Tolling White Paper 1

Potential Effects of Tolling and Pricing Strategies on Greenhouse Gas Emissions

Prepared for the Oregon Department of Transportation

by

Cambridge Systematics, Inc., with CH2M HILL

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Tolling White Paper #1

Potential Effects of Tolling and Pricing Strategies on Greenhouse Gas Emissions

Executive Summary

Advances in electronic technology have dramatically expanded how highways can be tolled and priced. It no longer is necessary to stop all vehicles at toll plazas. Vehicle usage of a particular highway, or even within an entire geographic area, can be recorded and a charged to the motorist electronically.

Tolling was traditionally a means of financing highway construction. Recent technological advances, however, create the possibility of tolling road use to accomplish other public objectives. In fact, pricing strategies are now being used in places to manage congestion and/or to generate revenue for other needed transportation improvements. This paper examines the potential effects of different forms of tolling and road pricing strategies on greenhouse gas emissions and discusses issues related to the analytical approaches used to quantify those effects. With the current emphasis on climate change, there is an emerging question about the degree to which road tolling and pricing can be used as a means of reducing greenhouse gas emissions from transportation sources. This paper is based on two presumptions. First, global warming is a complex issue. While much is known with a high level of confidence, there also are areas of continued uncertainty. Second, a strategy for how fast or how best to reduce greenhouse gas emissions has not yet been agreed upon. To gain public acceptance, emission reduction strategies will need to: a) reflect perceptions of the magnitude of the problem, and b) represent relatively cost-effective solutions.

Including greenhouse gas considerations in an analysis of road tolling and pricing strategies triggers important additional analytical requirements. These requirements go beyond those of the Oregon Department of Transportation (ODOT) and the state's metropolitan planning organizations. Tolling and pricing strategies may affect the number and type of vehicles owned by a household as well as where people live and work, the number of trips they take, the time of day trips are taken, whether they choose to drive or use transit or another mode of travel, and the roadway operating conditions in terms of vehicle operating speed and frequency of accelerations and decelerations. Some of these impacts may occur immediately, while others may take place over several years. An analysis of the impacts of road pricing on greenhouse gas emissions, therefore, needs to be based on how each of these factors will change over time and the resulting impacts on vehicle miles of travel (VMT) and vehicle operating conditions.

Carbon dioxide (CO_2), the most important transportation-related greenhouse gas, is emitted in direct proportion to vehicle fuel consumption, with variation by type of fuel.

Factors influencing fuel economy and, in turn greenhouse emissions are vehicle type, model year, and vehicle operating conditions (speed and acceleration).

While significant data and analytical methods are available to evaluate travel and emission impacts of potential road pricing strategies, existing approaches are still less than fully satisfactory. Improved and more detailed analytical approaches are being developed at the national level, but are not yet widely used. New and emerging comprehensive analytical approaches to quantifying transportation and greenhouse gas impacts are both data and resource intensive, thereby limiting their use to larger agencies with access to more advanced analytical tools. As a result, simplified quantitative methods often are employed. An important challenge for ODOT and metropolitan planning organizations, therefore, is to improve current travel demand, traffic, and greenhouse gas modeling capabilities. This data can be used to analyze the full range of potential road tolling and pricing applications.

A broader set of guidelines is needed to frame a greenhouse gas measurement and assessment process. These include using a time horizon that extends at least 40 years into the future and accounts for likely changes in vehicle fuel efficiency and vehicle fleet characteristics.

The importance of road pricing as a greenhouse gas emissions reduction strategy is dependent on the extent of its geographic and temporal application. A pricing measure implemented on a statewide or even an urban area basis in a way that affects all travel is likely to result in larger reductions in emissions than those in effect only during the peak-period or on a given roadway. Even if effective locally, the latter may represent only a very small portion of total state emissions.

While the relative cost-effectiveness of alternative approaches to reducing greenhouse gas emissions is an important decision-making criterion, it is only one of a number of concerns that transportation agencies need to consider when making capital investment and system management decisions. Other considerations such as institutional responsibility, public acceptance, technology, legal authority, administrative expense, and economic impacts should also be weighed. For example, the administrative expense of initiating and managing an urban congestion pricing program compared to traditional fuel taxes may be an especially important consideration.

Potential forms of road tolling and pricing include expanded use of traditional road and bridge tolls; implementation of systems of high-occupancy toll (HOT) lanes, express toll lanes, and truck-only toll (TOT) lanes; the use of cordon or area pricing around or within a defined area such as a central business district (CBD); and various approaches to mileage-based pricing. A mileage-based fee could be as simple as a fixed price per mile regardless of when or where traveled, or the fee could vary either by time-of-day or historical level of congestion. Other possibilities include fees based on the carbon content of the vehicle’s fuel, the type of fuel or power used, or the fuel efficiency of the vehicle.

Based on currently available quantitative estimates of greenhouse gas emission reduction effectiveness, the following conclusions emerge:

- Major decreases in motor vehicle greenhouse gas emissions are more likely to result from improvements in fuel economy standards and motor vehicle emission controls than from changing the pricing of road usage.

- The increase in fuel tax or magnitude of VMT fee necessary to achieve large reductions in travel and associated greenhouse gas emissions is significantly higher than the amount implied by currently proposed carbon taxes. Pricing implementation at these levels, therefore, should be based on more comprehensive objectives than just reducing greenhouse gas emissions.

- On a facility or project basis, road pricing designed for a more efficient operation of a roadway system should also lower greenhouse gas emissions. In other words, road pricing for other purposes can be designed to support greenhouse gas reduction efforts.

