives 2 and 3, primarily because of the larger transit subsidies needed. If alternative sources can be found for transit funding, the toll revenue will be available to provide a source of funding to support construction bonds for the highway improvements.

6.3 Social Benefits

Social benefits estimated include:

- Value of changes in external costs
- Value of time saved estimated at $12 per hour of vehicle delay, assuming an average vehicle occupancy of 1.33.
- Value of fuel saved due to reduced accelerations and decelerations, estimated at $3 per hour of vehicle delay reduced
- Disbenefits due to additional delays during construction due to work zones

The increase in external costs (including air pollution, noise and crashes) due to increased traffic relative to the No Build was estimated using an estimated cost of 6 cents per vehicle mile. Pricing has the effect of reducing external costs, and therefore increasing social benefits, since vehicle miles of travel are reduced.

To estimate excess delay due to construction activities during project implementation, it was assumed that delays would increase by 100% above prior recurring congestion delay, over a period of 250 days. According to a recent study of the impacts of temporary losses of highway capacity by Oak Ridge National Laboratory (17), non-recurring delay on U.S. freeways and principal arterials in 1999 amounted to 2.02 billion vehicle hours, while work zone delays *on freeways alone* amounted to 0.48 billion vehicle hours. Various studies, such as those done by the Texas Transportation Institute (18), suggest that recurring delay is equal to or less than non-recurring delay. Thus, work zones region-wide add at least 25% to recurring delays on regional networks, and perhaps more if delays on principal arterials are considered. Since we can safely assume that no more than 25% of a region's network is in work zone status at any one time, this suggests that the assumption of 100% increase in delay on a specific facility due to construction is a conservative assumption.

The resulting present value of social benefits over a 20-year period is presented in Table 2. The pricing alternatives significantly increase social benefits relative to alternatives with the same physical configuration but no pricing.

6.4 Economic Efficiency

Comparisons of social benefits against public costs for implementation can provide useful information for evaluation of alternatives. The information helps in understanding the merits of alternative design concepts, and in designing improvements to the concepts to increase the level of net benefits provided to the public. Table 2 presents estimates of annualized highway facility construction and right-of-way costs based on estimates from the Draft EIS report. These are then aggregated with annualized transit subsidy and pricing infrastructure and operation costs, to get total annual public costs. The present value of these costs for a 20-year period is then subtracted from the present value of benefits aggregated over all three segments, to get net present value. The pricing alternatives all demonstrate significant positive net present values, ranging from $517 million to $ 1.7 billion. Only one of the three conventional alternatives, Alternative 3, has a positive net present value. Its value amounts to $138 million, much lower than any of the pricing alternatives.

7.0 CONCLUSIONS

As pricing becomes increasingly tested and proven in the real world, it is moving out of the laboratory and into the field. This indicates that the time is ripe for pricing to be more seriously considered during the NEPA process, the forum for arriving at major transportation decisions. Given the variability of situations across the country, the authors offer no specific guidance on how or when this consideration is most appropriate -- as part of the 3C planning process that lays the foundation for the NEPA process, during NEPA scoping, or as part of the detailed consideration of alternatives under NEPA. Nevertheless, this paper has introduced relatively simple analytical procedures that may be used to estimate the impacts of pricing alternatives and generate information for use by decision-makers. The case study has also demonstrated that pricing can often effectively compete with conventional alternatives in addressing the purpose and need of a major highway project, while generating net revenue surpluses to make transportation improvements financially feasible.

Transportation agencies could use techniques such as those discussed in this paper to evaluate pricing alternatives and provide impact information to decision-makers. Transportation agencies could also undertake a concerted effort to educate the public about pricing alternatives and their advantages and disadvantages during the alternatives development phase of any study for a major highway project in a metropolitan area. As discussed in this paper, FHWA has developed several tools, both for public education as well as for analysis and evaluation. These tools will make it easier for transportation agencies to incorporate pricing alternatives into NEPA studies for major highway projects in metropolitan areas.

Evaluating pricing alternatives in the NEPA process will be an evolving practice for many years to come. Practitioners will need to constantly monitor the work of their peers. One resource to assist in this effort is the FHWA sponsored NEPA community of practice, Re:NEPA, (http://nepa.fhwa.dot.gov)

