Congestion Relief Analysis - Phase 2

Exploring Value Pricing in the Central Puget Sound Region

January 2009

Prepared for

Washington State Department of Transportation

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Prepared by

Fehr & Peers / Mirai

with

RST International

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Executive Summary

OVERVIEW

The Congestion Relief Analysis Phase 2 (CRA 2) provides state, regional and local transportation leaders with information on how various congestion pricing strategies could reduce congestion in the Central Puget Sound region. Asked by the Washington State legislature in 2003, the Washington State Department of Transportation (WSDOT) conducted a congestion relief analysis for the State's three major urban areas: Central Puget Sound, Spokane and Vancouver. CRA Phase 1 found that roadway pricing could be an effective part of a comprehensive congestion reduction strategy in the future and recommended that pricing be analyzed in more detail in a Phase 2 study.

Following the findings and the recommendation of Phase 1, CRA2 evaluated several pricing strategies in the Central Puget Sound region. These strategies included partial pricing using High Occupancy Toll (HOT) lanes, as well as a complete system of regional pricing of all highway lanes in the region. The HOT lane scenarios looked at various combinations of single and double HOT lanes, fully tolled "HOT Corridors" and converting existing general traffic lanes to HOT.

The analysis focused on answering the questions, "How effective could these various pricing strategies be in reducing congestion?" and "How much would they cost?" Due to limited funding, other important issues such as potential revenues, land use, environmental, social and economic impacts were not addressed in this study.

The study was conducted using an improved regional travel demand forecast model based on adopted regional land use growth management plans. The modeling assumed that people would make travel decisions in 2030 similar to today and that there will be no significant transportation technology advances over the next 25 years. The modeling also assumed that the freeway HOV lane occupancy requirement will be raised from 2+ to 3+ due to growing congestion within the HOV lanes if the 2+ policy is maintained.

The results of the computer modeling provided perspectives on how effective these strategies could be in reducing travel delay[1] relative to the 2030 baseline conditions in the Central Puget Sound region. Here are the major findings:

- As the urban area grows, congestion will grow too. The computer analysis showed that, without a substantial increase in transportation capacity beyond recent legislatively-approved projects[2], total regional travel delay could more than double by 2030.
- As travel demand grows, more and more of the regional network of HOV lanes will become congested and less efficient during the critical peak periods. To maintain the HOV lane travel time reliability, the HOV policy and standard will need to be revisited and perhaps changed. One of the changes could be to raise the occupancy requirement from HOV 2+ to HOV 3+. If that occurs and nothing else is done, most of the HOV lanes would become substantially underutilized. In this case, one option would be to allow some HOV 2s and SOVs users to buy-in into the HOV lanes to fully utilize the roadway capacity.
- Converting the existing and funded HOV lanes to HOT lanes could provide a reliable choice to travelers in the future. Implementation costs could also be reduced by implementing these HOT lanes without full design standards. However, given the limited HOV capacity available to sell, a single-lane HOT system is not expected to substantially reduce regional congestion. More would need to be done.
- A two-lane HOT lane network would offer travel time reliability to more travelers and likely reduce more delay than would a single-lane HOT network. However, the potential cost to provide a two-lane HOT lane network is estimated to range between $12 billion to $22 billion, depending on how it would be configured. To enable such a HOT lane network to function properly, direct access ramps at HOT facility interchanges would be necessary. The cost to construct the needed direct access ramps is expected to be substantial and should not be ignored (estimated at $500 million to $1 billion per interchange).

[1] In this analysis, a very basic indicator used to measure congestion is travel delay. Travelers are assumed to be experiencing delay when the traveling average speed is lower than the posted speed limits.

[2] The 2030 baseline conditions included the existing facilities plus the funding secured projects such as those included in the Nickel and Transportation Partnership Act (TPA) packages.

- Regionwide congestion pricing was found to be the most effective in reducing congestion. Compared to HOT lane networks that impact a portion of freeway travelers, regionwide congestion pricing would affect all travelers on the roadway system. The modeling indicated that regionwide pricing could dampen peak period travel demand and entice travelers to shift travel to non-peak periods and/or other travel options (transit and carpooling). The social implications of implementing a regional pricing program were not examined but would be considerable.

As the region considers using roadway pricing to balance transportation demand and supply, the results of the Congestion Relief Analysis Phase 2 can help decision makers examined the impacts and benefits of different pricing strategies. Much still needs to be learned and studied about the effects of pricing on congestion. Implementing real-world projects, such as the SR 167 HOT Lane Pilot Project, will offer insights into how one form of roadway pricing may work within this region.