- The Minneapolis, Seattle, and U.S. Department of Energy findings represent a reasonable baseline estimate of potential areawide benefits of HOT or express toll lanes. Fuel savings in the range of 1.4 to 2.5 percent are likely attainable within those urban areas where regional systems of HOT and TOT lanes are feasible. If rolled out in national metropolitan areas that experience moderate to heavy congestion, these savings in fuel consumption are likely to range from 0.5 to 1.1 percent. New urban freeway lanes, however, can be expensive; so these costs, the full range of potential benefits, and potential economic and land use changes should be included when assessing the cost effectiveness of these systems as an emissions reduction strategy.

- Achieving larger emission reductions from pricing strategies, such as those projected in many state-level climate change action plans, will require an aggressive and comprehensive program of pricing strategies broader in scope than typically associated with tolling and congestion-based road pricing. Road tolling and pricing, by itself, is not sufficient to achieve the desired reduction in transportation sector greenhouse gas emissions often targeted in state climate change action plans.

Improved analytical capabilities are needed for estimating project, regional, and state-level changes in greenhouse gas emissions that could result from candidate road tolling and pricing strategies. A two-pronged approach is recommended. T ODOT's Greenhouse Gas Statewide Transportation Emissions Planning (GreenSTEP) model should continue to be enhanced. This modeling approach can be used to conduct initial "sketch planning" analyses for a broader range of road tolling and pricing strategies than presently are possible. In parallel, existing state and urban area modeling systems should be improved to provide more detailed network-level analyses of potential changes in greenhouse gas emissions that could result from road tolling and pricing strategies.

Tolling White Paper 2

Geographic and Situational Limits

Prepared for the Oregon Department of Transportation

by

Parsons Brinckerhoff
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Tolling and Pricing White Paper #2

Geographic and Situational Limits

Section 1.0: Introduction and Policy Context: What Is the Purpose of This Paper?

Introduction

Advances in electronic technology enable the tolling of highways to be done in a variety of ways and for a variety of public policy objectives. It is now possible to toll individual freeway lanes in a manner that balances demand using variably priced tolls to meter traffic volumes and insure an unimpeded flow. These advances have improved the efficiency of toll collection and the traffic flow and operation of toll ways.

While efficiencies have been gained on existing toll roads, some tolling applications may only work well in particular circumstances. A new toll road, for example, must be able to provide sufficient time savings to warrant the toll motorists are being asked to pay.

The State of Oregon has a well established transportation planning process that is consistent with federal requirements and coordinated between ODOT, metropolitan planning organizations (MPOs), and local government. Oregon has state statutes as well as policies within the Oregon Transportation Plan (OTP) that refer to tolling and toll ways. The question is now being asked: In what circumstances does tolling make sense?

One purpose of this paper is to assist statewide planning efforts with the relatively new subject of highway tolling/pricing by considering where particular tolling applications are likely to be appropriate, or inappropriate, within Oregon. In other words, are there geographic or situational limits that should guide tolling policy in Oregon?

A second purpose of this paper is a discussion of the financing of toll roads in those cases where tolls are unlikely to be able to fund the full cost of facility construction and maintenance, a very likely circumstance in a sparsely populated state like Oregon. ODOT, as well as other transportation providers in the state, strives to communicate with the public in an open and clear fashion and to meet its commitments with a high degree of reliability. The inherent uncertainty of partially funded toll projects can challenge these objectives.

This paper discusses a range of potential tolling applications, but not every one. Section 3 of this paper details the range of applications included in this paper. Two primary policy objectives for tolling are discussed in this paper: tolling for revenue to finance new construction and tolling as a traffic or congestion management tool.

There are other papers commissioned concurrently as part of this policy process that address additional tolling considerations. Toll managed truck-only lanes are covered in Paper #7. The system-wide application of congestion pricing in urban areas is the topic of Paper #5. Paper #1 considers greenhouse gas emission reduction as a policy objective for tolling. This paper and the other papers in the series are intended to encourage public discussion and comment. Assertions and recommendations included in the document are those of the authors and do not constitute ODOT policy. Complex problems demand thorough study; this paper is intended to facilitate the consideration of the issues discussed herein.

This paper is divided into six sections, as follows:

- Section 1, Introduction, gives the background and policy context of tolling.
- Section 2, Toll Management Issues, discusses the challenges and issues with building, owning, and operating a toll facility.
- Section 3, Tolling Applications, discusses a proposed narrowing of circumstances and project types under which tolling would be appropriate and includes factors agencies should consider when assessing tolling applications.
- Section 4, Tolling Performance Parameters, provides discussion of more quantitative performance measures agencies could consider when evaluating the applicability of tolling for a project.
- Section 5, Consideration of Tolling in the STIP Process, provides a discussion about ways to incorporate the consideration of tolling into the Statewide Transportation Improvement Program (STIP) process, including situations where tolling does not cover the entire construction cost of a project.
- Section 6, Conclusions and Preliminary Recommendations, summarizes the paper's findings and conclusions, and provides some considerations for public discussion for expanding the Oregon Transportation Plan's tolling policies.

Section 6.0: Conclusions and Preliminary Recommendations

Tolling may not be a panacea for filling funding shortfalls and may not be appropriate in many instances in Oregon. In situations where it doesn't make sense to consider the use of tolling, criteria proposing conditions and minimum thresholds might lead decision-makers to remove tolling as a feasible alternative, thus making the discussion less cumbersome and "wishful." As policy discussions progress on tolling issues, some conditions and thresholds to consider include:

1. Tolling can be considered for appropriate types of project alternatives: modernization of a high-volume corridor, managed lane projects, extensions of state highways, and construction or reconstruction of major bridges.

2. A free alternate route may be critical to gaining public acceptance for tolling a facility. When tolls are being considered, the impact of a nearby free facility needs to be assessed.

The negative aspect of the free route is the competition it poses for the tolled facility, and the potential for it to reduce the use of and revenue generated by the tolled facility. There must be a balance between the use of the tolled facility and diversion of traffic onto the free alternate route.

