I-405/SR 167 Corridor **Funding and Phasing Report**

Appendix 1

2012 Planning Level Traffic and Revenue Study, CDM Smith

Washington State Department of Transportation

I-405 / SR 167 Express Toll Lanes

2012 Planning Level Traffic and Revenue Study

December 12, 2013

Washington State Department of Transportation

CDM Smith

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Chapter 1

Introduction

Over the years, traffic growth on I-405 has been strong, and congestion has continued to increase. This is expected to continue in the future in spite of major improvement programs within the Puget Sound region. It is consistent with trends in major urban areas throughout the United States. Widening roadways, such as I-405, has become increasingly more difficult due to right-of-way constraints, environmental, funding and other factors. In light of this situation, the Washington Department of Transportation (WSDOT) established an improvement plan for the I-405 corridor looking at the implementation of managed lanes.

Managed lanes, such as high occupancy toll (HOT) lanes or express toll lanes (ETL), are rapidly emerging as a potential solution to congestion. In order to ensure that the managed lanes do not become congested, toll rates are adjusted during the day as traffic volumes fluctuate. This pricing is called "dynamic tolling". For example, during periods of high traffic volumes (AM and PM peak hours) tolls for vehicles buying into the express toll lanes are significantly increased to discourage and limit overuse and keep the lanes free flowing. During off-peak peaks when traffic is lighter, the managed lane tolls are reduced. The principal of dynamic pricing ensures that a portion of the roadway capacity is provided under free flow conditions, therefore providing a highly reliable travel alternative for motorists. In the case of the I-405 corridor, the current policy assumption is that HOV vehicles (including transit vehicles) would be allowed to travel in the managed lanes for free while SOV vehicles pay the dynamic tolls.

In December 2011, the SR 520 Bridge Tolling Project was implemented adjacent to the I-405 corridor. This bridge allows users to pay tolls with a *Good To Go!* transponder or registered license plate (Pay By Plate) associated with a prepaid account, or by receiving a bill in the mail (Pay By Mail) generated from bridge toll equipment recording license plate images. This recent development and the SR 520 bridge proximity to the I-405 corridor has resulted in considering adding pre-paid account based Pay By Plate and Pay By Mail payment types for the I-405 managed lanes corridor (collectively called photo tolling) and is part of the Base Case Scenario described later in this chapter.

The traffic and revenue forecasts presented in this report were performed for the Option 1 configuration (I-405 North) as well as for the Option 4 configuration (I-405 North and South) of the proposed I-405 Express Toll Lanes project and included the SR 167 corridor. The limits of the study area covering the I-405 corridor include the I-5 interchange in Lynnwood in the north and the SR 512 interchange in Puyallup in the south including major east-west highways intersecting the project corridor.

Overview of CDM Smith's Previous I-405 and SR 167 Traffic and Revenue Studies

In 2002, CDM Smith (formerly Wilbur Smith Associates, WSA) was asked to conduct preliminary traffic and revenue studies for I-405 under three alternative widening and operational scenarios. In 2003, WSA conducted preliminary analysis for SR167 HOT lanes, followed in 2005 by toll system design and additional traffic and revenue analysis in support of the implementation of the pilot

project. Since 2006, CDM Smith has also conducted numerous assignments related to pricing analysis for the I-405 Express Lanes from Renton to Lynnwood, in various configurations and under different operational assumptions.

A comprehensive traffic and revenue study was performed in 2006 for the northern portion of the Express Lanes, from SR 520 to I-5 (Lynnwood). The comprehensive traffic and revenue study included an extensive program of market research, including stated preference surveys and an assessment of future socio-economic parameters in the study corridor. A detailed operations profile and operations simulation models were developed for the I-405 corridor.

When the SR 167 HOT lanes opened in 2008, CDM Smith began providing quarterly performance reviews and forecast updates. Currently, CDM Smith continues to provide these updates.

A planning level study update was performed in 2009 utilizing existing data as well as new global demand forecasts. The study examined the effects on traffic and revenue for 5 different infrastructure configurations. The traffic and revenue forecast expanded the study area to include both the I-405 and SR 167 Express Toll Lanes projects. The corridor then extended from the I-5 / I-405 interchange in Lynnwood, down I-405, down SR 167, and across SR 512 to the I-5 / SR 512 interchange in the South. The Express Toll Lanes considered in this study had several configurations, the largest of which extended from I-5/ I-405 in the north to near where SR 167 intersects the King County / Pierce County line south of Auburn.

In 2010/2011 an additional planning level study update was performed for the Option 1 configuration only between Lynnwood and Bellevue.

Reasons for Updating Previous Traffic and Revenue Studies

Subsequent to completion of the previous traffic and revenue studies and changes in project configurations, the Washington Department of Transportation (WSDOT) established a more refined definition of the Option 1 and Option 4 study corridor including modifications to the toll operation assumptions and WSDOT provided revised travel demand data sets to reflect current economic conditions as well as the most recent Puget Sound Regional Council travel demand model data and model version.

The Express Toll Lanes (ETL) in the I-405 corridor would be established by conversion and partial widening of the existing high occupancy vehicle (HOV) lanes where vehicles with two or more occupants (HOV2+ requirement) are currently allowed.

Experience from established managed lanes projects and the current HOV lanes in the corridor indicates an HOV2+ free policy will most likely result in future operational problems, especially in peak hours. Under such a policy, during peak hours the high number of toll free vehicles take up nearly all of the managed lanes facility capacity leaving a relatively small amount of traffic demand that is being subjected to pricing. Thus, managing the lanes to a fixed capacity limit using tolling to meet a free-flow policy becomes difficult or impossible. By federal requirement, free-flow conditions (at least 45 mph) must be maintained in the Express Toll Lanes. Depending on the overall growth in the Express Toll Lane corridor, the increase in HOV2+ free traffic will emphasize this limitation in the future and therefore constrain the ability to manage demand with pricing. This might lead to a situation where certain sections of the managed lanes would have to be operated as HOV lanes only.

Experience from the existing single lane HOV with HOV 2+ occupancy requirement suggests that even under current travel demand, the traffic operation in the corridor on these single lane sections deteriorates quite frequently to below desired operational conditions.

In order to gauge the impacts of the HOV requirements in the corridor, a variety of sensitivity tests was performed assuming various definitions of eligibility for peak and off-peak conditions.

Another significant change compared to previous study approaches is the consideration of video tolling (Pay By Plate, Pay By Mail). Earlier studies had only considered electronic toll collection (ETC), with the assumption that only vehicles equipped with a toll transponder would be eligible to use the Express Toll Lanes. Since December 2011, SR 520 Bridge Tolling has been implemented adjacent to the I-405 corridor. On SR 520, travelers that do not have a *Good To Go!* transponder can use the tolled facility, either by pre-registering their license plate (Pay By Plate) and depositing pre-paid tolls into an account with WSDOT or by receiving a bill in the mail without pre-registration (Pay By Mail). Due to this recent development, photo tolling for the I-405 managed lanes corridor has been added as a consideration and is part of the Base Case Scenario described later in this chapter.

This report summarizes the various analyses performed on behalf of the I-405 Corridor Office in the study corridor since July 2011 based on revised data sets and various options regarding tolling policies and occupancy requirements for toll-free trips. A new stated preference (SP) survey was conducted by another consultant to evaluate the willingness-to-pay or value of time (VOT) within the I-405 and SR 167 corridor as part of a parallel traffic and revenue study on behalf of the Washington State Transportation Commission (WSTC). The revised estimates for the value of time were obtained from WSDOT and the WSTC consultant and incorporated in the traffic and revenue study documented in this report. This study relies heavily upon data collected, and the analysis associated with the prior studies mentioned previously. However, the most current 2012 global travel demand model for the PSRC region was the basis for revised travel demand data sets including a calibration to most recent available count data. In addition, data from the new stated preference survey conducted for WSTC was utilized to supplement the traffic and revenue forecasting process.

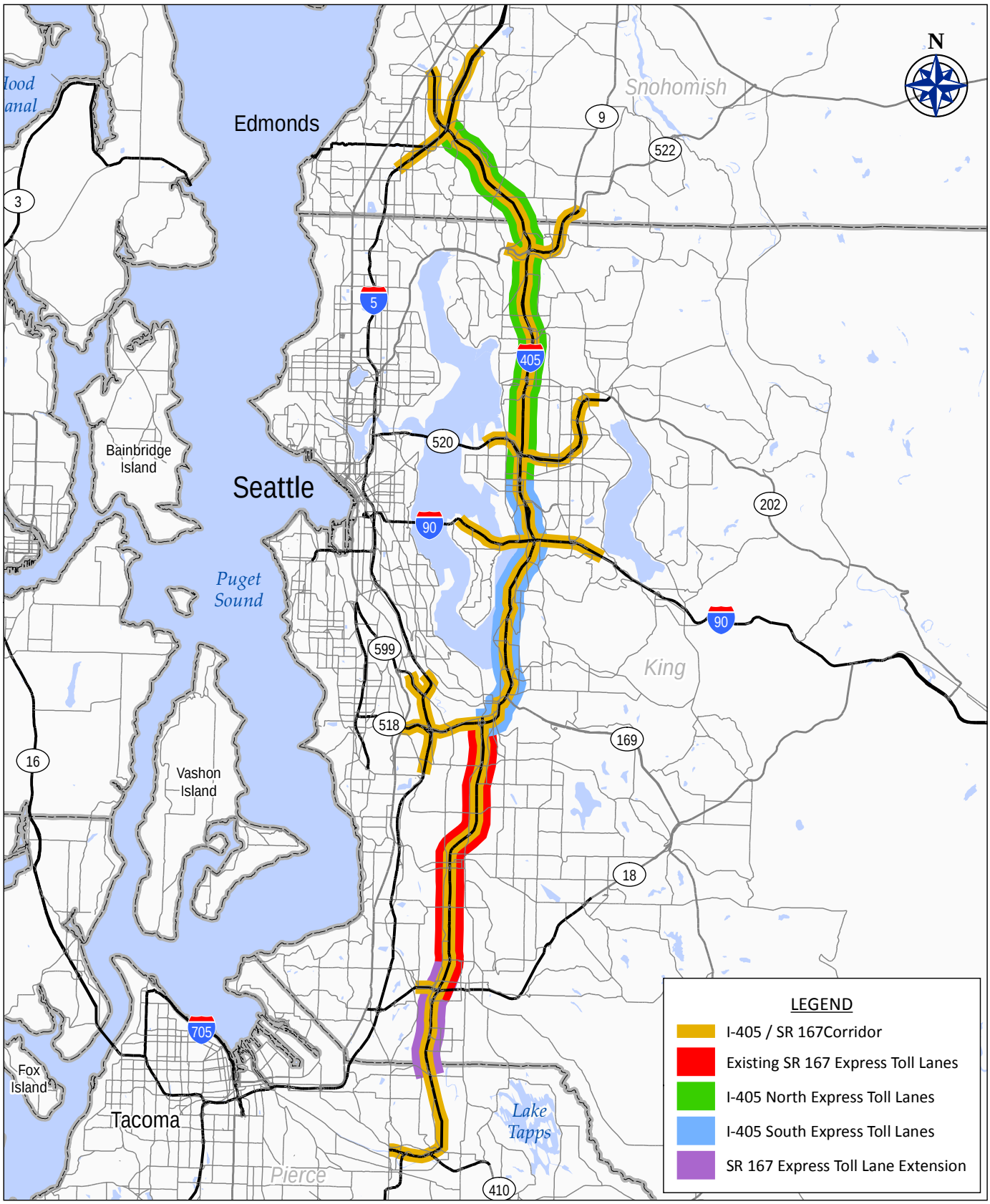
An analysis of existing facilities was performed by CDM Smith to incorporate a more detailed understanding of the ramp-up phase of the proposed managed lane project.

Toll Scenarios

Toll scenarios considered in this study include a Base Case scenario, three sensitivity test scenarios, and three comparison scenarios. The project corridor is shown in Figure 1-1 with the three major sections I-405 North, I-405 South and SR 167. The analysis was performed for Option 1 (I-405 North, SR 167) in opening year 2014 and 2018 and for Option 4 with all three sections in operation for 2018 and 2030 time horizons.

Base Case Scenario

The Base Case was defined as Option 1 (I-405 North) being in operation by 2014 and the SR 167 Express Toll Lanes being extended to the Pierce County Line (Phase 4 of the SR 167 Express Toll Lanes). It is assumed that both sections (I-405 North and SR 167) in the corridor would be operating under an HOV3+ requirement for toll-free trips and toll paying vehicles have the ability to pay tolls on the Express Toll Lanes via an account based *Good To Go!* transponder, account based Pay By Plate, or Pay By Mail. By 2018 the I-405 South section (Option 4) is assumed to be operational with the same



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LOCATION MAP

FIGURE 1-1

toll operations assumptions. The traffic and revenue estimates have been performed for 2014 and 2018 levels for Option 1 configuration as well as 2018 and 2030 time horizons for the Option 4 configuration.

Sensitivity Test Scenarios

Sensitivity tests were conducted to determine if other operational alternatives would be feasible, either from a perspective of transitioning between different operations approaches or as long-term alternatives. In order to evaluate impact on travel demand and managed lanes revenue, the following Base Case and sensitivity tests were performed:

- HOV3+ Free Operation with Transponder and Photo Billing (Base Case)
- HOV2+ Free Operation with Transponder and Photo Billing
- Peak HOV3+ Free and Off-Peak HOV2+ Free Operation with Transponder and Photo Billing
- HOV Discount with Transponder and Photo Billing

The HOV3+ Base Case scenario allows traffic management by pricing a relatively large amount of ETL travel capacity whereas the HOV2/HOV3+ free scenario represents a compromise between operational requirements during peak hours and the current user requirements on the existing HOV lanes and the SR 167 Express Toll Lanes in off-peak hours.

The HOV2+ Free with Transponder and Photo Billing scenario was tested to confirm results from previous study efforts which examined constraints especially in the outer years of the forecast in managing demand due to the high share of toll free vehicles, but assumed transponder-only access.

The final toll operation scenario was analyzed to understand the impact of an HOV discount on traffic and revenue, assuming that transponder payment and photo billing would be in place for full toll paying vehicles.

In the Base Case and sensitivity test scenarios, it is assumed that customers who wish to take advantage of a high-occupancy discount or exemption will need to have a transponder.

Comparison Scenarios

In addition, three scenarios without photo billing operation were tested to provide comparable results to the study performed on behalf of the Washington State Transportation Commission (WSTC) that assumed ETC (transponder) only toll payment. These do not follow the current defined tolling policy for the I-405/SR 167 Express Toll Lanes Project but are included in the appendix for reference:

- HOV2+ Free Operation with Transponder-Only Operation
- HOV3+ Free Operation with Transponder-Only Operation
- HOV Discount Assuming Transponder-Only Access to the Express Toll Lanes

In this analysis done by WSTC, it was assumed that HOV 3+ vehicles would not be required to have a transponder to use the Express Toll Lanes. These initial scenarios without photo billing also assumed the transition of the SR 167 section to an HOV3+ Free designation (under the HOV3+ Free scenario)

would begin in 2018. The Base Case and the HOV3+ Free Photo Billing scenarios assumed this transition would begin in 2014. The final toll operation scenario was analyzed to understand the impact of ETC only operation for tolled vehicles and a discount for HOV vehicles on traffic and revenue.