A Look into the Future of HOV Lanes

- More and more of the existing HOV lanes are becoming congested in the peak hour.
- If the occupancy requirement of 2+ is raised to 3+ for the purpose of maintaining HOV travel time advantages, the HOV lanes will be substantially underutilized and remain so in the foreseeable future.
- Converting some HOV lanes to HOT operations may have the potential to more efficiently use the lane capacity while maintaining the speed standard.

UNDERSTANDING HOW THE HOV LANES ARE WORKING

The scenarios involve converting the existing and planned HOV lanes to HOT lanes. Therefore, the central Puget Sound HOV lane system has to be understood in terms of how well it has been performing and how well it will perform in the future.

Central Puget Sound has one of the most comprehensive HOV lane networks in the nation. It has attracted so many travelers that some of the HOV lanes have become congested during peak periods. Maintaining the speed and person throughput advantage for HOV lanes is an important regional policy objective. As the travel demand continues to grow, more and more HOV corridors are expected to become congested and fall below the region's established performance standard of maintaining operating speed of 45 miles per hour 90% of the time during peak periods.

To maintain the HOV lane performance standard, one and/or two of the following things will need to be done:

- Reduce the number of vehicles that can use the HOV lane, i.e., raising the HOV occupancy requirement from 2+ to 3+; or
- Increase HOV capacity, i.e., adding more HOV lanes to meet the demand.

A third option, perhaps, is to lower the HOV speed standard. However, lowered speeds would not only make the HOV lanes less attractive, it would also reduce the efficiency or throughput of the HOV lanes.

HOT lanes provide a possible fourth option to combine HOV travel by allowing low occupancy vehicles to use remaining capacity on the HOV lanes with a price. Phase 2 explored several HOT lane scenarios to provide insight into how they could improve overall HOV and freeway performance.

WHAT WERE THE SCENARIOS?

The analysis included three (3) HOT lane scenarios, plus a regional pricing scenario. These scenarios covered a probable range of pricing actions within the Puget Sound region. The intention was to represent a range of possible pricing actions, but not to define all possibilities.

Figure 1 on the next page shows the basic interaction among the scenarios.