3. Tolling could be removed as a funding option on facilities:
   - With daily volumes of less than 20,000 average daily traffic (ADT) (or perhaps even less than 60,000 ADT);
   - With little to no or moderate improvement in travel time savings;
   - With little to no or moderate relief to traffic congestion on adjacent or parallel facilities;
   - That are less than three miles from a free alternate route;
   - With no toll exemption for buses or no transit service gained as part of the project; and
   - With low to moderate revenue return on facilities with medium traffic volumes and low or medium proposed toll, or high traffic volumes and low proposed toll.

4. Tolling could be considered on facilities:
   - With daily volumes over 60,000 ADT;
   - With substantial improvement in travel time savings;
   - With a high level of reduction in traffic delays on parallel facilities;
   - That are one to three miles away from a free alternate route;
   - Where transit has toll exemption for buses and toll revenue can fund a high level of peak transit service gained as part of the project; and
   - Where revenue return is high with high traffic volumes and a medium or high proposed toll.

5. Public acceptance is critical to the success of implementing a tolling project. It is easiest to incorporate tolling if the interest is initiated locally.

6. Situations in Oregon where tolling could be appropriate include:
   - Applying tolls on existing facilities to accelerate capacity-adding projects;
   - Building a managed lane (HOT lane) facility in a highly congested area where toll pricing can be used to manage congestion along a corridor as well as provide revenue for a high-priority capacity need and also be consistent with regional and statewide planning goals;
   - Constructing a toll bypass facility on which traffic volumes are expected to be moderate or high (and not where volumes are expected to be low); and
   - Building a new access road to an airport, port, or other significant trip generator.

With the appropriate use of tolling in project funding considerations and assessment of tolling's feasibility in bridging a project funding gap, Oregon could find that tolling in some instances is a useful revenue and congestion management tool. Clear policies and parameters will help ODOT and its agency stakeholders in making these feasibility assessments up front, before significant time and energy has been spent on developing a project where tolling is not appropriate.

Regardless of their potential benefits, however, tolling projects are not developed in isolation of the rest of the state highway program. The non-toll generated portion of project costs must be considered in the context of the programming and funding policies of the Oregon Transportation Commission. This suggests a need for clearer policy guidance as that suggested above.

Tolling White Paper 3

Travel Demand Model Sufficiency

Prepared for the Oregon Department of Transportation

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Executive Summary

Increasing highway congestion and the projected shortfall in gasoline tax revenues and other traditional sources of highway financing have renewed interest in tolls as both a revenue source and a demand management strategy. The Oregon Transportation Commission (OTC) seeks to understand the opportunities that highway tolling offers for improving the state's transportation infrastructure and managing its growing demand for travel. In recent years the OTC has taken steps to create the institutional and policy framework necessary to study how toll projects can support and advance Oregon's economic, environmental, and social welfare objectives.

Recent technological advancements have enabled the tolling or value pricing of highways in a variety of forms, including different combinations of managed and general purpose lanes, vehicle eligibility by type and occupancy, and toll differentiation by congestion levels or time of day, among others. Tolls are being used both for generating revenue and managing congestion. Pricing scenarios represent a challenge for demand forecasting, because traditional travel models are characterized by simplified representations of pricing and limited capabilities for predicting how travelers would change mode, route, departure time, destination, or even trip frequency in response to pricing.

When tolling is a factor of analysis, travel demand models will produce the necessary information regarding the patronage of the toll facility, as well as the impacts of tolling and pricing on corridor and regional travel hand for different groups of travelers. The accuracy of toll traffic and revenue (T&R) forecasts, however, is crucial for understanding how well the proposed project meets its policy objectives, and for the continued success of a tolling program once the State of Oregon has committed to its implementation.

In addition to the planning, public perception, and political aspects common to all major infrastructure investments, for tolling projects there is added scrutiny by private investors, bond rating agencies, and parties concerned about environmental justice. Bond or finance rating agencies and project sponsors in particular put T&R forecasting procedures under a high level of scrutiny that is in many respects quite different from the model evaluation/validation criteria applied in the public sector. In particular, the financial community seeks a good understanding of the uncertainty in the toll T&R forecast.

The Oregon Department of Transportation (ODOT) and the state's Metropolitan Planning Organizations (MPOs) have developed travel demand models to examine important questions related to the impact of transportation investments and of population and economic growth on the existing transportation infrastructure. Because there is little recent history of tolling in the state, other than the Cascade Locks and Hood River Bridges (currently), and several other Columbia River bridges (in the past), the travel demand models developed throughout the state are largely untested in terms of their sufficiency to predict motorist behavior for tolling situations. These models cannot be assessed by establishing how well they match current travel behavior or traffic patterns, since nowhere in the state are travelers required to choose between toll and free roads. Instead, the models need to be compared to national best practices for modeling and forecasting of toll traffic. In addition, opportunities for incorporating recommendations from recent research on toll traffic forecasting methods should be investigated.

This paper examines current travel demand modeling practices in Oregon with regard to tolling applications. This assessment evaluates the capability of the existing models to produce T&R forecasts for a wide range of tolling applications. It provides a detailed assessment of current modeling practices in Oregon, including a comparison to the national state-of-the-practice. Included are an explanation of technical aspects of travel demand models, an evaluation of the capability of existing models across a range of potential tolling applications, a description of the requirements placed upon the models by private investors, and general recommendations for improving model performance.

Our assessment of the sufficiency of Oregon's travel demand models to evaluate tolling applications is not limited to comparing the state's models to prevailing modeling practice. Nor are our recommendations for model improvement solely intended to upgrade these models to the state-of-the-practice. Advanced modeling practice and even state-of-the-art methods have been included among the recommended model improvements whenever relevant and applicable to overcome some of the known limitations and deficiencies of state-of-the-practice models.