Study Objective

The objective of this study was to focus on the impact of toll policy variations for the proposed I-405/SR 167 Express Toll Lanes. The analysis assumed the Option 1 configuration (I-405 North) between Lynnwood and Bellevue would be operational first, followed by the implementation of the Option 4 configuration (I-405 South) connecting the Option 1 configuration with the existing SR 167 Express Toll Lanes . This study made maximum use of the data and analyses in earlier reports, revised data sets provided by WSDOT, and the new stated preference survey data. It was prepared to provide input for the toll policy decision-making process to address toll operations and discounts scenarios from a traffic and revenue perspective.

This project involved the recoding of demand model networks to reflect the revised configurations being analyzed, updating demand data, revising the detailed operations corridor micro-simulation model (VISSIM), conducting operations simulation model runs and the development of new projections of traffic volumes and potential toll revenues. In addition information from the new stated preference surveys conducted on behalf of the Washington State Transportation Commission was used to modify the original 2006/2007 stated preference survey data and reflect current willingness-to-pay information and to scale the value of time based on travel distance.

Estimates of traffic and revenue developed for this study are intended for use in comparing toll operations scenarios. Once a preferred scenario is identified, a more detailed analysis and revision of the previous study input data would be required for the preferred project configuration and toll operations concept in order to certify the revenue estimates, in support of possible project financing.

The results shown in this report are not intended for purposes of project financing.

Project Corridor

As shown in Figure 1-1, the proposed Express Toll Lanes in Option 1 will extend from the I-5/I-405 interchange in the north (Lynnwood) to downtown Bellevue at the North East 6th Street direct access point where the Express Toll Lanes will merge back into the existing HOV lane south of NE 6th Street. The second phase of the project corridor will extend from the southern terminus of the Option 1 configuration in Bellevue to the northern terminus of the existing SR 167 managed lanes in Renton. The modeled corridor is represented in the form of a study area skeleton model as highlighted in green and includes sections of I-5 in Lynnwood; I-90; SR 520; and all interchanges along the I-405 and SR 167 corridors covering a total length of approximately 51 miles.

The study examined the following physical infrastructure configuration:

- Option 1: Conversion of the single HOV lane to a single Express Toll Lane between the I-5 and I-405 interchange and SR 522 and conversion of the HOV lane, and addition of one lane per direction, to create two Express Toll Lanes between SR 522 and SR 520/Downtown Bellevue

- Option 4: Includes the Option 1 configuration and assumes conversion of the single HOV lane and addition of one lane per direction between Bellevue and the I-405 and SR 167 interchange resulting in two Express Toll Lanes. The SR 167 Express lanes and the I-405 Express lanes would be connected via a flyover at the I-405 and SR 167 interchange.

The Option 1 configuration is assumed to be operational in 2014 followed by the opening of the Option 4 (I-405 South) in 2018.

Scope of Work

As with previous study efforts, a three-tiered modeling approach was used for the analysis:

- Extraction of corridor demand data from the regional transportation model
- Market share "micro-modeling" to estimate the share of traffic between the toll-free general purpose and the tolled managed lanes
- VISSIM micro-simulation modeling used to estimate changes in travel speeds and times under varying shares of traffic between the toll-free general purpose lanes and tolled managed lanes

The demand data from the PSRC model extracted for the sub-area, as well as the VISSIM simulation networks and data, were provided to CDM Smith by WSDOT. After completion of the traffic and revenue modeling, a final set of demand data was extracted for each operational scenario, including information about Express Toll Lane traffic versus general purpose lane traffic, and matrices with ramp-to-ramp toll and volume information were provided. This final set of demand data reflecting the tolled operation of the Express Toll Lanes was then used by WSDOT for the operational analysis of the Express Toll Lanes and the general purpose lanes.

WSDOT provided CDM Smith with all future-year global travel demand estimates that are based on the current PSRC travel demand model. The I-405 travel demand estimates were generated for subarea model covering the highlighted area shown in Figure 1-1. WSDOT provided separate sets of subarea demand data for 2014, 2018, 2030 time horizons. The data was also prepared for use in the traffic operations simulation model. The data received from WSDOT was formatted in half hour time increments for two six-hour periods from 5:00 AM to 11:00 AM and from 2:00 PM to 8:00 PM. The data was aggregated to hourly assignment periods and midday demand between 11:00 am and 2:00 pm was estimated by interpolation using traffic count information.

The demand model networks were re-coded to match the latest Express Toll Lane configuration for the revised Option 1 and Option 4 configurations. Based on the provided VISSIM micro-simulation network, a series of simulation runs for each assignment period was performed with varying loading conditions on the Express Toll Lanes. This information was used to estimate delays on the general purpose lanes.

As noted above, the 2006/2007 Investment Level Study included stated preference surveys, which measured motorists' willingness to pay tolls and general propensity to use the proposed Express Toll Lanes. In 2011 another stated preference survey was conducted for a parallel study on behalf of the Washington State Transportation Commission. This information was utilized and adapted to match the new forecast horizons. Other assumptions and modeling procedures used in this study that are

not related to demand data or network configurations were adapted from the older studies conducted by CDM Smith.

Order of Presentation

Chapter 2 provides a detailed description of modeled operational scenarios. The modeling approach is explained in Chapter 3, and Chapter 4 summarizes the results of the traffic and revenue analysis.

Appendices A through D include detailed tables and figures for the Base Case Scenario as well as the three sensitivity tests.

Appendices E, F and G include detailed tables and figures for the non-photo billing scenarios. These results are included for information only since these scenarios were evaluated before the Washington State Department of Transportation (WSDOT) has adopted photo billing as the official toll operations concept for the managed lanes in the I-405/SR 167 Express Toll Lanes corridor. Therefore the numbers are shown for purposes of comparison against the parallel study on behalf of the Washington State Transportation Commission at that time.

Chapter 2

Description of Scenarios

The project corridor extends between the I-405/I-5 interchange in Lynnwood to the north and the SR 167/SR 512 interchange in Puyallup to the south. In addition to I-405 and SR 167, the study area includes major east-west highways intersecting the main north-south project corridor. It was assumed that the Express Toll Lanes would be operated within the three major sections (facilities) of the corridor: I-405 North, I-405 South and SR 167. Each of these sections is assumed to have three tolling zones per direction. A single toll charge would be applied to vehicles traveling through each tolling zone. Since each tolling zone has multiple entry and exit points, tolls would be charged independently of the actual distance traveled within each zone.

The toll rates would be displayed on dynamic message signs informing the motorists about the cost to travel through the facility for each of the three tolling zones. The extension of the tolling zones for Option 1 (2014 and 2018) are shown in Figures 2-1 and 2-2 and the tolling zones for Option 4 (2018 and 2030) are shown in Figures 2-3 and 2-4. The tolling zones are labeled A through I (A-C for SR 167; D-F for I-405 South; and G-I for I-405 North). The infrastructure configuration is identical for the Base Case and all other toll operations scenarios.

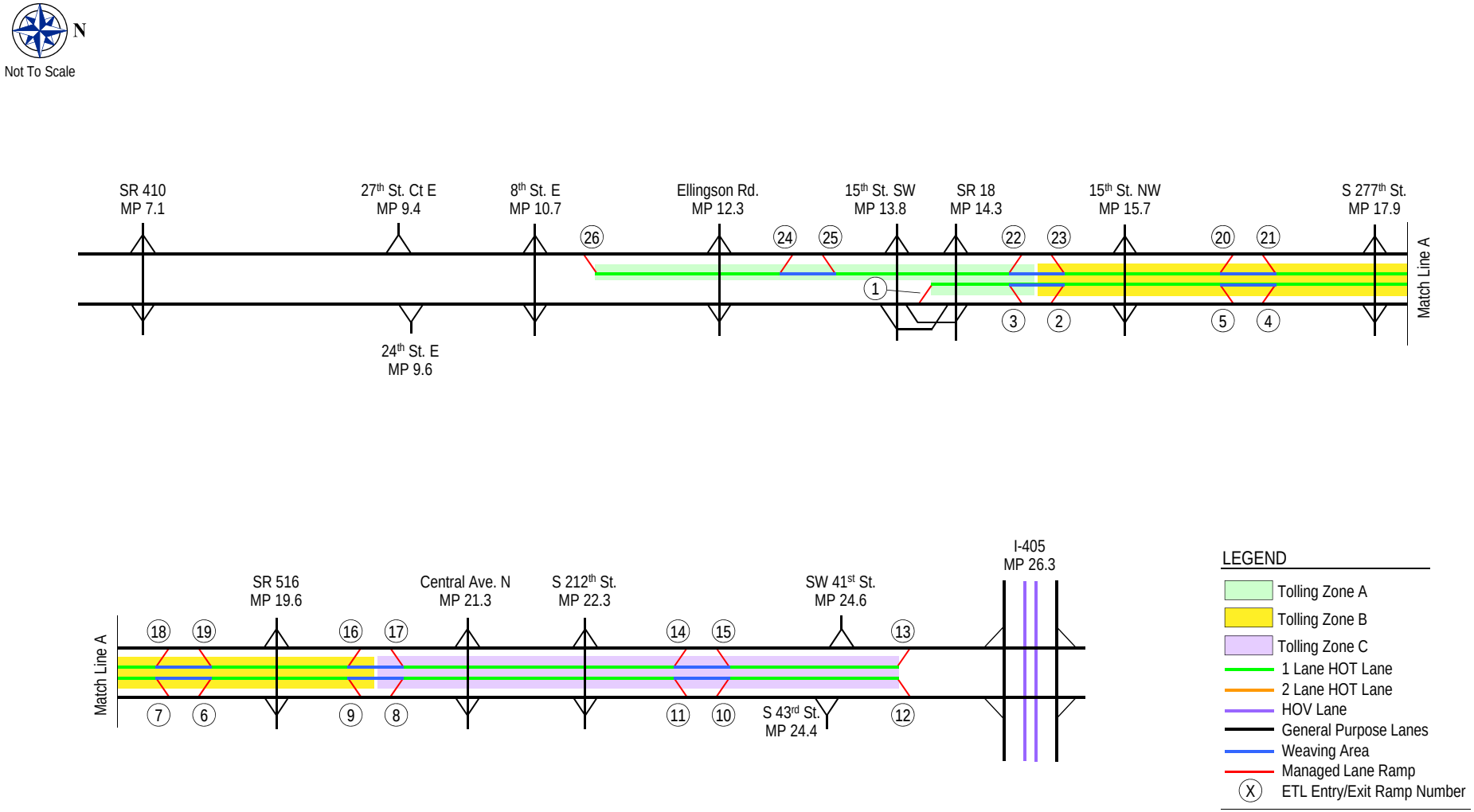
It is assumed that the Express Toll Lanes would be operated under a dynamic toll-setting algorithm that adjusts the toll rates based on measured volumes and/or traffic densities. The use of dynamic pricing aims to ensure that the Express Toll Lanes operate at or near free-flowing conditions at all times. Toll rates were assumed to be set to optimize traffic throughput on the Express Toll Lanes (Chapter 3 provides details on the approach used to determine the toll rates). It was assumed that no maximum toll rate (toll cap) would be set. Assumptions regarding minimum toll rates and increment charges by payment method are explained later in this chapter.

Toll Operation Scenarios

In order to evaluate the effects of different toll operations on traffic and revenue estimates, the following alternative toll operations concepts were tested:

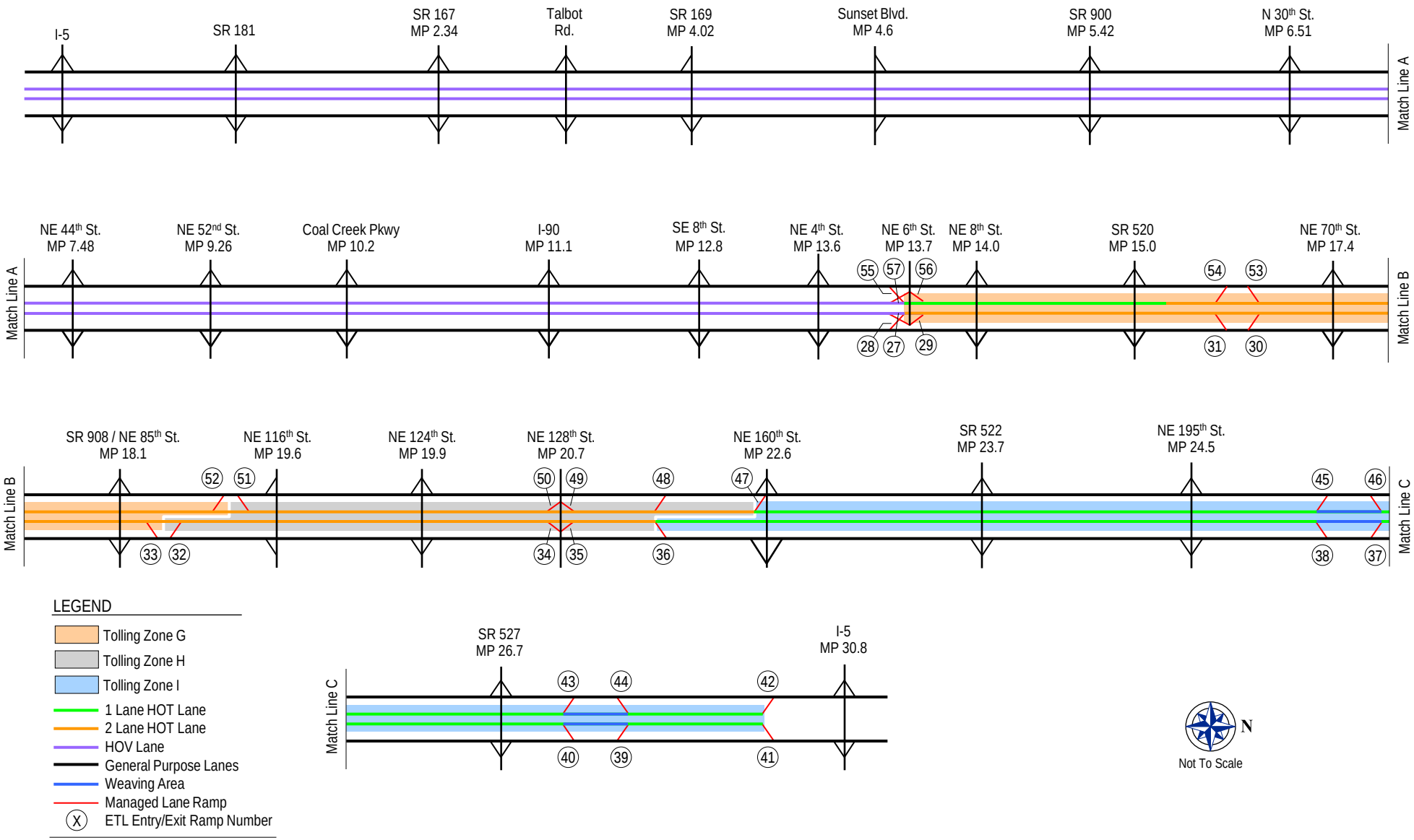
- HOV3+ Free Operation with Transponder and Photo Billing Payment (Base Case)
- HOV2+ Free Operation with Transponder and Photo Billing Payment
- Peak HOV3+ Free and Off-Peak HOV2+ Free Operation with Transponder and Photo Billing Payment
- HOV Discount with Transponder and Photo Billing

In the Base Case and three sensitivity tests, photo billing is assumed to be available which is consistent with the currently defined tolling policy for the I-405/SR 167 Express Toll Lanes Project. In these scenarios, customers who wish to take advantage of a high-occupancy discount or exemption must have a transponder.