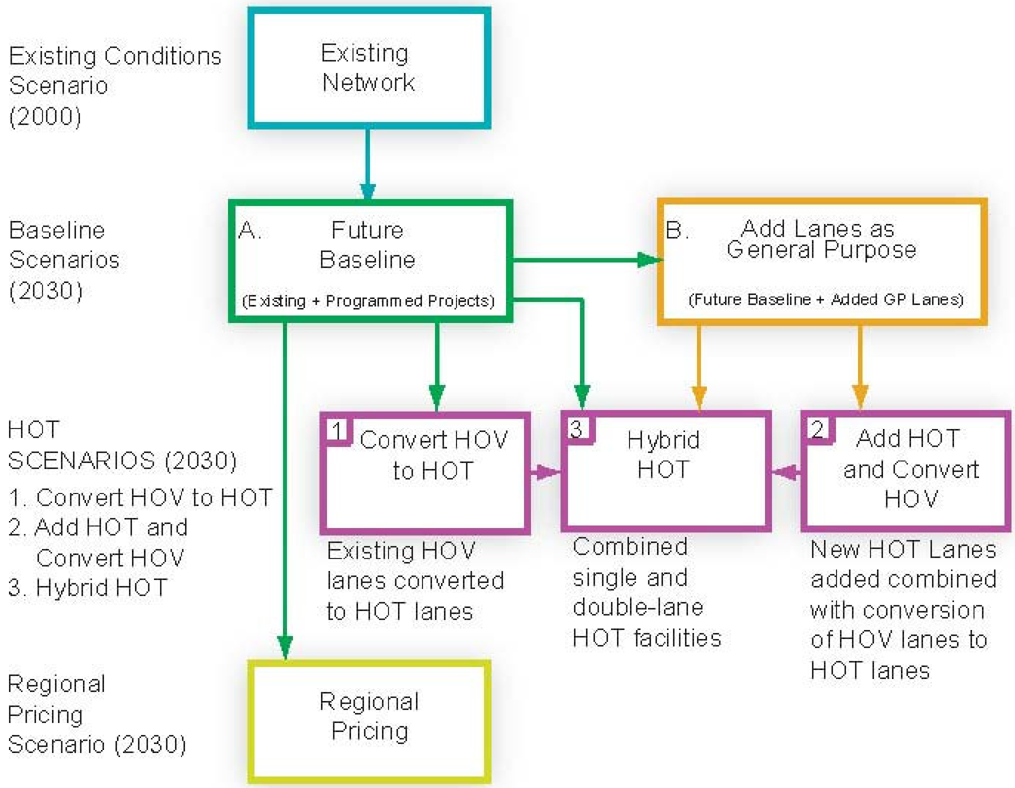
HOT Lane Scenarios

The three HOT lane scenarios covered a full spectrum of HOT applications. The first scenario (HOT Lane 1) considered converting all of the region's 200+ miles of existing and planned high occupancy vehicle (HOV) lanes and reversible express facilities into HOT lanes. The second scenario (HOT Lane 2) examined the effects of adding a lane to most of the freeways to create a 2-lane HOT system. The third scenario (HOT Lane 3) blended the several HOT lane elements of Scenarios 1 and 2 and full pricing of the cross-lake bridges (I-90 and SR 520) and sections of I-5 and the Alaskan Way Viaduct through downtown Seattle.

Regional Pricing Scenario

The regional pricing scenario imposed tolls on each highway link in the network without adding new road capacity. The scenario tested various combinations of fixed-rate and variable-rate tolls by time period throughout the day. Note that the HOV lanes (HOV 3+) would still operate for free.

Figure 1. Pricing Scenarios



HOW DID WE EVALUATE THE SCENARIOS?

The updated Puget Sound Regional Council's travel demand model was used to assess how well the scenarios performed in terms of addressing congestion. The analyses included a mixture of system-level and corridor-specific measures.

A baseline scenario was developed to compare with the various pricing scenarios. In order to better evaluate these scenarios, the Puget Sound Regional Council travel demand model was updated and improved. Changes were made to the mode split model, trip distribution parameters, and the time-of-day module. Time-of-day effects were considered important in trying to more reasonably model pricing strategies.

Modeling Assumptions

► Modeling year: 2030

► Time periods: 5 time periods; daily

► HOV definition: 3+

► Fixed land use and overall level of person-trip making for each scenario

► Tolls applied as function of roadway demand and levels of congestion

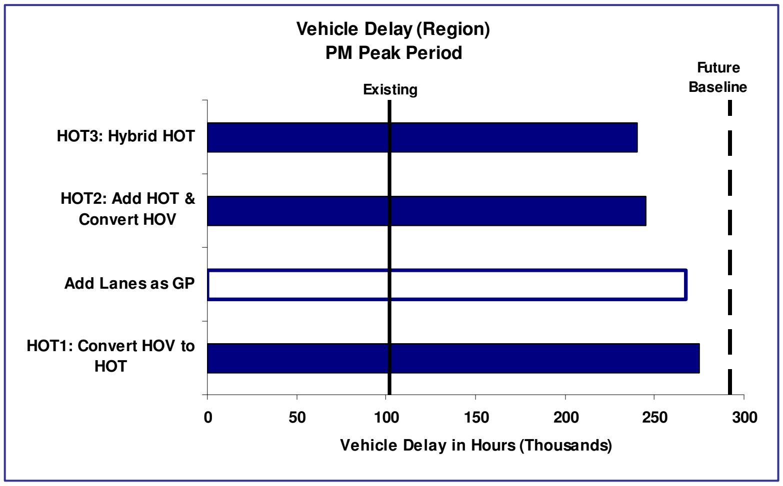
Costs were estimated as the public costs for implementing, mitigating, operating and maintaining the infrastructure investments associated with each HOT lane scenario. Project costs were expressed as a range of probable costs to account for uncertainties.

WHAT DID WE LEARN ABOUT HOT LANES?

HOT Lanes Reduce Delay

According to the regional model, by 2030, vehicle hours of delay in the region are expected to more than double from (2000) existing conditions in the AM peak period and nearly triple in the PM peak period. Compared to this condition, all of the HOT lane scenarios were forecast to produce reductions in vehicle delay (see **Figure 2**).

Figure 2. Regional Vehicle Delay PM Peak Period



Through variable tolling, when prices are set optimally, it should be possible to maintain relative high volume in the HOT lanes without compromising travel speed and reliability. As people buy-in into the underutilized HOV lanes (after raising the occupancy requirement to 3+) congestion (measured in vehicle hours of delay) in the adjacent GP lanes would reduce slightly. The modeling analysis showed that adding new freeway lanes would produce less delay if they were operated as HOT rather than if operated as General Purpose (GP) lanes. The delay reduction would be most pronounced during peak periods.