We find that all of Oregon's MPO models meet state-of-the-practice modeling standards, when compared to models for metropolitan regions of similar size. The Portland Metro model goes a step beyond the state-of-the-practice, by including advanced modeling features. The Statewide Integrated Model (SWIM) is in a category all by itself; it is in fact among the most advanced integrated land use/transport models worldwide, and incorporates many of the characteristics recommended for state-of-the-art, yet practical activity based models. None of these models, however, was specifically developed for evaluating tolling applications, and therefore all of them lack to varying degree one or more of modeling features essential for road pricing analyses. Furthermore, given the requirements placed upon travel demand models by the financial community, and recent advances in bringing travel behavior research into practice, Oregon statewide and MPO models could and should be improved to reflect state-of-the-practice tolling methodologies, and even some advanced features, prior to using them to forecast toll traffic and revenue.

A model structure that adequately incorporates all the known, relevant responses to road pricing – which include selection of route, trip departure time, mode, and destination, among others, is a necessary condition, and in our opinion the most important factor that contributes to the sufficiency of a travel demand model. For this reason much of this paper is dedicated to a discussion of essential and desirable model features. Another important contributing factor to model sufficiency is related to how well a model reproduces current travel conditions at a regional, corridor and facility level. Regional travel demand models are typically evaluated in terms of how well they reproduce regional travel patterns. However, this level of model validation may be insufficient for the specific facility, corridor, or subarea under study. Therefore a critical step before initiating a road pricing or traffic and revenue study is ensuring that the model is well-validated at a geographic scale commensurate with the scale of the project. Equally as important as the improvement of the models themselves is the undertaking of a fundamental shift in how models are used to produce toll traffic and revenue forecasts. A thorough analysis of the risks associated with the forecast needs to become an integral part of the forecasting process. Typical risks associated with toll projects are related to the model itself, to the model input data, and to specific circumstances associated with particular projects. This paper offers specific recommendations for implementing a toll application risk analysis program. The development of better models through more behaviorally-based model structures and improved model validation, and a more rigorous risk assessment approach, will help increase the credibility of toll traffic and revenue forecasts, as well as better integrate the transportation modeling culture with the culture of the investment analysis community.

White Paper 4

Economic Evaluation of Improved Reliability

Prepared for:

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Executive Summary

Over the past several years, the Oregon Transportation Commission (OTC) has initiated a review and assessment of the potential implications of highway tolling and pricing. This assessment produced a discussion about tolling and pricing options for Oregon and the ways these options might be put into practice. These ideas were documented in a report prepared for the Oregon Department of Transportation (ODOT) titled The Future of Tolling in Oregon: Understanding How Varied Objectives Relate to Potential Applications (Cambridge Systematics 2007). Several important questions about how tolling might be implemented and its potential effects arose from this report. This paper is one of a series of papers commissioned by ODOT to highlight specific topics required to develop a ". . . comprehensive and analytically sound set of policies regarding the potential use of tolling in Oregon."

Properly applied, either fixed or dynamic pricing can reduce traffic volumes, especially during peak travel periods when congestion bogs down large parts of the highway system. Reduced traffic volume helps to maintain free flow conditions and, in so doing, may assure the motorist both a faster and a more "time certain" trip over tolled portions of the highway system. The ODOT Future of Tolling `report identified improved reliability – i.e., reduction in the variability and uncertainty of travel times – as one of the most important results of using pricing and tolling for traffic management. This increase in reliability has an economic value for motorists.
There have been no systematic attempts either to quantify the value of improved reliability or to factor it into economic evaluations of priced and non-priced highway corridor alternatives in Oregon. This white paper:

1. Examines ways to measure reliability,
2. Reviews the ways reliability can be included in an economic analysis of pricing and tolling policy, and
3. Discusses some of the practical implications of measuring and evaluating reliability for the pricing and tolling applications identified in the Future of Tolling report.

Measuring Reliability

Measuring reliability has proved difficult in the past because it requires more than just estimating the average travel time between two points. Instead, reliability measures have to account for the entire range of travel times that motorists are likely to experience between two points. This means the time needed to make each individual trip has to be measured and recorded. Recent advances in technology and vehicle detection have made it possible to measure reliability for limited access highways where vehicles entering and exiting the highway can be monitored.[1] The most significant issue in measuring reliability is that there are no current techniques for accurately determining reliability for major arterials or primary and secondary roads. Reliability measurement technologies have only been applied to limited-access highways. This is a fundamental problem in assessing the economic impacts of tolling and pricing policy,

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[1] Such a system is in place in the Portland metropolitan area. It measures reliability on several – but not all – of the region's Interstate Highways and a few of the limited-access state highways that connect to the Interstates.

because there are inevitably motorists who cannot or will not pay the toll and choose other, untolled routes. These "diverted" motorists increase the congestion on untolled routes, which are invariably local roads and arterials connecting points otherwise accessible via the tolled roadways. Because we cannot measure the effects of reduced reliability on such roads, we cannot determine the effects of reduced reliability on roads that receive diverted traffic. As a result, we can only address the benefits of improved reliability, not the detrimental effects of diverted traffic for travelers on these associated, untolled roads.

Economic Analysis of Improved Reliability

Economic effects depend on how reliability is valued by each trip-maker and how the consequences of improved reliability are reflected in decision-making and commercial cost management. The most important distinction is between personal and commercial travel. For personal travel, there is extensive research on the value of travel time (including the value of variation in travel time – which is a key element of reliability), personal trip-making decisions, and the relationships between travel activity and trip/tour-making characteristics. Most of the more recent survey-based information on personal travel choices and behaviors captures the direct effects of improved reliability on personal travel choices. It is a relatively straightforward exercise to determine the overall value of reliability improvements, but only if appropriate measures of reliability are available for all affected roadways.

In contrast, there is substantially less information available about the indirect effects of changes in reliability on personal travel. How the overall amount of travel is constrained or expanded by improved (or reduced) reliability remains largely unaddressed in the research and associated data collection activities. For tolling projects of limited scope, such as tolling a single freeway or building a new freeway, these indirect effects are usually negligible. But for projects of a larger scope, such as system-wide pricing or cordon pricing, indirect effects may be substantial.