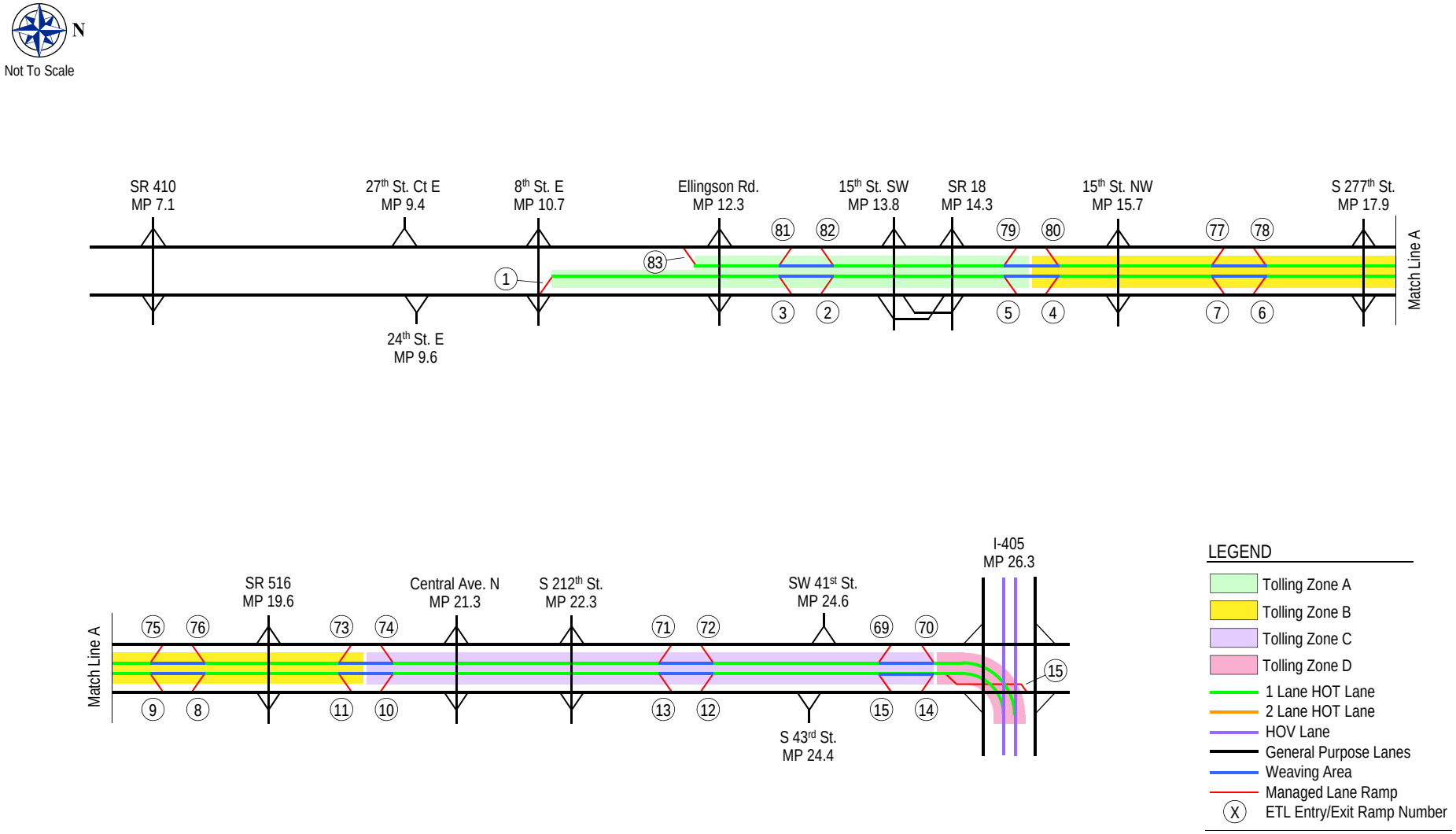
OPTION 1 TOLLING ZONES - SR 167

FIGURE 2-1



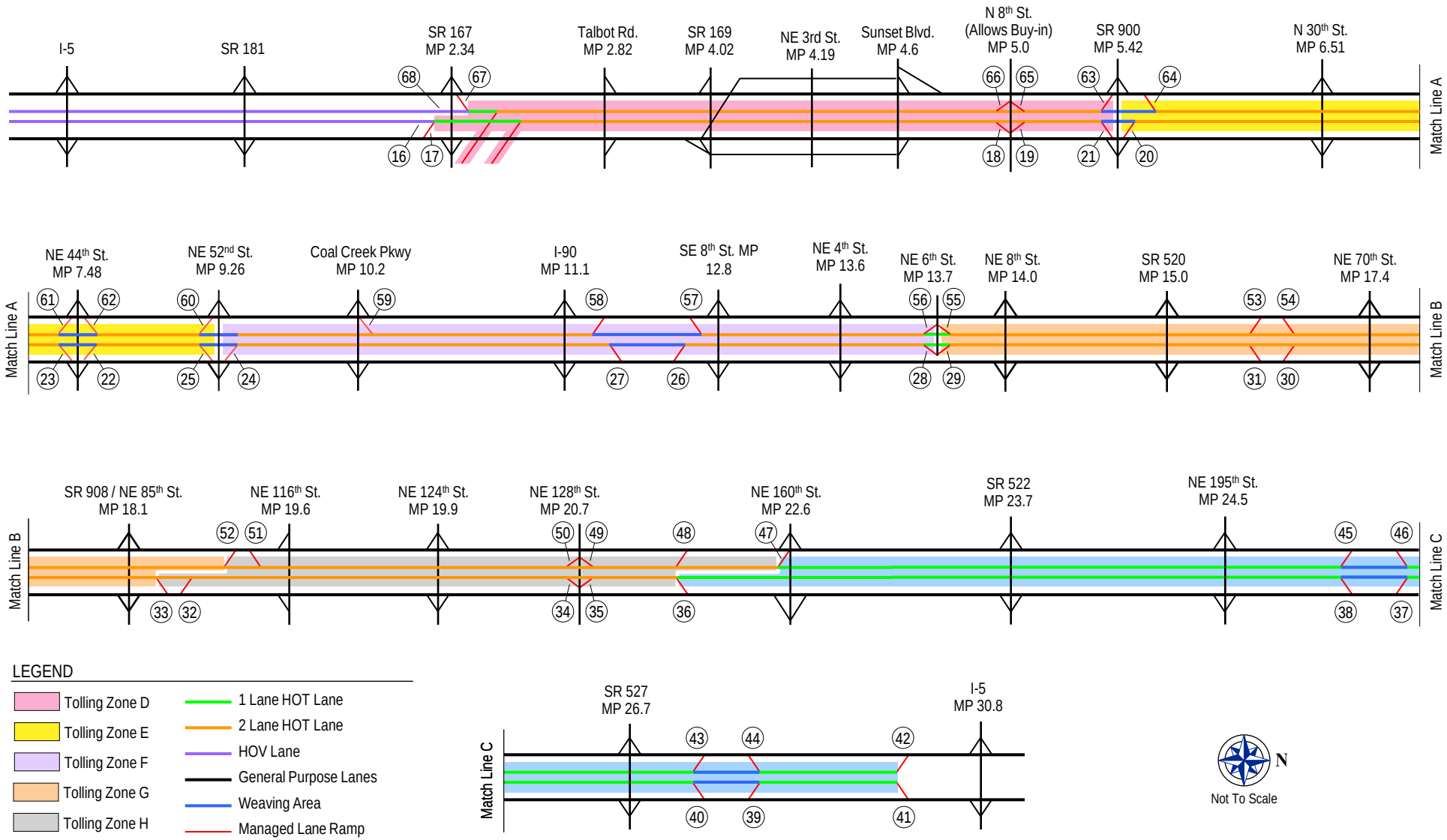
OPTION 1 TOLLING ZONES - I-405

FIGURE 2-2



OPTION 4 TOLLING ZONES - SR 167

FIGURE 2-3



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OPTION 4 TOLLING ZONES - I-405

FIGURE 2-4

In addition, three comparison scenarios without photo billing payment were tested to provide results comparable to the study performed by another consultant on behalf of the Washington State Transportation Commission that assumed ETC (transponder) only toll payment:

- HOV2+ Free Operation with Transponder-Only Payment
- HOV3+ Free Operation with Transponder-Only Payment
- HOV Discount With Transponder-Only Payment

These comparison scenarios do not follow the currently defined tolling policy for the I-405/SR 167 Express Toll Lanes Project but are included in the appendix for reference. Also, the analysis done by WSTC assumed that HOV 3+ vehicles would not be required to have a transponder to use the Express Toll Lanes.

Detailed assumptions specific to each scenario are described in the following paragraphs. Toll operations assumptions that are common to all tested scenarios are described later in this chapter.

Base Case Scenario

HOV3+ Free Operation with Transponder and Photo Billing Payment

The Base Case scenario assumes that vehicles with three or more occupants can use the Express Toll Lanes free of charge (HOV3+ Free operation), but are required to have a transponder. The toll paying single occupant vehicles (SOV) and vehicles with two occupants (HOV2) can pay to use the express lanes either by using a *Good To Go!* transponder or via license plate tolling (Pay By Plate or Pay By Mail).

On SR 167, the transition from the current HOV2+ Free and transponder-only operation to the HOV3+ Free with transponder and photo billing payment is assumed to be operational starting in 2014.

The traffic and revenue analysis was performed for years 2014 and 2018 for the Option 1 configuration, and for years 2018 and 2030 for the Option 4 configuration. The tolls were determined based on the approach described in Chapter 3.

Sensitivity Test Scenarios

HOV2+ Free Operation with Transponder and Photo Billing Payment

This alternative tolling scenario is identical to the Base Case except for the eligibility requirement for toll free trips being changed to HOV2+ Free. This scenario was tested to verify whether the HOV2+ Free requirement limits the ability to manage travel demand on the Express Toll Lanes.

Peak HOV3+ Free and Off-Peak HOV2+ Free Operation with Transponder and Photo Billing Payment

In this scenario, it is assumed that the HOV3+ Free requirements would apply only during the morning peak period (5:00 am – 10:00 am) and the afternoon peak period (3:00 pm – 8:00 pm). During the non-peak or midday periods, HOV2+ Free requirements would apply. All other parameters remain identical to the Base Case scenario.

HOV Discount with Transponder and Photo Billing

This scenario is identical to the Base Case except that HOV vehicles receive a discount on toll rates. HOV2 and HOV3+ vehicles equipped with an electronic toll transponder will receive a discount of $0.50 in 2014, $0.55 in 2018 and $0.75 in 2030 on each major segment (SR167, I-405North, I-405 South). The discount is initially set at $0.50 in opening year 2014 and is increased by 2.5% inflation over time. If the applicable discount exceeds the regular toll rate, HOV2 and HOV3+ vehicles will travel free of charge. This scenario is consistent with the adoption of a general tolling policy for the I-405/SR 167 Express Toll Lanes requiring the option of license plate tolling (photo billing).

Comparison Scenarios

HOV2+ Free Operation with Transponder-Only Operation

This scenario assumes access to the Express Toll Lanes requires a transponder for tolled vehicles. High occupancy vehicles with two or more occupants are exempt from paying a toll and photo billing is not applicable. This scenario was evaluated before the general tolling policy for the I-405 / SR 167 Express Toll Lanes included license plate tolling (photo billing). All other parameters remain identical to the Base Case scenario. The results are included in this report for purposes of comparison against a similar scenario that was tested in a study performed on behalf of the Washington State Transportation Commission.

HOV3+ Free Operation with Transponder-Only Operation

This scenario assumes access to the Express Toll Lanes requires a transponder for tolled vehicles. High occupancy vehicles with three or more occupants are exempt from paying a toll and photo billing is not applicable. This scenario was evaluated before the general tolling policy for the I-405 / SR 167 Express Toll Lanes included license plate tolling (photo billing). All other parameters remain identical to the Base Case scenario. The results are included in this report for purposes of comparison against a similar scenario that was tested in a study performed on behalf of the Washington State Transportation Commission.

HOV Discount with Transponder-Only Payment

This scenario assumes that access to the Express Toll Lanes requires a toll transponder for all vehicles; in other words, the photo billing option is not available. HOV2 and HOV3+ vehicles receive a discount of $1.00 in 2014, $1.10 in 2018 and $1.50 in 2030 on each major segment (SR 167, I-405 North, and I-405 South). The discount is initially set at $1.00 in opening year 2014 and is increased by 2.5% inflation over time. If the applicable discount exceeds the regular toll rate, HOV2 and HOV3+ vehicles will travel free of charge. This scenario was evaluated before the adoption of a general tolling policy for the I-405/SR 167 Express Toll Lanes requiring the option of license plate tolling (photo billing). All other parameters are identical to the Base Case scenario.

Assumptions Common to All Scenarios

The following assumptions are common to all scenarios. They are based primarily on the 2006 and 2011 stated preference survey results, and on recent experience from the SR 520 Bridge Tolling project adjacent to the I-405 corridor.

Proportion of Non-Eligible Users

The 2006 stated preference survey and the recent 2011 survey suggest that about 20% of the respondents are not willing to choose the tolling option. The major reasons are opposition to paying a toll, not willing to get a *Good To Go!* transponder and various other reasons. Based on this data and discussions with WSDOT, the following assumptions (Table 2-1) were made regarding non-eligible users:

- ETC (transponder) only operation : 28% of the vehicles are assumed to be non-eligible users, meaning that they would never choose to pay a toll
- Photo Billing: 12% of the vehicles are assumed to be non-eligible users

The proportion of non-eligible users is assumed to remain the same in 2014, 2018 and 2030.

The portion of the demand that is considered non-eligible was separated before the toll diversion analysis was performed. The above percentages are related to the potential travel demand for the Express Toll Lanes (Input demand). These assumptions are based on the stated preference surveys and doe reflect the share of potential Express Toll Lane users but are not related to travel demand forecasts. The actual percentages of eligible users travelling in the Express Toll Lanes vary and are dependent on the toll rates and time savings.

Table 2-1
Shares of Non-Eligible Users

	Forecast Year		
Scenario	2014	2018	2030
Transponder Only Scenarios	28%	28%	28%
Photo Billing Scenarios	12%	12%	12%

Payment Methods

The data describing the potential usage of the Express Toll Lanes was further refined to reflect the methods of payment as shown in Table 2-2. Again, these proportions were based on results of the 2011 stated preference survey related to the potential user behavior. For the photo-billing scenarios, it is assumed that the proportions remain constant between opening year and 2018, and will change for 2030 to reflect an increase of transponder usage in the outer years.

Table 2-2
Input Shares of Method of Payment

Transponder Only Scenarios

	Forecast Year		
Market Segment	2014	2018	2030
Non-Eligible	28%	28%	28%
Transponder	72%	72%	72%
Total	100%	100%	100%

Photo Billing Scenarios

	Forecast Year		
Market Segment	2014	2018	2030
Non-Eligible	12%	12%	12%
Transponder	72%	72%	80%
Pay-By-Plate	4%	4%	2%
Photo-Billing	12%	12%	6%
Total	100%	100%	100%

Minimum Toll Rates and Variation of Charges by Payment Type

The user groups are charged different tolls depending on the method of payment. The charges are assumed to vary as shown in Table 2-3. Trips are subject to a minimum toll charge per facility. Facilities are defined as the SR 167 Express Toll Lanes, the I-405 South Express Toll Lanes and the I-405 North Express Toll Lanes.