> Caution should be taken in directly using the modeling results in this study to make implementation decisions on roadway pricing. It should be noted that the evaluation results of each scenario documented in this report are directly linked to a particular set of toll rates tested. These toll rates were tested at rates considered reasonable for the traffic conditions in each roadway corridor. However, the results would change as toll rate assumptions change.

HOT Lanes have the Potential to Increase Vehicle and Person Throughputs

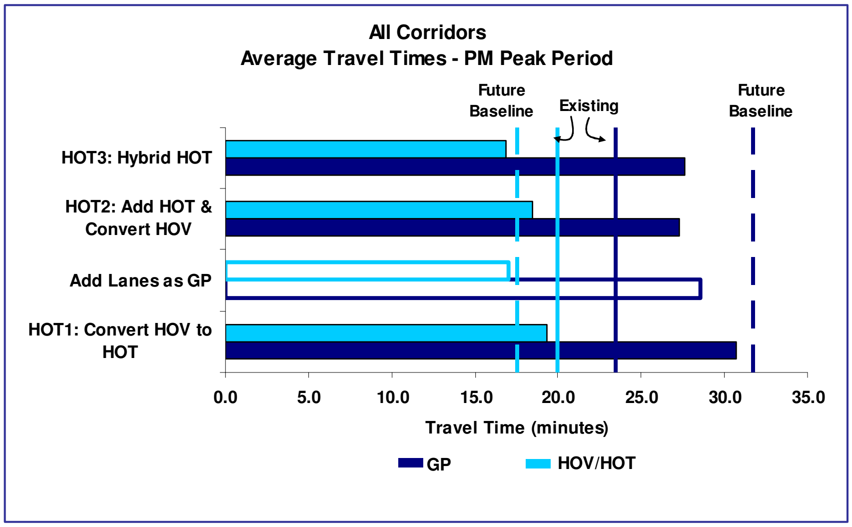
The analysis indicated that each of the HOT lane scenarios have the potential to increase total vehicle and person throughput on corridors when the freeways operate with HOT lanes as compared to their operation with HOV or GP lanes. The potential throughput gains associated with the HOT lane scenarios is two-fold. First, the throughput in the HOV lanes can be increased as HOV 2 and SOV vehicles are allowed to "buy-in" to the lanes. Second, the adjacent GP lanes may operate with slightly less congestion as some HOV 2 and SOV buy-in into HOT lanes;

this shift can result in less congestion in the GP lanes and thus potentially enable the GP lanes to regain some of their lost efficiency.

HOT Lanes Can Improve Travel Time

Another measure of system performance is overall travel time between origins and destinations along the freeway system. Travel time was estimated for GP and HOV traffic along freeway corridors for the peak direction of travel during the PM peak period. **Figure 3** compares the results among the scenarios. The following trends are evident in most of these travel time corridors.

Figure 3. Average Travel Times in All Corridors



General Purpose Traffic

GP travel times are expected to increase substantially by 2030. The model tested the effects of adding GP lanes as well as the effects of creating HOT lanes. The "Add Lanes as GP" scenario would improve GP travel times by adding general freeway capacity, while continuing to operate the managed lanes for HOV only. GP travel times would further decrease by operating this added freeway capacity as a HOT lane and by converting the existing HOV lanes to HOT. The scenarios that converted a peak direction GP lane into a HOT lane showed mixed results on GP lane operations. Careful setting of toll rates would be necessary to manage the freeway travel times.

HOV/HOT Lane Traffic

HOV lane travel times are forecast to decrease by 2030. This is due to the assumed change in HOV occupancy from HOV 2+ to HOV 3+. Implementing HOT lanes would attract new users to the HOV/HOT lanes and the HOT travel times would likely increase, but remain similar to or below existing HOV travel times. Acceptable HOT lane speeds would be maintained using the variable toll rates.

HOT Lane Cost Estimates Vary Based on Design

The estimated costs for the three HOT lane scenarios vary widely depending upon the extent of the HOT lane system and the amount of new construction assumed in each scenario. As shown in **Table 1**, the costs ranged from around $0.5 Billion to convert the existing HOV lanes to HOT (using minimal design standards) to over $20 Billion to construct new freeway HOT lanes. The highest cost components of each scenario were the additional freeway lanes and reconstruction of interchanges to provide direct HOT to HOT lane connections. The tolling technology costs and creation of HOT lane access/egress points also should not be ignored within constrained urban corridors.