The effects of reliability on the costs of commercial (business) travel are well understood and have been extensively studied and documented in the business logistics literature. However, the economic consequences of improving reliability of highway systems have not been systematically included in highway planning and project evaluation. One of the most difficult aspects of such an evaluation is that each sector of the commercial economy or business "cluster" has very different ways of responding to and managing transportation costs. This is because the transportation cost component of production varies greatly, depending on how each industry has organized its logistics support and production processes.

A major misconception about economic evaluation of reliability on business travel is that the true costs of improving reliability can be assessed simply by valuing the combined effects of reliability on over-the-road travel time savings and the reduction of travel time variation. While these are important elements of commercial transportation, there are often behind-the-scenes operations that are highly dependent on the reliability of deliveries and shipments. These dependent operations – whether related to inventory control, production scheduling, warehouse systems management or the number of vehicles and drivers to employ – vary greatly depending on the type of business and how it uses the transportation system.

Emerging research on the effects of reliability on commercial travel highlights the relationship between transportation system reliability and business productivity. Productivity of commercial transportation influences the ways businesses can access new markets or respond to challenges in serving existing markets. However, very little attention has been paid to gathering the kind of business and operations data needed to assess the effects of reliability on commercial operating costs, or to incorporate these costs into traditional travel demand modeling. Thus, there is a serious gap in our knowledge about how tolling and pricing policy influences business productivity.

Reliability and Tolling Applications

Tolling and pricing options range from adding one or two new toll roads to tolling all or part of existing freeways (toll managed lanes or HOT lanes) to charging tolls to operate vehicles within designated areas (cordon pricing). As the size and complexity of tolling applications increase, measuring the effects of tolling on the reliability of both tolled and untolled roads becomes more difficult. Even for the most straightforward of tolling options – tolling a new highway – measurement of changes in reliability requires taking diversions to arterial and secondary roadways into account. It may be possible to estimate some localized effects of reduced reliability due to congestion of local roads. But converting a large number of existing freeways to tolled roads or imposing area-wide or cordon pricing will require inventing ways to measure reliability that are far more extensive than current methods. This is a major hurdle in developing the information needed to evaluate the economic effects of changes in reliability.

Even if these measurement issues are overcome, there is a substantial gap in our ability to evaluate the economic consequences of improved reliability on personal and commercial travel. The direct effects of improved reliability can be reasonably evaluated for personal travel for most of the single-project pricing applications envisioned in the Future of Tolling report. However, as the complexity of pricing applications is extended to more comprehensive pricing schemes like multiple freeways or cordon pricing, assessing the offsetting reductions in reliability on untolled highways that receive diverted traffic will be central to determining the net economic impacts of these proposals. The indirect effects of reduced reliability on personal travel also become a significant component of an economic evaluation. Estimating indirect effects depends a great deal on measuring the ways that diverted traffic affects local roads, neighborhoods, and travel patterns.

Evaluating the effects of tolling applications on commercial operations will require significant advances in available information and research before the economic effects of reliability can be assessed with even a reasonable degree of confidence. Although the business logistics literature covers the effects of reliability on process design and logistics costs, little if any of this information has been synthesized to support the kind of analysis needed to assess the economic effects of changes in reliability on highway systems. Changes in highway system reliability can have major economic impacts on business operations, productivity, and market access. These factors can influence the economic competitiveness of a region or a state. Therefore, the economic impacts of tolling and pricing on commercial operations should be carefully evaluated, especially if system-wide pricing is considered (such as for a large number of major freeways or for area-wide pricing). Even in situations where single facility pricing is an option, changes in operations in response to the direct and indirect effects of pricing can affect the competitiveness of businesses that routinely use the priced facility or the roads that receive diverted vehicles. The primary concern is not so much for the effects of improved reliability on long-distance and high-speed commercial travel, but for the economic effects of diversions on local streets and the impacts such diversions will have on the reliability of the "last mile" moves required for all commercial travel.

White Paper #5

Assessing the Economic Effects of Congestion Pricing

Prepared for:

Oregon Department of Transportation

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White Paper #5

Assessing the Economic Effects of Congestion Pricing

Executive Summary

Until recently, the idea of congestion pricing has lived in academia, where economists debated about things like recovering the difference between marginal private costs and marginal social costs, public goods and private goods, and regressive versus progressive policies. With new highway capacity so expensive to build and the environmental consequences of highway expansion a continuing concern, congestion pricing has moved from Ph.D. dissertations to the front page of newspapers.

Congestion pricing is different from tolling. Congestion pricing is not just about the revenue, but also about changing travel behavior to make the most efficient use of the transportation system. The basic idea is to shift some drivers to noncongested periods, other modes, alternative routes, or into shared-ride vehicles to let traffic flow more smoothly.

Most other products and services use market forces to set prices that provide value to the customer and profit to the producer. If demand exceeds supply, prices rise and some customers choose not to buy. Hotels, airlines, telecommunications, electricity, and some transit systems are examples of industries that use pricing to spread demand in order to avoid expensive investments in expansion. There is little history of such pricing techniques on highways because the technology to allow such pricing did not exist until a decade or two ago.

The most well-known congestion pricing projects in the United States are high-occupancy toll lanes (HOT lanes), where single-occupant drivers pay a toll to use a carpool lane, with the toll varying to keep lanes free flowing. This paper is not about HOT lanes. Instead, this paper is about congestion pricing concepts where tolls are charged on existing highways for the express purpose of changing travel patterns. Specifically, we looked at cordon or area pricing, tolling all freeways in a metropolitan area, freeway pricing in lieu of freeway expansion, and mileage-based pricing.