Trips using more than one facility are subject to a minimum toll per facility and a Pay By Mail surcharge per facility. The minimum toll rate is set at $0.71 per facility. The toll charge increment for Pay By Plate and photo-billing are set at $0.25 and $1.50 per facility, respectively. These charges are in 2012 dollars and were inflated at 2.5 percent per year to determine future year levels.

The resulting future year toll amounts are shown in Table 2-3. A vehicle equipped with a transponder travelling through all three facilities in 2030 is subject to a $3.33 minimum toll. A vehicle using the Pay By Plate payment option incurs an additional $1.17 charge resulting in a cost of at least $4.50 for such a trip. A vehicle paying with photo-billing incurs a $3.33 minimum toll charge and a $7.05 incremental charge for the photo-billing payment, resulting in a minimum charge of $10.38 for such a through trip in 2030.

The parameters described in this chapter were used as input to estimate toll transactions and revenue for the analysis of the Base Case scenario and all of the sensitivity tests.

The methodology for this process is described in detail in Chapter 3 and Chapter 4 provides a summary of the traffic and revenue estimates.

Table 2-3
Definition of Charges by Payment Type

Transponder Only Scenarios

Toll Charge	Forecast Year 2012	2014	2018	2030
Minimum Toll SR 167	$0.71	$0.75	$0.83	$1.11
Minimum Toll I-405 South	$0.71	$0.75	$0.83	$1.11
Minimum Toll I-405 North	$0.71	$0.75	$0.83	$1.11
Minimum Toll Through-Trip	$2.14	$2.25	$2.49	$3.33

Photo Billing Scenarios

Toll Charge	Forecast Year 2012	2014	2018	2030
Minimum Toll SR 167	$0.71	$0.75	$0.83	$1.11
Minimum Toll I-405 South	$0.71	$0.75	$0.83	$1.11
Minimum Toll I-405 North	$0.71	$0.75	$0.83	$1.11
Minimum Toll Through-Trip	$2.14	$2.25	$2.49	$3.33
Pay-By-Plate Increment SR 167	$0.25	$0.26	$0.29	$0.39
Pay-By-Plate Increment I-405 South	$0.25	$0.26	$0.29	$0.39
Pay-By-Plate Increment I-405 North	$0.25	$0.26	$0.29	$0.39
Pay-By-Plate Increment Through-Trip	$0.75	$0.78	$0.87	$1.17
Photo-Billing Increment SR 167	$1.50	$1.58	$1.74	$2.35
Photo-Billing Increment I-405 South	$1.50	$1.58	$1.74	$2.35
Photo-Billing Increment I-405 North	$1.50	$1.58	$1.74	$2.35
Photo-Billing Increment Through-Trip	$4.50	$4.74	$5.22	$7.05

Note: All charges are shown in future year Dollars and are inflated with 2.5 % per year from 2012 on.
Toll Charges shown 2012 as well as for I-405 South in 2014 are for purposes of comparison only.
The I-405 North portion of the express toll lanes is assumed to open in 2014, the I-405 South portion is assumed to open in 2018.
Photo tolling scenarios require HOVs to have a transponder.

Chapter 3

Modeling Approach

This traffic and revenue analysis included the development of multi-level detailed traffic models, an assessment of optimum toll levels, estimates of traffic volumes by time of day and travel direction, estimates of revenue potential and extraction of the final demand data for purposes of operational analyses. Details on the modeling approach are presented in this chapter.

Modeling Approach Overview

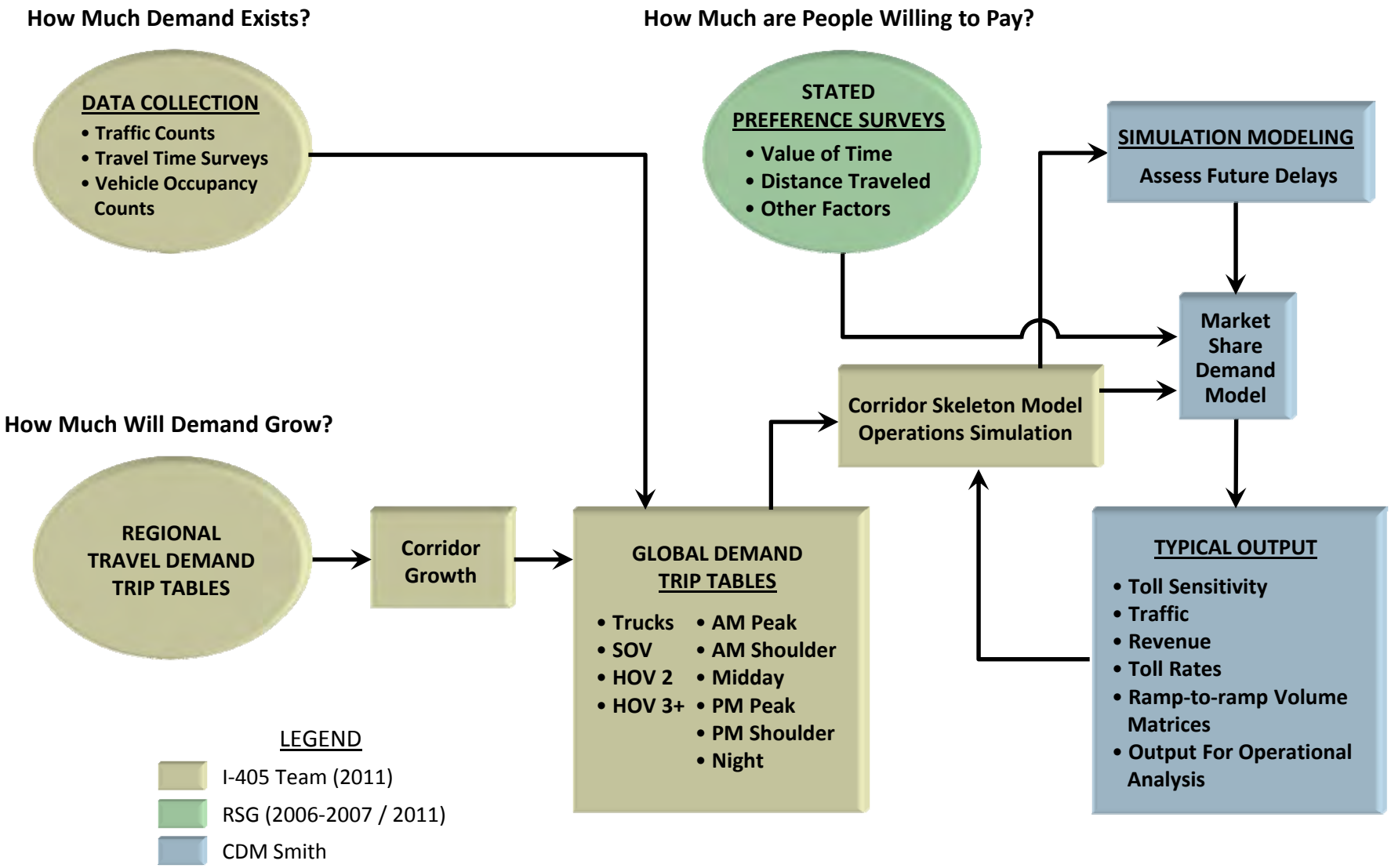
Figure 3-1 presents an overview of the methodology used to develop estimates of traffic and revenue for the project alternatives. Generally, a traffic and revenue study addresses the following four overall questions:

- How much traffic demand currently exists in the corridor?
- By how much is the demand expected to grow in the future?
- What share of traffic can be expected to use the toll facility?
- What will drivers be willing to pay?

The overall modeling approach used in this study required the development and/or utilization of three independent models. These included:

- Regional model for global demand estimates – The global demand model provides an estimate of the total amount of traffic expected to use the project corridor under improved conditions. These estimates were based on the latest version of the PSRC regional travel demand model and were provided to CDM Smith by WSDOT.
- Travel time simulation model – The existing VISSM micro-simulation models[1] of the project corridor were adapted to identify changes in travel time and delay on different segments of the general purpose lanes under various loading configurations. Motorists' willingness to pay a toll to use express toll lanes depends heavily on congestion levels and traffic backups in the toll-free general purpose lanes. The simulation model is an enhanced tool to provide a better indication of delay conditions under varying levels of demand. The simulation model was run under various loading levels and the resulting delay information was integrated into the market share model.
- The market share demand model – This model was used to estimate the share of total traffic in the I-405 / SR 167 corridor that would choose the express toll lanes, versus the toll-free general purpose lanes, under varying operating conditions and toll rates. The share of corridor traffic using the express toll lanes depends on several factors, including: location of access/egress

[1] Vissim 5.1 micro-simulation networks and demand matrices were provided by WSDOT.



CDM Smith

MODELING APPROACH

FIGURE 3-1

points, differences in configurations, time savings offered by the express toll lanes, and the toll rates being charged.

Periods of Analysis

The market share demand model trip tables were extracted from the global demand model runs and were calibrated to match capacities at various bottleneck locations. This was done in order to recognize the constraint of traffic demand due to the congestion in the corridor, and the effect that the increased capacity of the express toll lanes will have on the overall corridor demand (latent demand in the corridor),

The extracted subarea matrices were provided by WSDOT for the time periods from 5:00 AM to 11:00 AM and from 2:00 PM to 8:00 PM, in half-hour increments. Based on this, the demand data was aggregated to hourly assignment periods. The demand between 11:00 AM and 2:00 PM was estimated using data from the adjacent morning and afternoon periods, as well as profiles from available count data and previously used demand data.

The analysis periods used in the market-share demand model and the micro-simulation model were as follows:

- AM1: 5:00 AM - 6:00 AM
- AM2: 6:00 AM - 7:00 AM
- AM3: 7:00 AM - 8:00 AM
- AM4: 8:00 AM - 9:00 AM
- AM5: 9:00 AM - 10:00 AM
- AM6: 10:00 AM - 11:00 AM
- MD1: 11:00 AM - 12:00 PM
- MD2: 12:00 PM - 1:00 PM
- MD3: 1:00 PM - 2:00 PM
- PM1: 2:00 PM - 3:00 PM
- PM2: 3:00 PM - 4:00 PM
- PM3: 4:00 PM - 5:00 PM
- PM4: 5:00 PM - 6:00 PM
- PM5: 6:00 PM - 7:00 PM
- PM6: 7:00 PM - 8:00 PM

The overnight period from 8:00 PM to 5:00 AM was not analyzed explicitly. It was assumed that no tolls would be collected during this time period. The demand modeling was performed for weekday conditions. The traffic and toll revenue forecasts presented later in this report assume a certain fixed percentage of traffic and revenue will occur during the weekends.

Travel Time Simulation Model (VISSIM)

Traditional travel demand models do not well replicate the impact of merging and weaving maneuvers on highway capacity, nor can they reflect the impact of downstream queuing on highway

segments. A microscopic simulation model, VISSIM, was used to assist in estimating the impacts of the project travel speeds on different segments of the highway. VISSIM models each vehicle as a separate entity. The roadway geometry and interaction with other vehicles influences the behavior of each vehicle in the model. A certain level of randomness in vehicle behavior is also introduced with various vehicle behavior parameters and the assumed speed distributions of desired free flow speeds rather than using fixed speeds.

The infrastructure configuration and the demand data for the micro-simulations were provided by WSDOT. A series of VISSIM runs were made using differing assumptions on traffic shifts to the express toll lanes, for each of the fifteen demand model time periods, at 2014, 2018 and 2030 levels. As traffic shifts into the express toll lanes, the amount of traffic in the general-purpose lanes would decrease, resulting in lower congestion levels in the general-purpose lanes. A total of nine runs were made for each of the fifteen primary analysis periods, for each direction. Within each time period, for each general-purpose lane link, a relationship was developed between the "traffic demand" on the link and its modeled travel speed. Volume-delay curves were developed for each mainline link on the general purpose lanes by reporting traffic demand and travel speed for all nine runs.

Market Share Demand Model

The market share demand model considers the following major routing possibilities:

- General-purpose lanes
- Express toll lanes
- Local arterials
- Routes using a combination of these three choices

During the assignment process, travel time between a path using the express toll lanes was compared to travel time on a path using the next best free routes (usually the general-purpose lanes). For each travel movement, the proportion of motorists expected to use the express toll lanes is a function of the computed time savings and the cost to use the lanes vs. the value placed on time savings by the motorist value of time (VOT).

The market share model relies on developing an equilibrium condition between the toll cost and the estimated time savings. If more traffic uses the express toll lanes, there is less congestion in the general-purpose lanes and lower time savings. Less time savings would result in less traffic choosing the express toll lanes. For each toll rate level, there is an equilibrium point between the level of traffic congestion in the general-purpose lanes (time savings) and the amount of traffic willing to pay a toll to save that same amount of time.

At lower toll levels, there is a higher propensity to use the express toll lanes resulting in lower traffic volumes on the general-purpose lanes; this leads to lower congestion levels in the general-purpose lanes and reduced time savings in the express toll lanes. At higher toll levels, there is less traffic in the express toll lanes and more traffic remains in the general-purpose lanes; this leads to more congestion in the general-purpose lanes and increased time savings in the express toll lanes. For each toll rate level, the toll diversion modeling process goes through a series of iterations to find the equilibrium

point between the calculated time savings and the resulting congestion levels, replicating the interactions between traffic volumes in the general-purpose and the express toll lanes.

Determination of Toll Rates

Managed lanes projects, such as that being contemplated on the I-405 corridor, typically make use of variable tolls based on traffic congestion levels. In general, tolls are increased during periods of high congestion while lower tolls are used when volumes are lower.

As described in Chapter 2, a minimum charge of at least $0.71 per facility for transponder transactions and surcharges of $1.50 for photo billing and $0.25 for Pay By Plate transactions (2012 dollars, inflated to modeling years with 2.5 percent per year) were assumed. A full range of toll rates were tested, from $0.05 per mile to $3.50 per mile, for each time period and travel direction. This per mile rate was translated into toll charges for each tolling zone by direction.

The determination of optimum toll rates of a managed lanes facility is considerably different than that of a typical toll facility. Optimum rates for managed lanes can be dictated by three, sometimes conflicting criteria:

- Optimizing toll revenue potential
- Optimizing demand in the managed lanes yet assuring a congestion-free ride
- Optimizing the distribution of traffic between the general purpose lanes and the tolled, managed lanes

Traffic and revenue estimates have typically been based on toll rates which reflect a tolling policy to optimize the utilization of the express toll lanes. For purposes of this study, the transaction and revenue numbers, shown later in this report, reflect this strategy (Traffic optimization).

Vehicle Categories

For each of the trip tables, the market share model demand was separated into five components: trucks, single occupancy vehicle (SOV) work trips, SOV non-work trips, HOV2 and HOV3+ vehicles. The five vehicle categories were assigned simultaneously until an equilibrium condition was reached for a particular toll rate. Depending on the assumed tolling regulations for each study option, either HOV2 and/or HOV3+ vehicles were allowed free access to the express toll lanes.

Before the analysis began, WSDOT determined that heavy trucks would not be allowed to use the express toll lanes. As a result, a portion of the market share model trip tables was separated out to represent truck traffic. This portion was assigned only to the arterial streets and general-purpose lanes.

The assumptions for the proportion of HOV2 and HOV3+ trips for the 5:00 AM to 8:00 PM demand trip tables are shown in Table 3-1.