Table 1. HOT Lane Construction Summary (2007 Dollars)

Scenario	Roadway Improvement Cost ($M)	Systemwide Tolling Technology Cost ($M)	Total Scenario Cost ($M)
HOT 1: Convert HOV to HOT	350-470	180-240	530-710
HOT 2: Add HOT & Convert HOV	19,300-25,700	420-550	19,720-26,250
HOT 3: Hybrid HOT	10,200-13,600	260-350	10,460-13,950

Source: WSDOT 2007

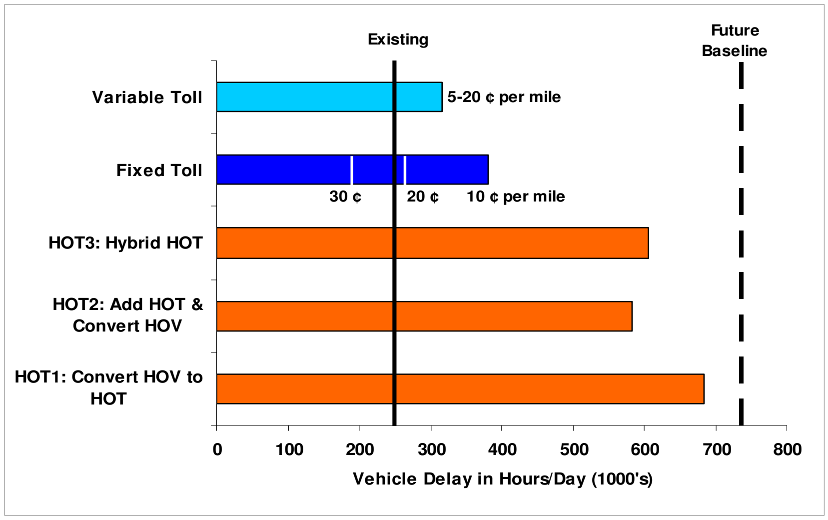
WHAT ABOUT PRICING ALL ROADS?

The regional pricing scenario assumed that all elements of the regional roadway network, with the exception of HOV or transit-only lanes, would be tolled on a per-mile basis. Toll rates for each roadway segment and travel direction would be determined by the demand and capacity relationships of the roadway segments. Both fixed rate and variable rate tolling scenarios were tested. **Figure 4** shows the vehicle hours of delay for each scenario compared to regional pricing scenarios.

In contrast to the HOT lane scenarios, congestion pricing would be applied to all roadways. Therefore, this scenario is expected to have more impact on traveler's behavior - causing people to drive less, shift travel to less congested time periods and to other modes, or make shorter trips to closer destinations. For example, shoppers could be motivated to frequent stores located near their homes or to shop during off-peak hours instead of shopping at a larger mall further away or driving during more expensive peak hours. Fewer trips in the peak period can result in reduced delay.

While the cost to implement regionwide pricing is not fully quantified in this study, the regional pricing scenario did not assume additional lanes or reconstruction of interchanges, and would not require additional pavement for buffer space as required under HOT lane scenarios. As a result, the implementation costs would be substantially lower than costs of the HOT lane scenarios. The analysis indicates that the efforts to identify a regional pricing fee schedule that could work for all roads and at all times will be a challenge (both in a modeling context and most likely in real world applications too).

Figure 4. Vehicle Hours of Delay – Regional Pricing



CONCLUSIONS

Congestion not only causes delay, but also results in lost throughput and renders the system less efficient. Traffic bunching and slowdowns caused by too many vehicles trying to use the limited transportation capacity at the same time rob the system 40%, to 60% of its ability to pass vehicles through. This wastes energy, generates pollution and frustrates citizens.

The Congestion Relief Analysis Phase 2 provided an analysis of the potential effectiveness of roadway pricing strategies to reduce congestion within the Puget Sound region. The model analysis indicated that a regionwide HOT lane network could play an important role in improving travel time reliability and reducing delay, while not ignoring the need and potential costs to provide some additional lanes or lane width and direct HOT lane connections. The analysis also pointed out that regionwide congestion pricing is the most effective strategy among the scenarios analyzed in reducing regional travel delays. However, there are many socioeconomic, land use, and environmental impacts that would need to be carefully evaluated and addressed before its implementation.

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