When something is perceived as free -- or at a price near free - people tend to consume as much of that good as possible. The use of public roads is often considered free or nearly free. This results in what economists call “market failure,” which we commonly experience as congestion. Because the theory of congestion pricing is not well understood, a common concern is that it impinges on our perceived right to travel whenever or wherever we please and that we are “double paying” for something for which we have already paid in the form of taxes. In actuality, the purpose of congestion pricing is to expose drivers to the full social cost of road use through directly charging for those costs that vary with congestion.†

The fundamental problem of congestion pricing is that while it results in an economically efficient solution to road congestion—making the best use of the roadway system—the entire population, on average, is worse off. This is because congestion pricing charges everyone for something for which they had not previously been charged: the benefits of travel and the impact of their travel on others.

In fact, the overall value of the toll that is paid is very likely to exceed the travel-time saving benefits of congestion pricing. With congestion pricing, not everyone will fare the same. The ultimate economic argument over whether society is better off and who wins or loses is entirely dependent upon how toll revenue is spent. If the portion of the toll revenue equivalent to the losses experienced by drivers is refunded to society through, for example, a reduction in the gas tax or other taxes, there may still be dollars left over to invest in the system. This redistribution leaves no one worse off, and some better off than before.

Under any system in our typology—other than full mileage-based pricing—some people will be "priced off" of the highway of their choosing, and will thus "lose" when compared to their current situation. The other losers in this situation will be those drivers previously using an alternate route or living along alternative routes that have additional traffic and congestion caused by drivers avoiding the priced system. It is possible that the overall impact on the system will be positive—society at large will "win;" but those paying on the highway may win at the expense of others who have been priced off or who happen to share the roads with the priced off drivers.

Peoples' choices of how, when, where, and whether to travel are influenced by numerous attributes of the transportation system, land use patterns, demographics, social attitudes, and other items we may not even recognize. Any change in the system—a new highway, bus service changes, or congestion pricing—can result in a reassessment of old travel patterns. Responses can be short-term (choose a different route or mode) or long-term (choose a different place to locate a home or business) and can vary by type of trip (personal, business, shopping). The responses will affect various income groups differently, and have different effects on people in one area versus another.

Before addressing the implementation challenges of congestion pricing—the technology, administrative expense, privacy considerations, decisions about how to use the revenue—one must tackle the real problem of developing analytical methods that can reasonably predict the outcomes. Analytical techniques to test transportation options have come a long way since the 1950s, but most travel demand models have not been designed to adequately evaluate all the short- and long-term implications of congestion pricing. Methods to evaluate the effect of

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† Charging people the social cost of their activity is called charging the "marginal social cost." This is the total cost to society as a whole for producing one further unit, or taking one further action, in an economy. This total cost of producing one extra unit of something is not simply the direct cost born by the producer, but also must include the costs to the external environment and other stakeholders.

pricing on traffic flow, land use, greenhouse gas emissions are in their infancy, and lack good real-world data. Translating these factors into an economic analysis is, therefore, doubly challenging, but not reason enough to discard congestion pricing.

Congestion pricing needs to be approached with caution, and transparent, comprehensive, and methodologically correct analyses undertaken. The concepts are not easy to understand—even for transportation professionals—and some of the analysis methods have not yet been fully developed or tested. Analysts need to be open about where assumptions and methods may have more than the typical level of uncertainty, and test the implications of different assumptions. As with any controversial concept, early and frequent public and elected official engagement is important in order to provide adequate time and funds for the difficult analyses required to properly answer the bona fide questions of the public.

Any analysis of congestion pricing should include comparisons to fully formed alternatives so that elected officials can reasonably choose among available options. Complicated analyses must be condensed such that understanding does not require advanced degrees in economics and traffic flow, but not so simplified as to eliminate the nuance and acknowledgement of areas of uncertainty. None of this is any different from the kind of care that should be given to any project. However, the kind of changes that would come about as a result of congestion pricing amplifies the importance of this approach.

White Paper #6

Economic Comparison of the Alternatives for Tolling Projects

Prepared for:

Oregon Department of Transportation

Prepared by:
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February 2009

Executive Summary

Benefit-cost analysis (BCA) is a widely used tool that will allow Oregonians to improve decision-making for prioritizing a variety of tolling project alternatives and in comparing tolled alternatives against untolled alternatives. BCA is a technique for comparing two or more projects by comparing benefits and costs that are realized and expended in different years. Tolling introduces new concepts or issues to the transportation planning process that can be addressed through BCA, including:

- The economic benefit to motorists of improved speed and reliability. Improving travel reliability is a primary motive for some tolling applications, such as toll-managed lanes.
- The reaction of motorists to the presence of tolls, particularly when diverting their trips to untolled roads. Such traffic diversions may increase congestion on these untolled facilities, and in turn, may result in lower speeds, decreased safety, and other negative impacts. The negative impacts of these diversions are counted in BCA by subtracting them from the positive impacts found in other parts of the analysis.
- Properly framing non-tolled alternatives to tollway proposals. Tollways, other than bridges, must be of a sufficient size to offer the motorist enough improvement in travel time or reliability to merit paying the toll. Non-tolled alternatives may be phased in smaller increments.
- The public may question the need and appropriateness for tolling, particularly on facilities constructed with public funds. Tolled facilities can offer some clear benefits in improved travel time and reliability, which are important considerations in achieving general public acceptance of toll proposals. BCA provides a transparent analysis to the public for evaluating benefits and costs of potential tolling projects.

The framework of BCA includes three major components:

1. A specified analysis period, usually 20–30 years, which should be consistent among all alternatives being compared.
2. A realistic base case that is an estimate of future expected conditions and costs (such as increased roadway maintenance or anticipated rehabilitation) if a build alternative is not constructed.
3. A discount rate that reflects the "time value of money," in the sense that money in hand today is more valuable than the same amount of money received in the future. "Present Value" represents the value of money at the beginning of a project. The discounting rate is the annual rate at which future dollars lose value compared to present value. Accordingly, the value of future benefits is lowered as:

    - A discount rate is increased; and
    - Years elapse from the start a project.