Table 3-1
Comparison of Mode Split and Share of Potential Tolled and Toll Free Trips

2014 Phase 1

		Modal Split Trip Tables				Share of Potential Tolled Trips			Share of Potential Toll Free Trips		
		SOV	HOV2	HOV3	Trucks	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios
AM1	5:00 AM - 6:00 AM	73.4%	16.0%	2.4%	8.1%	97.6%	81.5%	97.6%	2.4%	18.5%	2.4%
AM2	6:00 AM - 7:00 AM	73.0%	16.5%	2.8%	7.7%	97.2%	80.7%	97.2%	2.8%	19.3%	2.8%
AM3	7:00 AM - 8:00 AM	69.8%	19.2%	3.3%	7.7%	96.7%	77.4%	96.7%	3.3%	22.6%	3.3%
AM4	8:00 AM - 9:00 AM	69.5%	17.9%	3.2%	9.3%	96.8%	78.8%	96.8%	3.2%	21.2%	3.2%
AM5	9:00 AM - 10:00 AM	70.9%	16.3%	3.2%	9.6%	96.8%	80.5%	80.5%	3.2%	19.5%	19.5%
AM6	10:00 AM - 11:00 AM	71.6%	15.5%	3.0%	9.9%	97.0%	81.5%	81.5%	3.0%	18.5%	18.5%
MD1	11:00 AM - 12:00 PM	71.8%	15.8%	3.1%	9.3%	96.9%	81.1%	81.1%	3.1%	18.9%	18.9%
MD2	12:00 PM - 1:00 PM	72.2%	16.1%	3.1%	8.6%	96.9%	80.8%	80.8%	3.1%	19.2%	19.2%
MD3	1:00 PM - 2:00 PM	72.5%	16.5%	3.1%	7.9%	96.9%	80.4%	80.4%	3.1%	19.6%	19.6%
PM1	2:00 PM - 3:00 PM	73.1%	16.6%	3.3%	7.0%	96.7%	80.1%	80.1%	3.3%	19.9%	19.9%
PM2	3:00 PM - 4:00 PM	72.1%	17.7%	3.9%	6.3%	96.1%	78.4%	96.1%	3.9%	21.6%	3.9%
PM3	4:00 PM - 5:00 PM	73.0%	17.9%	4.0%	5.1%	96.0%	78.1%	96.0%	4.0%	21.9%	4.0%
PM4	5:00 PM - 6:00 PM	73.8%	18.0%	4.0%	4.2%	96.0%	78.0%	96.0%	4.0%	22.0%	4.0%
PM5	6:00 PM - 7:00 PM	75.9%	16.3%	3.3%	4.5%	96.7%	80.4%	96.7%	3.3%	19.6%	3.3%
PM6	7:00 PM - 8:00 PM	76.4%	16.2%	2.9%	4.5%	97.1%	80.9%	97.1%	2.9%	19.1%	2.9%

2018 Phase 1

		Modal Split Trip Tables				Share of Potential Tolled Trips			Share of Potential Toll Free Trips		
		SOV	HOV2	HOV3	Trucks	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios
AM1	5:00 AM - 6:00 AM	71.4%	17.7%	2.6%	8.3%	97.4%	79.7%	97.4%	2.6%	20.3%	2.6%
AM2	6:00 AM - 7:00 AM	71.6%	17.6%	2.9%	7.8%	97.1%	79.5%	97.1%	2.9%	20.5%	2.9%
AM3	7:00 AM - 8:00 AM	68.2%	20.5%	3.5%	7.8%	96.5%	76.1%	96.5%	3.5%	23.9%	3.5%
AM4	8:00 AM - 9:00 AM	67.8%	19.3%	3.4%	9.5%	96.6%	77.3%	96.6%	3.4%	22.7%	3.4%
AM5	9:00 AM - 10:00 AM	70.7%	17.0%	3.2%	9.1%	96.8%	79.8%	79.8%	3.2%	20.2%	20.2%
AM6	10:00 AM - 11:00 AM	71.4%	16.1%	3.0%	9.4%	97.0%	80.9%	80.9%	3.0%	19.1%	19.1%
MD1	11:00 AM - 12:00 PM	71.7%	16.4%	3.0%	8.9%	97.0%	80.6%	80.6%	3.0%	19.4%	19.4%
MD2	12:00 PM - 1:00 PM	72.0%	16.7%	3.1%	8.2%	96.9%	80.2%	80.2%	3.1%	19.8%	19.8%
MD3	1:00 PM - 2:00 PM	72.3%	17.0%	3.1%	7.6%	96.9%	79.8%	79.8%	3.1%	20.2%	20.2%
PM1	2:00 PM - 3:00 PM	72.8%	17.1%	3.3%	6.7%	96.7%	79.6%	79.6%	3.3%	20.4%	20.4%
PM2	3:00 PM - 4:00 PM	71.2%	18.5%	3.9%	6.4%	96.1%	77.6%	96.1%	3.9%	22.4%	3.9%
PM3	4:00 PM - 5:00 PM	72.2%	18.6%	4.0%	5.2%	96.0%	77.4%	96.0%	4.0%	22.6%	4.0%
PM4	5:00 PM - 6:00 PM	72.9%	18.8%	4.0%	4.3%	96.0%	77.2%	96.0%	4.0%	22.8%	4.0%
PM5	6:00 PM - 7:00 PM	74.9%	17.3%	3.3%	4.5%	96.7%	79.4%	96.7%	3.3%	20.6%	3.3%
PM6	7:00 PM - 8:00 PM	75.3%	17.2%	2.9%	4.5%	97.1%	79.9%	97.1%	2.9%	20.1%	2.9%

2018 Option 4

		Modal Split Trip Tables				Share of Potential Tolled Trips			Share of Potential Toll Free Trips		
		SOV	HOV2	HOV3	Trucks	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios
AM1	5:00 AM - 6:00 AM	68.6%	19.0%	3.9%	8.5%	96.1%	77.0%	96.1%	3.9%	23.0%	3.9%
AM2	6:00 AM - 7:00 AM	68.5%	19.1%	4.5%	7.9%	95.5%	76.4%	95.5%	4.5%	23.6%	4.5%
AM3	7:00 AM - 8:00 AM	65.7%	21.3%	5.1%	7.8%	94.9%	73.5%	94.9%	5.1%	26.5%	5.1%
AM4	8:00 AM - 9:00 AM	66.1%	19.8%	4.8%	9.4%	95.2%	75.5%	95.2%	4.8%	24.5%	4.8%
AM5	9:00 AM - 10:00 AM	68.7%	17.5%	4.6%	9.1%	95.4%	77.9%	77.9%	4.6%	22.1%	22.1%
AM6	10:00 AM - 11:00 AM	69.4%	16.7%	4.6%	9.4%	95.4%	78.7%	78.7%	4.6%	21.3%	21.3%
MD1	11:00 AM - 12:00 PM	69.8%	16.9%	4.5%	8.8%	95.5%	78.6%	78.6%	4.5%	21.4%	21.4%
MD2	12:00 PM - 1:00 PM	70.2%	17.2%	4.4%	8.2%	95.6%	78.4%	78.4%	4.4%	21.6%	21.6%
MD3	1:00 PM - 2:00 PM	70.7%	17.4%	4.3%	7.6%	95.7%	78.2%	78.2%	4.3%	21.8%	21.8%
PM1	2:00 PM - 3:00 PM	71.2%	17.4%	4.6%	6.8%	95.4%	78.0%	78.0%	4.6%	22.0%	22.0%
PM2	3:00 PM - 4:00 PM	70.0%	18.5%	5.0%	6.5%	95.0%	76.5%	95.0%	5.0%	23.5%	5.0%
PM3	4:00 PM - 5:00 PM	70.7%	18.8%	5.2%	5.3%	94.8%	76.0%	94.8%	5.2%	24.0%	5.2%
PM4	5:00 PM - 6:00 PM	71.6%	18.9%	5.2%	4.3%	94.8%	75.9%	94.8%	5.2%	24.1%	5.2%
PM5	6:00 PM - 7:00 PM	73.8%	17.5%	4.3%	4.4%	95.7%	78.2%	95.7%	4.3%	21.8%	4.3%
PM6	7:00 PM - 8:00 PM	74.3%	17.3%	4.0%	4.5%	96.0%	78.8%	96.0%	4.0%	21.2%	4.0%

2030 Option 4

		Modal Split Trip Tables				Share of Potential Tolled Trips			Share of Potential Toll Free Trips		
		SOV	HOV2	HOV3	Trucks	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios	HOV3+Free Scenarios	HOV2+Free Scenarios	HOV3+Free Peak HOV2+Free Off-Peak Scenarios
AM1	5:00 AM - 6:00 AM	69.7%	17.2%	4.8%	8.4%	95.2%	78.1%	95.2%	4.8%	21.9%	4.8%
AM2	6:00 AM - 7:00 AM	72.5%	14.1%	5.4%	8.0%	94.6%	80.5%	94.6%	5.4%	19.5%	5.4%
AM3	7:00 AM - 8:00 AM	68.8%	16.6%	7.7%	6.9%	92.3%	75.7%	92.3%	7.7%	24.3%	7.7%
AM4	8:00 AM - 9:00 AM	67.9%	16.9%	6.2%	9.1%	93.8%	77.0%	93.8%	6.2%	23.0%	6.2%
AM5	9:00 AM - 10:00 AM	71.0%	14.4%	5.7%	8.9%	94.3%	79.9%	79.9%	5.7%	20.1%	20.1%
AM6	10:00 AM - 11:00 AM	71.5%	13.6%	5.7%	9.3%	94.3%	80.7%	80.7%	5.7%	19.3%	19.3%
MD1	11:00 AM - 12:00 PM	72.0%	13.6%	5.7%	8.7%	94.3%	80.7%	80.7%	5.7%	19.3%	19.3%
MD2	12:00 PM - 1:00 PM	72.8%	13.4%	5.7%	8.0%	94.3%	80.8%	80.8%	5.7%	19.2%	19.2%
MD3	1:00 PM - 2:00 PM	73.6%	13.3%	5.7%	7.4%	94.3%	81.0%	81.0%	5.7%	19.0%	19.0%
PM1	2:00 PM - 3:00 PM	74.1%	13.2%	6.2%	6.5%	93.8%	80.6%	80.6%	6.2%	19.4%	19.4%
PM2	3:00 PM - 4:00 PM	69.9%	16.5%	6.9%	6.7%	93.1%	76.6%	93.1%	6.9%	23.4%	6.9%
PM3	4:00 PM - 5:00 PM	70.3%	16.6%	7.7%	5.4%	92.3%	75.7%	92.3%	7.7%	24.3%	7.7%
PM4	5:00 PM - 6:00 PM	70.0%	17.8%	7.7%	4.4%	92.3%	74.5%	92.3%	7.7%	25.5%	7.7%
PM5	6:00 PM - 7:00 PM	73.4%	16.9%	5.2%	4.5%	94.8%	77.9%	94.8%	5.2%	22.1%	5.2%
PM6	7:00 PM - 8:00 PM	74.0%	16.8%	4.8%	4.4%	95.2%	78.4%	95.2%	4.8%	21.6%	4.8%

Note: HOV3+Free Peak and HOV2+Free Off-Peak Scenarios are assuming an HOV2+Free requirement during the non-peak period from 10:00 am through 3:00 pm.

It should be noted that the proportion of HOV2 and HOV3+ vehicles are based on data obtained from model forecasts. The real amount of traffic in these vehicle categories might vary due to future changes in transportation policies to increase the amount of carpooling, to decrease vehicle miles travelled, or for other reasons. A significant change in these assumptions could result in a significant change in revenue estimates. It could also reduce the ability to manage demand in the express toll lanes, as toll-free traffic do not react to toll increases.

Capacity Assumptions

In order to keep the express toll lanes free-flowing, the demand using the facility has to be limited by charging appropriate toll rates. The capacity assumptions used to determine the necessary toll charges are dependent on the specific configuration of the express toll lanes, and the location and type of ingress and egress points.

When determining the toll charges, the available capacity for toll-free and tolled traffic is not only determined by the number of toll lanes and the corresponding capacity threshold (1,600 vehicles per hour on single lane sections and 3,200 vehicles per hour on two-lane sections), but also by the ratio of traffic exiting, entering and passing through, at the ingress and egress points.

It was assumed that the connecting ramps provide a capacity threshold of up to 1,600 vehicles per hour. If the upstream volume is close to the capacity threshold and the number of exiting vehicles exceeds the number of entering vehicles, the downstream volumes will have to be below the available capacity threshold. On sections with a single express toll lane, the volume continuing through the ingress/egress locations would have to be the capacity threshold on the adjacent sections of the toll lanes minus the balance of entering and exiting traffic.

This may result in sections of the express toll lanes where the volumes are actually below the allowable capacity thresholds due to imbalanced entering and exiting volumes.

Due to the length of the project corridor, the traffic passing through one tolling zone will be influenced by tolls in other tolling zones. Also, a change in tolls in one tolling zone will have impacts on the usage of various segments upstream and/or downstream.

This complex set of interactions required several iterations to determine optimal toll rates meeting the goal of optimizing the usage of the express toll lanes. This process was performed for each tolling zone and direction, modeling time period, forecast horizon and operational scenario. In total, 900 toll rates were determined for each tested scenario.

Ramp-Up Factors

Revenues were prepared over the projection period extending from 2014 to 2030. Annual revenue forecasts were developed for each option and adjusted in the early years to reflect the “ramp-up” phenomena usually experienced on most new toll facilities. The process of estimating ramp-up factors is explained in this section.

Typically the travel demand model results do not reflect the fact that new managed lanes facilities do not operate at full demand during the first years of operation. The lower than usual usage during this period (ramp-up) is caused by a variety of factors related to managed lanes:

- Users are slowly getting used to the facility and it takes time to overcome user skepticism
- Some users in certain scenarios need to get a transponder or register a plat and intense marketing is required to increase the number of new customers
- It takes time for users to understand the limited access facility design and the toll operation regulations, and to become aware of the potential time savings
- The operation of the facility might undergo certain adjustments during the first years of operation that might affect usage and revenue

In order to reflect these differences between the model estimates and actual conditions during the first few years of operation, the traffic and revenue estimates are usually reduced by applying the so-called "ramp-up factors" on an annual basis.

To get a better understanding of these ramp-up phases and help determine what factors to use, CDM Smith was tasked to review existing facilities and provide a summary of observed ramp-up impacts. The following paragraphs discuss the characteristics of the facilities used in the analysis and the rationale for the ramp-up factors ultimately applied to the traffic and revenue forecast.

Facilities Reviewed

The facilities reviewed in the ramp-up analysis include six managed lane toll facilities in the United States. Each of the facilities had been in operation for at least three years at the time of the study. Transaction data was either publicly available or permission was obtained from the operating toll authority for use in this report.