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REFERENCES

1. National Transit Institute and Parsons Brinckerhoff Quade & Douglas, Inc. *Major Investment Studies: Desk Reference*. FHWA and FTA. August 1996.
2. US DOT. *Report to Congress on the Value Pricing Pilot Program.* FHWA. In process of publication.
3. DeCorla-Souza, Patrick. FAIR lanes: A New Approach to Managing Traffic Congestion. *ITS Quarterly*, Spring 2000 Issue. Vol VIII Number 2. Available at: http://docs.vircomnet.com/mobility/ITS_vc/FAIRLanes.html.
4. Chen, Chao and Pravin Varaiya. The Freeway Congestion Paradox. Access. Number 20. Spring 2002. University of California Transportation Center, Berkeley, CA.
5. Eno Transportation Foundation. *The Role of Pricing in the Nation's Future Transportation System*. Washington, DC. 2002.
6. The Fairfax Research Group. *I-15 Managed Lanes Value Pricing Project Planning Study: Telephone Survey*. San Diego Association of Governments. November 7, 2001.
7. Forkenbrock, David and Jon Kuhl. *A New Approach to Assessing Road User Charges*. Public Policy Center, The University of Iowa. 2002.
8. US DOT. *Participant Notebook for NHI Course No. 15260, Advanced Travel Demand Forecasting Course*. Publication No. FHWA-HI-99-003. Washington, DC, December 1999.
9. METRO Regional Services and Oregon Department of Transportation. *Traffic Relief Options Study*. *Technical Appendix*. November 2000.
10. DeCorla-Souza, Patrick. Using STEAM for Benefit-Cost Analysis of Transportation Alternatives. Paper no. 98-0083. *Transportation Research Record 1649*. Transportation Research Board. 1998.
11. SRF Consulting Group, Inc. *Travel Demand Forecasting, Phase I Results.* Technical Report for the Twin Cities Regional Value Pricing Study. Minnesota Department of Transportation. February, 2002.
12. US DOT. *Participant Notebook for NHI Course No. 15257, Estimating the Impacts of Urban Transportation Alternatives.* Publication No. FHWA-HI-94-053. Washington, DC, November 1995.

13. DeCorla-Souza, Patrick, Harry Cohen and Kiran Bhatt. Using Benefit-Cost Analysis to Evaluate Across Modes and Demand Management Strategies. Presented at the 66th Annual Meeting of the Institute of transportation Engineers. *1996 Compendium of Technical Papers.* Institute of Transportation Engineers. 1996.
14. DeCorla-Souza, Patrick and Harry Cohen. Estimating Induced Travel for Evaluation of Metropolitan Highway Expansion. *Transportation.* Kluwer Academic Publishers. Volume 26, No.3. August 1999DeCorla-Souza, Patrick.
15. DeCorla-Souza, Patrick. Evaluation of Toll Options Using Quick-Response Analysis Tools. Paper No. 03-2946. Prepared for presentation at the January 2003 Annual Meeting of the Transportation Research Board. January 2003.
16. Sierra Research, Inc. and J. Richard Kuzmyak. *COMMUTER Model User Manual for Analysis of Voluntary Mobile Source Emission Reduction and Commuter Choice Incentive Programs*. U.S. EPA. Draft Final report. September 1999.
17. Chin, S.M., O. Franzese, D.L. Greene, H.L. Hwang, and R.C. Gibson. *Temporary Losses of Highway Capacity and Impacts on Performance*. Publication no. ORNL/TM-2002/3. April 2002.
18. Texas Tansportation Institute. *2002 Urban Mobility Study*. Texas A & M University. College Station, TX. 2002.

TABLE 1. TRAVEL DEMAND ESTIMATES FOR SOUTHERN SEGMENT OF TRAVEL CORRIDOR

	No Build	Conventional Alternatives			Pricing Alternatives		
		No 1	No 2	No 3	No 4	No 5	No 6
Total daily person trips	445,000	445,000	445,000	445,000	445,000	445,000	445,000
Total initial daily vehicle trips	333,689	323,011	323,011	323,011	304,509	306,356	309,371
Peak period mode shares: (prior to induced travel)							
Solo driver	80.00%	72.34%	72.34%	72.34%	63.94%	65.11%	67.01%
Carpool	16.00%	22.13%	22.13%	22.13%	21.30%	20.61%	19.48%
Transit	4.00%	5.53%	5.53%	5.53%	14.76%	14.29%	13.51%
Peak period person trips:							
(prior to induced travel)							
Solo driver	178,000	160,952	160,952	160,952	142,266	144,864	149,103
Carpool	35,600	49,238	49,238	49,238	47,383	45,849	43,345
Transit	8,900	12,310	12,310	12,310	32,851	31,787	30,051
Total	222,500	222,500	222,500	222,500	222,500	222,500	222,500
Induced vehicle trips	0	12,558	14,442	18,112	-556	6,474	36,251
Total daily vehicle trips	333,689	335,570	337,453	341,123 (	303,954	312,830	345,622
Portion of daily vehicle trips: On Freeway	280,299	289,488	292,094	297,620	249,723	268,079	309,107
On Arterials	53,390	46,081	45,359	43,503	54,231	44,751	36,515

TABLE 2. SUMMARY OF IMPACTS OF ALTERNATIVES

	Conventional Alternatives			Pricing Alternatives		
	No 1	**No 2**	**No 3**	**No 4**	**No 5**	**No 6**
Total travel delay reduced daily (person hours)	89,221	94,490	118,597	68,962	143,520	173,343
Gross annual revenues from tolls (mil.$)	$0	$0	$0	$28	$31	$9
Total annualized costs for pricing (mil.$)	$0	$0	$0	$3	$3	$3
Annual transit subsidy increase (mil.$)	$5	$5	$5	$42	$40	$37
Annualized highway facility cost (mil $)	$250	$303	$272	$14	$303	$272
Total annualized public cost (mil $)	$255	$308	$277	$59	$346	$312
Present value of benefits (Mil.$)	$2,279	$2,420	$3,075	$2,053	$4,184	$5,073
Present value of costs (mil. $)	$2,704	$3,266	$2,937	$477	$3,667	$3,306
Net present value (mil. $)	-$425.22	-$845.84	$137.56	$1,428	$516.88	$1,766.32
Cost per hour of congestion delay reduced	$11	$13	$9	$3	$9	$7