BCA can only reflect benefits to the extent that all costs and benefits can be "monetized" into dollar terms, including converting a benefit or cost not in monetary form, such as personal time savings, into a monetary equivalent. Factors that cannot be monetized must be considered separately. Consequently, there may be cases in which a project looks unfavorable from a BCA perspective, but is viewed favorably because it has additional, hard-to-quantify benefits (e.g., reduced noise to properties abutting the roadway).

In particular, benefit-cost literature recommends that toll revenues not be considered in benefit-cost analyses. From this perspective, tolls are simply payments made by users to transportation providers in exchange for the travel time, safety, and operating cost benefits received.
BCA compares the net value of monetized benefits to users of a highway facility (a new roadway, new lane, or reconfigured lane) to the value of building and maintaining the facility. The most common highway-related benefits considered in a BCA include: value of time saved by drivers, savings due to increased safety, and lower vehicle operating costs as a consequence of the project. Costs are usually the sum of construction, annual operating, routine maintenance, and scheduled capital rehabilitation costs. The following are some typical benefits and costs that must be considered in evaluating transportation projects.

Net User Benefits

- Value of time saved
- Lower costs due to increased safety
- Lower vehicle operating costs

Costs

- Construction costs, including costs associated with toll collection, if applicable
- Annual operating costs
- Routine maintenance costs
- Capital rehabilitation costs

The benefit-cost ratio is the value of all discounted benefits divided by discounted costs. When benefits exceed costs, the benefit-cost ratio is greater than 1.0; conversely, when benefits do not equal costs, this ratio is less than 1.0.

BCA does not specify whether a project or particular alternative is affordable to construct, it does not fully address environmental issues (unless these impacts are monetized), and it does not address equity issues. Moreover, BCA does not consider the impacts of changing access to multimodal facilities, delivery markets, labor markets, or customers that can be attributed to a proposed toll or untolled roadway or bridge. Increased access potentially improves cost-competitiveness for businesses, changes patterns of household spending, and leads to more personnel and business income for Oregon’s economy. These latter benefits, however, are economic impacts and fall outside the benefit-cost framework.

Although BCA effectively measures whether the benefits of a project will exceed its construction and operating costs, it should not be the sole analytical tool used to make decisions. A package of analytical methods is required to fully evaluate the costs and benefits of transportation projects, including economic impact analysis, environmental analysis, and financial analysis, as well as equity considerations.

White Paper #7

Truck-Only Toll (TOT) Lanes

Prepared for:

Oregon Department of Transportation

Prepared by:
Cambridge Systematics, Inc., with CH2M Hill

February 2009

White Paper #7
Truck-Only Toll (TOT) Lanes

Executive Summary

The purpose of this white paper is to explore the potential application of truck-only toll (TOT) lanes in Oregon. Currently, a handful of truck-only facilities exist in the United States, among them the I-5 climbing lane in Oregon, but there are no TOT lanes.

The TOT lanes proposed in the last few years are of two main types: long-haul and urban. Examples of proposed long-haul TOT applications include the I-70 corridor spanning Missouri, Illinois, Indiana, and Ohio (which may or may not involve tolls); the Trans-Texas Corridor; the I-15 corridor in California; and a truck tollway network proposed by the Reason Foundation. Urban TOT lanes have been proposed in California on SR 60 and I-710, and Miami, where lanes are intended to aid traffic getting into and out of busy ports. Another type of urban TOT lane system was proposed in Atlanta to reduce urban traffic congestion and improve the mobility of freight to and through the region.

This paper provides a scan of recent TOT lane proposals in the United States and addresses issues related to design and configuration of TOT lanes, estimating travel demand, financial feasibility, and evaluation considerations. Finally, it offers some perspectives on the potential applicability of TOT lanes in Oregon.

Design and Configuration

TOT lanes have special design and configuration requirements. For example, pavement must be designed to accommodate the heavier loads due to exclusive truck use or overweight limit allowances, staging areas must be provided for assembling and disassembling long combination vehicles (LCV) if these are allowed to operate, and on/off ramps must be designed to allow heavy vehicle safe access to and from adjacent highway facilities. Design and configuration issues are similar for long-haul and urban TOT facilities, with the exception of issues related to cross-sectional configuration, access/egress ramps, and staging facilities.

In rural corridors, the minimum cross-section for TOT lanes is one lane in each direction, with outer breakdown shoulders and passing lanes every few miles and on hills for truck passing maneuvers. This type of design requires a minimum right of way (ROW) of 54 feet (excluding passing lanes). Adding another lane in each direction would increase ROW requirements to at least 78 feet.

Most studies on TOT lanes in urban corridors suggest providing two lanes in each direction. ROW requirements for a four-lane at-grade TOT lane facility ranges from 88 to 98 feet, depending on the width of inner and outer shoulders. In urban areas with

ROW constraints, it has been proposed to build TOT lanes on elevated structures or underground. Constructing new lanes in urban environments is likely to be very expensive regardless of configuration, but elevated or underground concepts add significant construction costs.

The need for access/egress ramps in TOT lane corridors depends on the nature of the corridor. For corridors serving long-haul/through trips, access points can be limited to key interchanges and staging areas (if LCVs are permitted to operate). In urban corridors where most trips are relatively short distances, more access points are required. The cost and financial analyses of TOT lane options should consider the tradeoffs between capital costs, usage/toll revenues, and safety.

Studies from the Texas Transportation Institute, the U.S. Department of Transportation (DOT), and the Georgia Department of Transportation (GDOT) offer guidance when considering these issues. Cambridge Systematics, Inc., (CS) currently is conducting a National Cooperative Highway Research Program (NCHRP) study on various topics concerning truck-only lanes, including design and configuration issues.