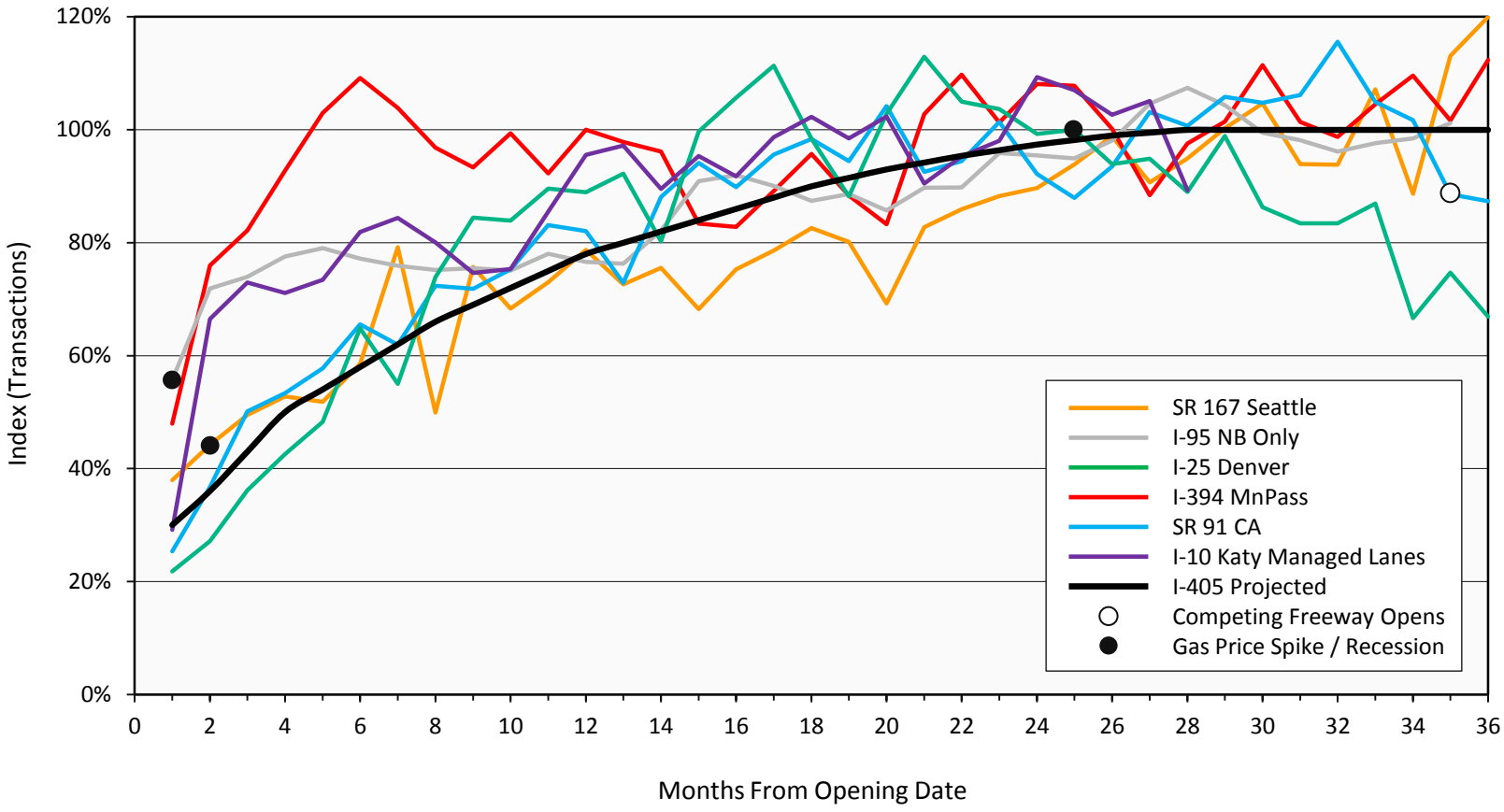
Table 3-2 presents a comparison of the general facility characteristics.

Table 3-2 – Comparison of Existing Managed Lane Facilities Characteristics

Roadway	Urban Area	Distance (mi)	Lanes ML	Lanes GP	Total Corridor Demand (000's)	Manner of Toll Collection	Tolling Policy
I-10 Katy Freeway Managed Lanes	Houston, TX	12	4	10	245 - 277	Transponder Only	HOV2+ free peak period
I-25 HOV Express Lanes(1)	Denver, CO	7	2	8	224 - 235	Transponder/Video	HOV2+ free
I-95 Express Lanes	Miami, FL	6	2	8	260 - 295	Transponder Only	HOV3+ free, Registered
I-394 MnPass Express Lanes(1)	Minneapolis, MN	11	1/2	4	154 - 165	Transponder Only	HOV2+ free
SR 91 Express Lanes	Orange County, CA	10	4	8	250 - 260	Transponder Only	HOV3+ free, discount in PM
SR 167 HOT Lanes	Seattle/Tacoma, WA	9	2	4	114 - 117	Transponder Only	HOV2+ free

(1) Indicates reversible facility

I-10 Katy Freeway Managed Lanes, located in Houston Texas, consist of two managed lanes in each direction in the middle of ten general purpose lanes (five in each direction). The twelve-mile facility opened in April of 2009, replacing a single reversible high occupancy vehicle (HOV) lane. High occupancy vehicles travel in the lanes for free during peak periods, and transit vehicles travel for free at all times. During peak periods, vehicles are distributed to one of the two lanes based on occupancy. The Katy Managed Lanes are tolled based on time-of-day pricing and require an EZ TAG or other interoperable Texas toll payment tag.



CDM Smith

OBSERVED RAMP UP - TRANSACTIONS

FIGURE 3-2

I-25 HOV Express Lanes extend seven miles from downtown Denver to US36, and consist of one lane in each direction in the middle of eight general-purpose lanes. The lanes operate under a HOV2+ free condition, tolling single occupancy vehicles for the use of excess HOV lane capacity. The I-25 HOV Express Lanes opened in June 2006. Transponders were the only payment method until January 2009 when video tolling was introduced.

I-95 Express Lanes in Miami-Dade and Broward County in Southeast Florida opened as a two-lane all-electronic toll (AET) facility in February 2008 (northbound only). The southbound lanes (2) opened in the summer of 2008. The Express Lanes were introduced as a solution to existing HOV lanes which no longer provided reliable level of service for HOVs and transit buses. The project also included re-striping the existing general purpose lanes and shoulders to accommodate one extra lane of non-tolled capacity. The I-95 Express Lanes operate under an HOV3+ free tolling policy. Dynamic pricing is employed on the lanes with roadway monitors continuously reporting conditions (in the express lanes only) and adjusting the toll rates accordingly. Ramp metering has also been introduced in the corridor since the opening of the Express Lanes.

I-394 MnPass Express Lane was developed and completed through a public/private partnership and opened for use by motorists in May 2005. The I-394 MnPass Express Lane is a single reversible lane opened to HOVs and toll paying SOVs in the peak travel direction only and during peak travel periods only. It is an AET facility requiring a MnPass transponder for SOVs. Toll rates are determined using dynamic pricing based on traffic conditions in the Express lane.

SR 91 Express Lanes in Orange County, CA opened in 1995 as the first fully automated tollway in the world. Set within the median of the Riverside Freeway, the ten mile long Express lanes consist of two primary HOT lanes along with one 3+ only carpool lane (designated for HOV3+ and motorcycles only) in each direction. The lanes are tolled using an open road tolling system requiring a FasTrak transponder for use. A pre-set time of day pricing schedule is in place.

SR 167 HOT Lanes, in South King County, consist of one HOT lane in each direction and opened to toll paying SOV traffic in May 2008 as a pilot project. The SR 167 HOT Lanes operate under an HOV2+ free policy and requires a transponder for use by SOV traffic. The SR 167 HOT Lanes are dynamically priced based on traffic conditions with the option for "HOV Only" when the lanes become too congested.

Ramp-Up in Transactions

Figure 3-2 presents the observed ramp-up in transactions on the six managed lane facilities used in the analysis. The figure also shows the ramp-up factors applied to the proposed I-405 / SR 167 Express Toll Lanes traffic and revenue forecast.

Due to significant fluctuations in the rate of increase in transactions, an exact date marking the transition from ramp-up to normal long-term growth is not always clearly identifiable. Thus a level of professional judgment was employed when determining the one-hundred percent benchmark for each facility represented in Figure 3-2. It should also be noted that in the absence of substantial toll rate changes, observed ramp-up in toll revenue mirrored transactions closely.

Established transponder penetration rates and motorists generally high level of exposure to toll facilities contribute greatly to the rate of growth in the initial months of operation. The I-10 Katy Freeway Managed Lanes and the I-95 Express Lanes are two examples of this. Both Houston, TX and Miami, FL had established networks of toll roads prior to the opening dates and subsequently experienced an unusually rapid rate of ramp-up in the initial two months of operation. After the initial spike, both facilities settled into a growth pattern similar to the other four represented in the figure. When accounted for on an annual basis, the difference in the ramp-up factors caused by this initial spike is minimal. The I-25 HOV Express Lanes, SR 91 Express Lanes and SR 167 HOT Lanes experienced a slower ramp-up common to startup toll facilities. Despite these differences, each facility completed ramp-up by, or shortly after twenty-four months of operation.

It is important to note the timing of the start of the 2008 recession and gas price spike relative to the opening date of the toll facilities. The I-95 Express Lanes and SR 167 HOT Lanes opened just prior to these adverse events. While it doesn't appear to have negatively impacted ramp-up in the initial months of operation, it is clear that growth rates for both flattened out between six and eighteen months after opening. This sluggishness is indicative of reduced demand for the express lanes and is borne out in a reduction in overall corridor demand during that timeframe.

The I-394 MnPass Express Lanes experienced a unique ramp-up profile achieving full utilization within six months. It should be noted that MnPass had to increase the minimum toll after six months of operation to manage excess demand for lanes. It is reasonable to assume that ramp-up was completed so rapidly due to the unduly low minimum toll rate as usage of the lanes was reduced and subsequently stabilized within months of the rate increase.

Even with so many variables, the overarching trend in observed ramp-up serves to develop reasonable ramp-up factors for the I-405 project. The proposed I-405 / SR 167 Express Toll Lanes are similar to the I-95 Express lanes and I-10 Katy Managed lanes in that they will likely benefit from established transponder penetration rates and motorists generally high level of exposure to toll facilities. While these similarities could lead to a similar spike in transactions during the initial months of operation, the subsequent sluggishness in performance experienced by these facilities and the ongoing economic difficulty are reasons to remain conservative when determining ramp-up factors for the I-405 / SR 167 Express Toll Lanes forecast. This in combination with the minimal difference this initial spike causes in annualized ramp-up factors lead to the development of the projected ramp-up factors for the proposed I-405 / SR 167 Express Toll Lanes represented by the black line in Figure 3-2. This line translates to annualized ramp-up factors of 57.8 percent, 89.8 percent and 99.7 percent to be applied to years one, two and three, respectively.

Value of Time

The value of time assumptions used in the previous traffic and revenue study were based on a stated preference (SP) survey from 2006. A new SP survey for the I-405 / SR 167 corridor was conducted in 2011.[2] The new SP survey results were reviewed to evaluate the need to adjust the value of time parameters. Table 3-3 shows a comparison of the 2006 and 2011 value of time results (in 2006 dollars). The median income of the survey respondents is about 30% higher in the new survey. The

[2] Washington State I-405/SR 167 Travel Study Report, Prepared for Cambridge Systematics, Inc., Resource Systems Group, Inc. (RSG), December 2011

revised aggregate value of time is about 22 percent higher than the 2006 survey value and the consumer price index for the same time period increased by about 12%.

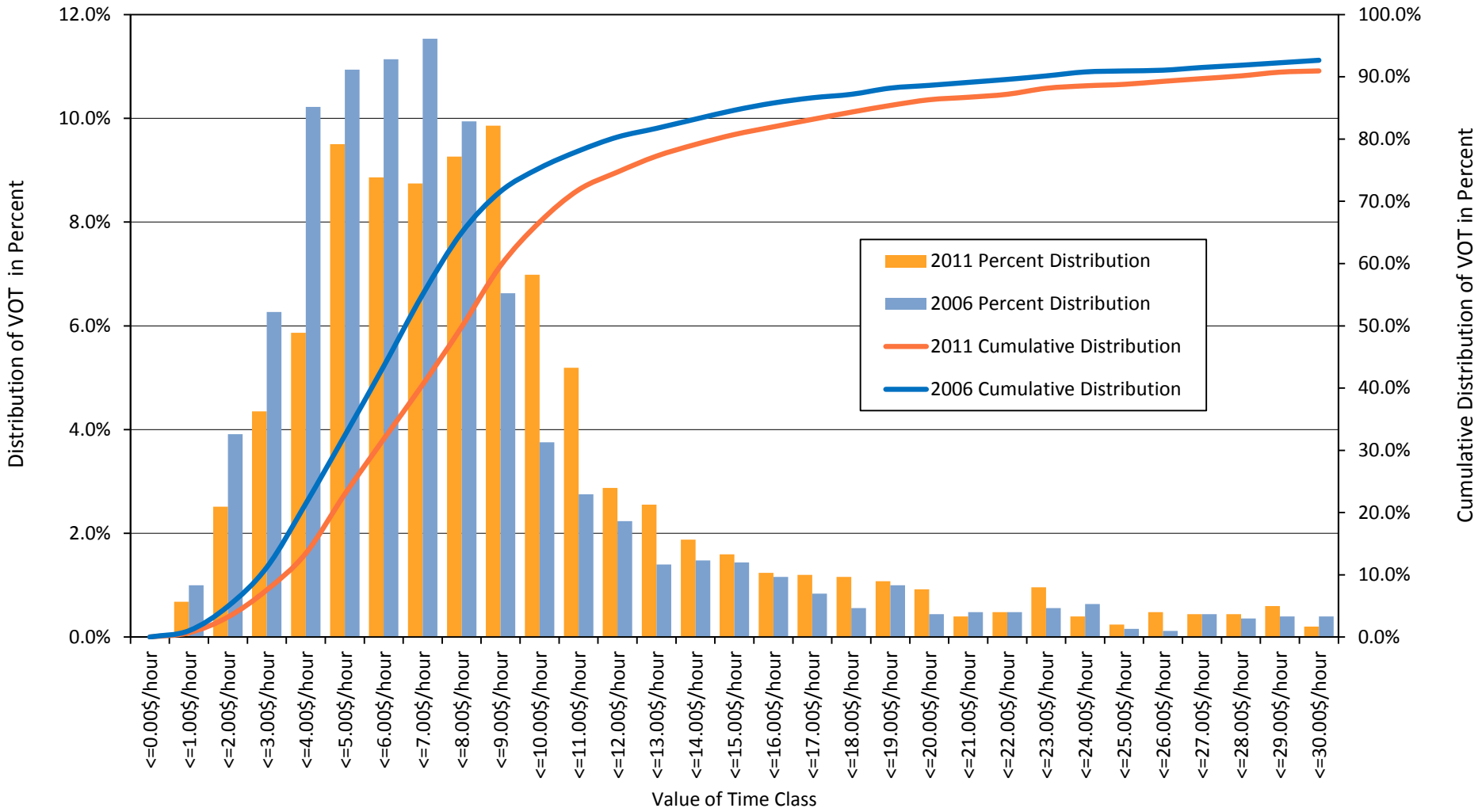
The new value of time estimates derived from the 2011 survey were used to normalize the detailed 2006 survey data based on income and value of time data. Figure 3-3 shows a comparison of the frequency distribution and the cumulative frequency distribution of the values of time based on the 2006 and the 2011 stated preference surveys.

The 2011 survey was conducted for the entire I-405 / SR 167 corridor whereas the 2006 survey was limited to the I-405 North section only. The new survey data showed a significant dependency of the value of time on distance travelled. For shorter distances, the value of time would be reduced whereas longer trips were showing an increase in value of time. Therefore a distance dependent adjustment of the base value of time per travel purpose and time period was applied to reflect this dependency as shown in Figure 3-4. The value of time was also scaled with the current income data for the corridor to adjust the values based on the relationship between the survey sample income data and the corridor income data. As a result, a zone-to-zone value of time matrix dependent on travel distance was developed for each travel purpose and time horizon.

Table 3-3
Comparison of SP Survey Results

	2006 Survey	2011 Survey	Percent Change	AAPC
Median Income	$67,500	$87,500	+29.6%	5.33%
Median VOT				
(Dollars/Hour)	$9.65	$11.74	+21.7%	4.00%
(Dollars/Minute)	$0.161	$0.196		
CPI Index	207.6	232.8	+12.1%	2.31%

Note:
Values are shown in 2006 Dollars. AAPC is the calculated average annual percent change.