Demand for TOT Lanes

The extent to which trucks will be attracted to TOT lanes depends on the relationship between the value that truckers get from the facility and the price being charged. Estimating the value of time for trucks is challenging because of the diversity in the trucking industry and the competitive nature of operating cost information. In long-distance TOT configurations, the main value to truckers comes from allowing LCV on to the toll lanes, thereby providing productivity benefits for the special lanes. If the toll rate is set so that the increased productivity exceeds the value of the toll, some truckers may be attracted to the new lanes. For urban TOT lanes, the value of the lane derives from the opportunity for a truck to avoid congestion. Because trucks tend to operate all day, but auto use tends to peak during morning and evening commute periods, urban TOT lanes are likely to struggle to attract demand during nonpeak periods.

Travel time reliability is another potential benefit of TOT lanes, especially in urban environments; but reliability benefits also are likely to be limited to peak commute periods in most locations. Also, not all truckers may value travel time reliability sufficiently to warrant the toll.

How frequently trucks can access the special lanes is another issue related to demand for TOT lanes. More frequent access points help demand, but can hurt traffic operations and increase costs. Making the use of TOT lanes mandatory has been proposed; this would significantly affect the demand profile for a TOT lane.

Financial

As with any toll facility, a TOT lane might be expected to have some or all of its operations, maintenance, and capital costs covered by toll revenues, either through government-initiated financing or through public private partnerships (PPP). With a publicly financed facility there are numerous ways to structure financing that are well beyond the scope of this paper. Most structures are likely to include some form of revenue or general obligation bonds, with the toll proceeds pledged to pay off the debt after satisfying operating and maintenance requirements.

The literature shows mixed results related to the stand-alone financial feasibility of TOT lanes and such analyses must be done on a case-by-case basis. Arguably, the most financially viable business models are those that allow LCV to use special lanes for a fee in intercity line-haul conditions, thus providing productivity benefits regardless of travel time savings. Construction costs for highway lanes in intercity environments are typically lower than in urban environments, further enhancing the financial picture for such applications.

Urban TOT lanes are squeezed from two sides in that the costs of construction are likely to be high, and the revenue potential limited to a few hours of the day.

Evaluation Considerations of TOT Lane Proposals

The applicability of TOT lanes in Oregon will depend on whether there are corridors, both urban and rural, that may warrant providing a separate truck facility. This decision is based on truck volumes, congestion levels, existing truck activity centers, and the willingness of truckers to pay for using TOT lanes. Beyond the benefit to truckers, other goals for a successful TOT lane might include:

- Enhancing safety for all transportation systems;
- Reducing congestion, improving level of service, and improving access and mobility for all citizens;
- Providing a plan for truck lanes that is fiscally responsible, economically feasible, and equitable for all parts of the state;
- Supporting local, regional, state, and national economic development initiatives; and
- Avoiding, minimizing, and mitigating adverse impacts on the built, natural, social, and cultural environments.

Conclusions

When considering TOT lanes in the context of Oregon's transportation needs, it is instructive to do so from the perspective of the different types of TOT concepts: long-haul truckways, urban access to ports, and urban congestion relief/travel time reliability.

The main selling point of dedicated long-haul truckways is that they would be built to standards that would allow LCV to operate safely, and truckers would be willing to pay to use these facilities to reap greater productivity from the line-haul portion of their trip. Oregon, however, already allows LCV on major highways, so there is little additional value to be derived from this variety of TOT lane in Oregon.

Truck access to ports is not a significant concern in Oregon, so creating new highway capacity to service this market through TOT facilities is not likely.

Congestion exists in parts of the Portland metropolitan area and is expected to increase over time. Right of way is limited, and there is little appetite for freeway expansion. Urban corridor TOT lanes may be a potential solution to providing trucks with a reduced-congestion alternative to moving around the metropolitan area.

As with any infrastructure project, consideration of urban corridor TOT lanes requires careful examination of the capital and operating costs, environmental impacts, user benefits and costs, economic benefits and costs, and financial feasibility. The outcome of such analysis will vary widely depending on the specifics of any proposal, but the following general comments apply:

- The cost of new lanes in urban areas is high. Because of special design standards, the cost of new lanes that cater to trucks are higher. In Atlanta, the cost per lane-mile of implementing new truck-only lanes was estimated to be approximately $21 million. Other TOT studies show lane-mile costs in urban areas ranging between $10 million and $30 million, depending upon the inclusion of mixed at-grade and elevated structures, ROW costs, and other construction elements (e.g., interchanges, mobilization).
- Truck travel demand is fairly level over the course of the day, whereas auto traffic tends to peak in the morning and evening commute periods. Truckers will pay only for time or reliability savings, and those savings are significant only during commute peak-periods. This likely means little demand for special TOT lanes because potential time savings would be limited.
- Long-distance trucks passing through the Portland metro area may see little value in time savings that are a small percentage of the total travel time of a trip. Other types of truckers--in particular delivery services needing to visit multiple customers per day--may be more sensitive to travel time delay and reliability and more willing to pay a toll. The question is: what fraction of the truck demand in the region is made up of this type of truck, and to what extent are they traveling in congested time periods when paying a toll would be worthwhile?
- It is difficult to raise enough money through tolls for a standard road that generates revenue all day. A road (or lane) that is expensive due to location and design standards but only has value to the customer for a few hours per day is not likely to succeed.
- Currently, many toll roads are built with a combination of toll-leveraged funds and government funds. In this case, government should calculate whether expenditure for this subsidy is the best use of public funds, or whether there are

other, more cost-effective means of achieving the same objective. This calculation would be entirely subject to the specifics of the proposal.

Truck-only toll facilities can provide value in Oregon, but the opportunities are limited and should be compared carefully to other ways to accomplish similar objectives.