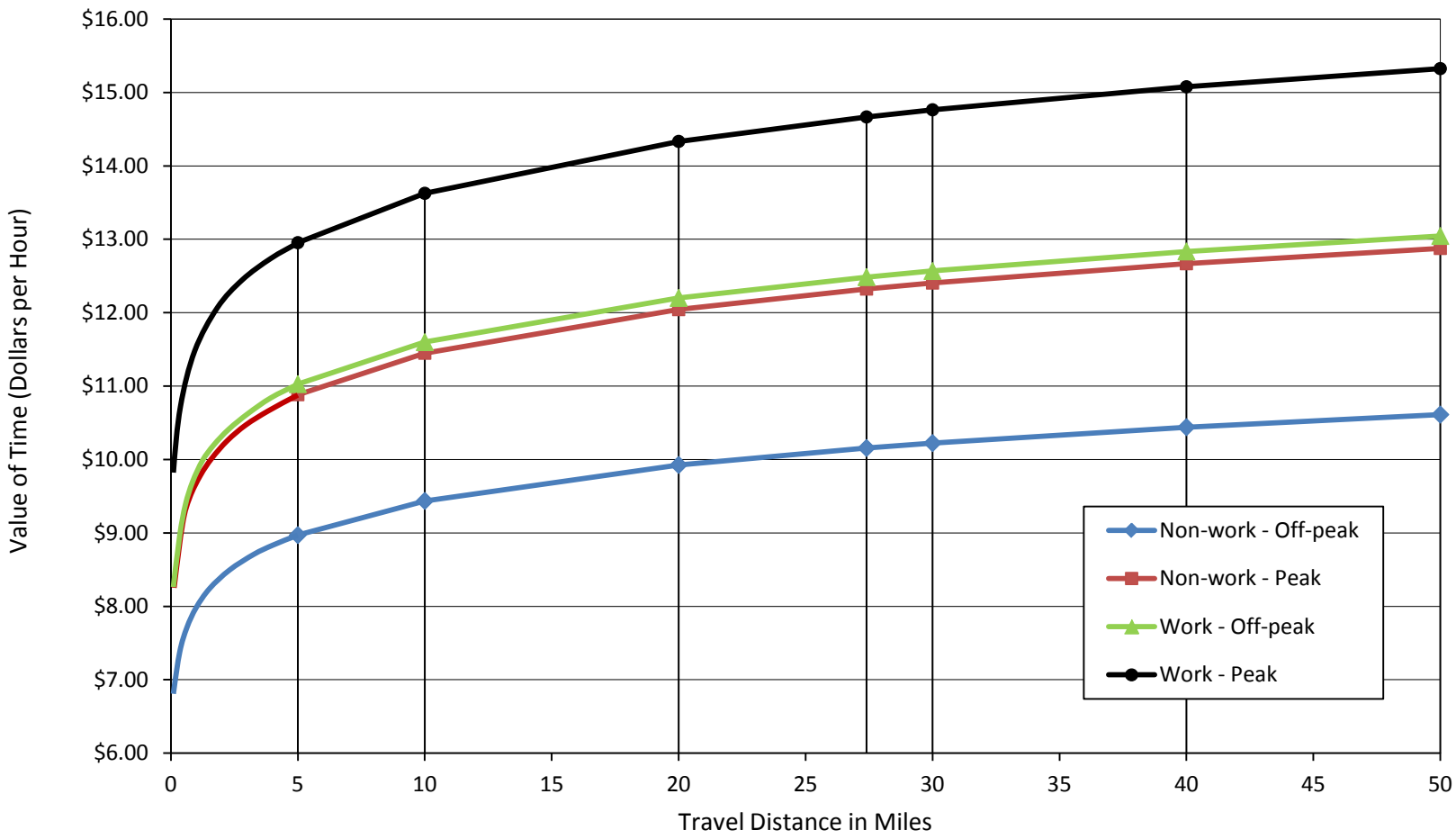


Note: The 2011 values were derived by normalizing the 2006 data to 2011 levels based on 2011 survey data.

DISTRIBUTION OF VALUE OF TIME FROM STATED PREFERENCE SURVEY ANSWERS

CDM Smith

FIGURE 3-3



VALUE OF TIME VERSUS TRAVEL DISTANCE FOR SINGLE OCCUPANT VEHICLES

FIGURE 3-4

Chapter 4

Estimated Traffic and Revenue

Basic Assumptions

Estimates of traffic and revenue for the proposed I-405 / SR 167 Express Toll Lane alternatives included in this report are based on a number of basic assumptions, all of which are considered reasonable for purposes of this analysis:

1. The project configurations, vehicle restrictions, proposed access locations and toll rates will be consistent with what is described in this report and tolls will be set to optimize throughput in the Express Toll Lanes

2. Heavy trucks will be prohibited from using the Express Toll Lanes under all alternatives

3. Tolls would be collected by means of electronic toll collection, using the existing *Good To Go!* transponder technology. No cash collection would be provided. Electronic tolls would be assessed based on the number of tolling zones that a vehicle passes through, with a minimum toll of at least $0.71 per facility (I-405 North, I-405 South, SR 167) in 2012 dollars

4. In scenarios where photo-billing is assumed to be available, users can also use the Express Toll Lanes without a transponder and pay the tolls either via Pay By Plate or Pay By Mail with the surcharges as described in Chapter 2. This toll collection concept is identical to the one currently applied to the SR 520 Bridge Toll and is the preferred toll collection concept for the I-405 / SR 167 Express Toll Lanes. Customers who wish to take advantage of a high-occupancy discount or exemption must have a transponder

5. The toll charged per tolling zone is independent from the actual distance travelled, within this tolling zone, and will be set to meet the tolling concepts, as described above

6. Electronic toll operations are assumed to be actively monitored and strictly enforced to minimize potential revenue loss due to toll evasion. No adjustments for toll evasion have been made to toll revenue estimates included in this report, and it is assumed that losses due to evasion are compensated by fines and charges for violations

7. Estimates of annual toll revenue included in this report have been adjusted to reflect "ramp-up" during the first three years of operation with the factors previously described in this chapter

8. An annual inflation rate of 2.5 percent from a base of 2012 was assumed to inflate minimum toll rates and toll caps, if applicable, to future-year levels

9. It was assumed that transportation improvements included in the PSRC model networks would be implemented. No other competing routes, or capacity improvements other than the study option improvements, described in this report, would be implemented, within the

forecast period. No additional general-purpose lane capacity would be provided along the Express Toll Lane corridor

10. Economic growth in the study corridor will generally follow the assumed patterns of the socio-economic data in the PSRC model. In addition, no significant departure from the future demand levels provided to CDM Smith for use in the traffic and revenue analysis will occur

11. The proportion of HOV2 and HOV3+ vehicles and transit mode choice will remain consistent with the PSRC forecasts and the data provided by WSDOT

12. Other non-revenue vehicles permitted to use the managed lanes, including various types such as motorcycles, transit buses, etc., will not be a significant portion of the Express Toll Lane traffic

13. The proposed Express Toll Lanes would be well-maintained, efficiently operated and effectively signed and promoted to encourage maximum usage

14. No limiting policy would be in effect to drastically reduce vehicle traffic and/or vehicle usage

15. Motor fuel will remain in adequate supply and increases in price will not substantially exceed the overall rate of inflation over the long term

16. No local, regional or national emergency will arise which would abnormally restrict the use of motor vehicles

Any significant departure from these basic assumptions could impact estimated traffic and toll revenue for the proposed Express Toll Lane facility; and such impacts could be significant.

Traffic and Revenue Analysis

This section of the report describes the traffic and revenue analysis. It will discuss the optimum toll rate analysis, estimates of weekday traffic for various future years and estimated annual transactions and revenue.

Optimum Rate Analysis

Managed lanes projects, such as the Express Toll Lanes being contemplated in the I-405 corridor and already in operation on the SR 167 corridor, make use of variable tolls based on traffic congestion levels. Tolls are increased during periods of high congestion while lower tolls are used when demand levels are lower.

The determination of optimum toll rates of a managed lanes facility is considerably different than that of a typical toll facility. Optimum rates for managed lanes can be dictated by three, sometimes conflicting criteria:

- Maximizing toll revenue potential
- Maximizing demand in the managed lanes, yet assuring a congestion free ride

- Optimizing the distribution of traffic between the non-tolled general purpose lanes and the tolled managed lanes

Most times, the objectives of revenue maximization and demand management generally function in concert, although the demand management objective usually controls in the event of a conflict. That is, in some cases it may be necessary to use rates beyond the revenue maximizing point to effectively manage demand in the managed lanes. This is more likely to occur under high congestion conditions, typically later in the forecast period.

However, the objectives of revenue maximization and optimization of demand between free and tolled lanes may well be in conflict. Revenue maximization may occur at one toll rate, but may result in traffic on the tolled managed lanes that is well below the capacity of those lanes. It may be an objective to increase the amount of traffic served by the managed lanes, thereby reducing demand and congestion in the general purpose lanes. This optimum distribution is often attained at toll rates below those which would produce maximum revenue.

For purposes of this study, traffic and revenue estimates have been based on toll rates which meet the second objective, which is, maximizing demand in the Express Toll Lanes while maintaining free-flow conditions in the Express Toll Lanes.

Tolling Concept

Under the tolling concept assumed for the I-405 / SR 167 corridor, a trip passing through a tolling zone, which has multiple entry and exit points, is charged a single, flat toll rate, independent of the actual distance travelled within this zone. Therefore, the per mile toll rates used in the toll sensitivity analysis are being converted into toll charges for each zone by multiplying the per–mile rates times the longest distance covered by each tolling zone. This zone pricing is common on managed lane facilities and tends to increase the share of long-distance trips, due to a relatively higher price for trips using only a short portion of a tolling zone. It was also assumed that any trip would have to pay a minimum toll, from $0.75 in 2014, $0.83 in 2018 to $1.11 in 2030 (Table 4-1) for vehicles equipped with a toll transponder. Other payment methods require an additional surcharge as described in Chapter 2. This minimum toll is intended to cover operating costs and to discourage short distance trips, which could potentially create operational issues by weaving in and out of the Express Toll Lanes, and therefore reduce the throughput in the corridor. The toll limits were assumed to be inflated by 2.5 % from 2012 on.

Rate Sensitivity Analysis

A wide range of typical toll rates were tested for each tolling zone and each analysis period, in each travel direction, for both operational scenarios. As noted previously, there were fifteen analysis periods used in the study, generally extending from 5:00 AM to 8:00 PM. Separate traffic assignments were run, at up to 27 different toll rates, for each of these analysis periods. Toll sensitivity curves were produced for each alternative, for each tolling zone, for each analysis period, for each analysis year, for the full range of rates. An illustrative example of the toll sensitivity results for the Base Case in 2018, PM2 Shoulder Hour (3:00 –4:00 pm), Tolling Zone G, southbound is shown on the left side of Figure 4-1. The sample on the right hand side represents the corresponding sensitivity curve for the same tolling zone for the HOV2+Free Scenario. In the example for the Base Case, the optimum toll rate was determined to be $0.45 per mile which is to the left of the revenue optimal point ($2.00 per mile), but

Table 4-1
Comparison of Toll Free Requirements and Minimum Toll Requirements

2014 Phase 1

Scenario	Toll Free Designation			Minimum Toll Charge Transponder				Pay-By-Plate Increment				Photo Billing Increment				HOV Discount			
	5:00 AM - 10:00 AM	10:00 AM - 3:00 PM	3:00 PM - 8:00 PM	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip
Base Case - HOV3+Free Photo Billing	HOV3+Free	HOV3+Free	HOV3+Free	$0.75	---	$0.75	$1.50	$0.26	---	$0.26	$0.52	$1.58	---	$1.58	$3.16	---	---	---	---
HOV2+Free Photo Billing	HOV2+Free	HOV2+Free	HOV2+Free	$0.75	---	$0.75	$1.50	$0.26	---	$0.26	$0.52	$1.58	---	$1.58	$3.16	---	---	---	---
HOV3+Free Peak and HOV2+Free Off-Peak Photo Billing	HOV3+Free	HOV2+Free	HOV3+Free	$0.75	---	$0.75	$1.50	$0.26	---	$0.26	$0.52	$1.58	---	$1.58	$3.16	---	---	---	---
HOV Discount Photo Billing	All Pay (1)	All Pay (1)	All Pay (1)	$0.75	---	$0.75	$1.50	$0.26	---	$0.26	$0.52	$1.58	---	$1.58	$3.16	$0.50	---	$0.50	$1.00

2018 Phase 1

Scenario	Toll Free Designation			Minimum Toll Charge Transponder				Pay-By-Plate Increment				Photo Billing Increment				HOV Discount			
	5:00 AM - 10:00 AM	10:00 AM - 3:00 PM	3:00 PM - 8:00 PM	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip
Base Case - HOV3+Free Photo Billing	HOV3+Free	HOV3+Free	HOV3+Free	$0.83	---	$0.83	$1.66	$0.29	---	$0.29	$0.58	$1.74	---	$1.74	$3.48	---	---	---	---
HOV2+Free Photo Billing	HOV2+Free	HOV2+Free	HOV2+Free	$0.83	---	$0.83	$1.66	$0.29	---	$0.29	$0.58	$1.74	---	$1.74	$3.48	---	---	---	---
HOV3+Free Peak and HOV2+Free Off-Peak Photo Billing	HOV3+Free	HOV2+Free	HOV3+Free	$0.83	---	$0.83	$1.66	$0.29	---	$0.29	$0.58	$1.74	---	$1.74	$3.48	---	---	---	---
HOV Discount Photo Billing	All Pay (1)	All Pay (1)	All Pay (1)	$0.83	---	$0.83	$1.66	$0.29	---	$0.29	$0.58	$1.74	---	$1.74	$3.48	$0.55	---	$0.55	$1.10

2018 Option 4

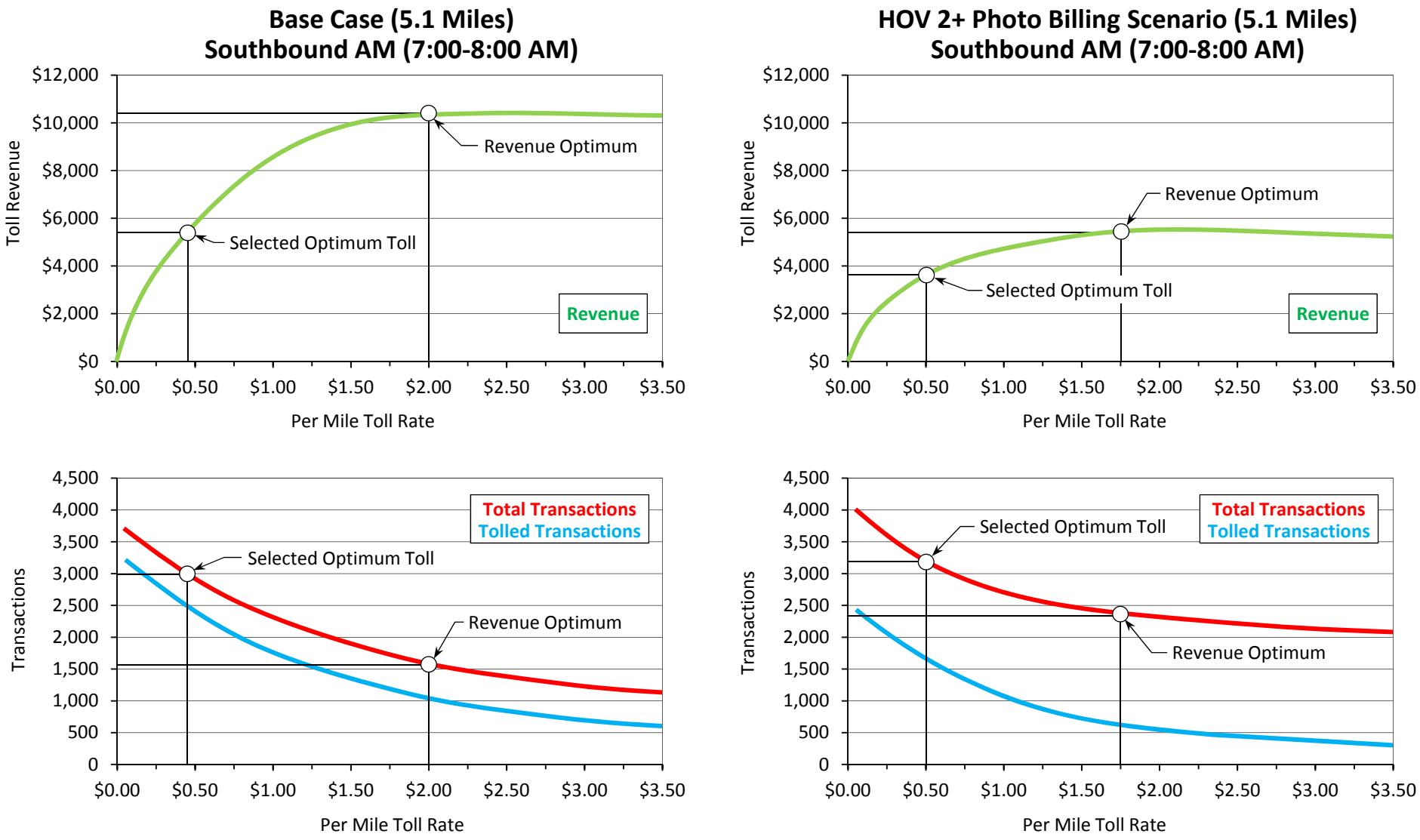
Scenario	Toll Free Designation			Minimum Toll Charge Transponder				Pay-By-Plate Increment				Photo Billing Increment				HOV Discount			
	5:00 AM - 10:00 AM	10:00 AM - 3:00 PM	3:00 PM - 8:00 PM	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip
Base Case - HOV3+Free Photo Billing	HOV3+Free	HOV3+Free	HOV3+Free	$0.83	$0.83	$0.83	$2.49	$0.29	$0.29	$0.29	$0.87	$1.74	$1.74	$1.74	$5.22	---	---	---	---
HOV2+Free Photo Billing	HOV2+Free	HOV2+Free	HOV2+Free	$0.83	$0.83	$0.83	$2.49	$0.29	$0.29	$0.29	$0.87	$1.74	$1.74	$1.74	$5.22	---	---	---	---
HOV3+Free Peak and HOV2+Free Off-Peak Photo Billing	HOV3+Free	HOV2+Free	HOV3+Free	$0.83	$0.83	$0.83	$2.49	$0.29	$0.29	$0.29	$0.87	$1.74	$1.74	$1.74	$5.22	---	---	---	---
HOV Discount Photo Billing	All Pay (1)	All Pay (1)	All Pay (1)	$0.83	$0.83	$0.83	$2.49	$0.29	$0.29	$0.29	$0.87	$1.74	$1.74	$1.74	$5.22	$0.55	$0.55	$0.55	$1.65

2030 Option 4

Scenario	Toll Free Designation			Minimum Toll Charge Transponder				Pay-By-Plate Increment				Photo Billing Increment				HOV Discount			
	5:00 AM - 10:00 AM	10:00 AM - 3:00 PM	3:00 PM - 8:00 PM	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip	SR 167	I-405 South	I-405 North	Through Trip
Base Case - HOV3+Free Photo Billing	HOV3+Free	HOV3+Free	HOV3+Free	$1.11	$1.11	$1.11	$3.33	$0.39	$0.39	$0.39	$1.17	$2.35	$2.35	$2.35	$7.05	---	---	---	---
HOV2+Free Photo Billing	HOV2+Free	HOV2+Free	HOV2+Free	$1.11	$1.11	$1.11	$3.33	$0.39	$0.39	$0.39	$1.17	$2.35	$2.35	$2.35	$7.05	---	---	---	---
HOV3+Free Peak and HOV2+Free Off-Peak Photo Billing	HOV3+Free	HOV2+Free	HOV3+Free	$1.11	$1.11	$1.11	$3.33	$0.39	$0.39	$0.39	$1.17	$2.35	$2.35	$2.35	$7.05	---	---	---	---
HOV Discount Photo Billing	All Pay (1)	All Pay (1)	All Pay (1)	$1.11	$1.11	$1.11	$3.33	$0.39	$0.39	$0.39	$1.17	$2.35	$2.35	$2.35	$7.05	$0.75	$0.75	$0.75	$2.25

Note: (1) HOV2 and HOV3+ vehicles receive a discount of $0.50 in 2014, $0.55 in 2018 and $0.75 in 2030 on each facility (SR167, I-405North, I-405 South).
If the regular toll rate does not exceed the applicable discounts, HOV2 and HOV3+ vehicles will travel free of charge.

All toll rates are shown in current year (Future year) Dollars and are inflatedwith 2.5 percent per year.



TOLLING ZONE G - SOUTHBOUND
2030 AM SHOULDER HOUR WEEKDAY TOLL RATE SENSITIVITY CURVES

CDM Smith

FIGURE 4-1

the rate of $0.45 was determined as the rate to keep the traffic below the capacity threshold. Only HOV3+ vehicles are toll exempt and are not reacting to pricing. The example on the right for the HOV2+Free Scenario with Photo Billing indicates that the amount of toll-free traffic is almost half of the total traffic (much higher than the base case) and therefore the market segment that is subject to pricing is significantly smaller than in the Base Case. This results in a significantly lower amount of toll revenue at the selected optimum toll of $0.50 per mile.

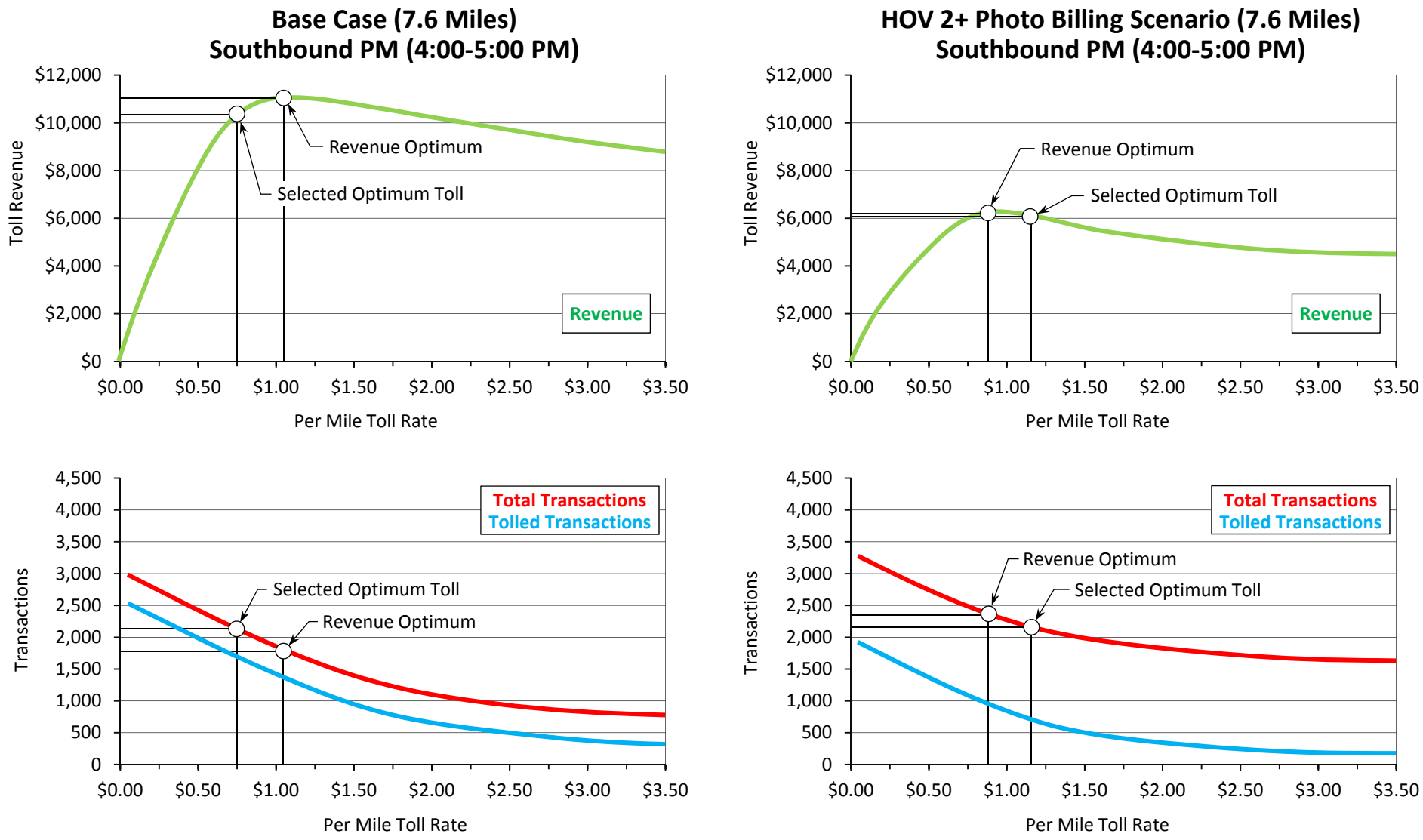
Another comparison of toll sensitivity curves is shown in Figure 4-2 for tolling Zone I in the southbound direction for the PM2 shoulder period. Due to the relatively high share of toll-free traffic at this single lane section, the toll rate to manage demand under the HOV 2+ free condition during the PM2 time period ($1.15 per mile) is significantly higher than in the Base Case ($0.75 per mile) since the available capacity that can be sold to single occupancy vehicles is limited and the amount of traffic reacting to pricing in this scenario is rather small in comparison to the total ETL demand. The resulting revenue for this time slice in the Base Case is significantly higher than the revenue from the HOV2+Free Scenario. In the Base Case a large amount of vehicles (SOV and HOV2) pay a smaller per-mile toll rate whereas in the HOV2+Free Scenario a limited number of vehicles (SOVs) pay a significantly higher per-mile toll rate due to the requirement to manage demand. At this point the rate to manage demand falls beyond the revenue optimal point on the downside of revenue curve.

Depending on the demand, directional split and traffic patterns as well as the assumptions in regard to toll-free traffic, the toll rates will vary significantly and might have to be raised beyond even the revenue optimal points to manage the demand in the various toll zones as well as at the ingress and egress locations. The capacity thresholds used to determine the toll rates were described in Chapter 3.

Traffic and Revenue Results

Detailed tables showing the results of the traffic and revenue analysis for the Base Case are shown in Appendix A. The tables contain the following information:

- Per-mile toll rates for each tolling zone (Appendix Tables 1-1, 2-1);
- Zone-to-zone toll rate matrices showing toll charges by period (Appendix Tables 1-2-1 through 1-2-15 and Tables 2-2-1 through 2-2-15);
- Transaction and revenue data by toll zone and period (Appendix Tables 1-3-1 through 1-6-2, Tables 2-3-1 through 2-6-2);
- Total transaction and Revenue estimates by period (Appendix Tables 1-7 through 1-10 and Tables 2-7 through 2-10);
- Annual revenue streams (Appendix Tables 3-1 through 3-4);
- Ramp-up estimation per facility (Appendix Table 4); and
- Figures with traffic volumes per period on the Express Toll Lanes (Appendix Figures 1-1 through 4-3).



TOLLING ZONE I - SOUTHBOUND
2030 PM SHOULDER HOUR WEEKDAY TOLL RATE SENSITIVITY CURVES

CDM Smith

FIGURE 4-2

Per-mile rates, toll charges per tolling zone and revenue estimates shown in this report are expressed in current dollars[1].

Appendices B through D contain similar information with identical table numbering for the performed sensitivity tests assuming

- HOV2+ Free Operation with Transponder and Photo Billing
- Peak HOV3+ Free and Off-Peak HOV2+ Free Operation with Transponder and Photo Billing
- HOV Discount with Transponder and Photo Billing

The additional three scenarios without photo billing operation that were tested to provide comparable results to the study performed on behalf of the Washington State Transportation Commission that assumed ETC (transponder) only toll payment are shown in Appendices E, F and G:

- HOV2+ Free Operation with Transponder-Only Operation
- HOV3+ Free Operation with Transponder-Only Operation
- HOV Discount Assuming Transponder-Only Access to the Express Toll Lanes

Per-Mile Toll Rates

Detailed tables containing the per mile toll rates for each tolling zone, direction, modeling time period, and forecast year are shown in Tables 1-1 and 2-1 for transponder users (Base toll rate), which can be found in the Appendix to this report. Surcharges for certain payment types or discounts for certain market segments are being applied in addition to the transponder toll rates. The pattern of increase in per-mile rates over time does not follow the growth pattern of the demand data. This is typical for any managed lane project and is caused by a more than proportional increase of congestion in the general purpose lanes. This results in a more than proportional increase in time savings when using the Express Toll Lanes and therefore increases the pressure for traffic to buy into the Express Toll Lanes. This effect follows a non-linear relationship. A relatively small growth of demand usually results in a significant increase in toll rates to manage demand. In contrast, a relatively small drop in corridor demand or lower growth estimates can have a significant effect on toll rates and thus toll revenue potential for an express toll lane project. As mentioned before, the per-mile toll rates were determined in an interactive process, where all parts of the express toll lanes had to meet the demand management requirements.

Zone to Zone Toll Rate Matrices

A unique toll charge was calculated for each toll segment for transponder users, based on the per-mile rate multiplied by the corresponding longest distance traveled, in each zone. In each direction, depending on the operational scenario, toll charges for up to nine toll zones per direction were applied in the demand modeling process for the up to three facilities with three tolling zones each. Tables 1-1 through 1-15, in the Appendix, show toll charge matrices for the Base Case for the Option 1 configuration for each time period and the 2014 and 2018 forecast years. Similar tables for Option 4 are shown in Tables 2-1 through 2-15 for 2018 and 2030 modeling horizons. The matrices contain the total toll cost for a trip entering the Express Toll Lane system at a certain toll zone, travelling on the

[1] "current dollars" is the dollar value in the future year of the estimate.

Express Toll Lanes, and exiting at another tolling zone (or the terminus of the system). If the toll charge values are lower than the appropriate minimum toll charge for each facility, the minimum toll charge in each facility would be applied. The toll modeling process and the revenue calculations were done applying the minimum toll charge requirements shown in Chapter 2.

Applicable discounts and surcharges for different payment methods were applied in addition to the transponder toll charges shown in the tables in the Appendix to obtain the resultant Pay By Plate, photo-billing and discount toll rates where applicable.

Traffic and Revenue per Period

Weekday traffic (toll-free, tolled and total values) by direction and aggregated operating periods, is shown in the Appendix Tables 2-7 through 2-10, for each forecast year and aggregated time period. The tables also contain average toll rates, weekday revenue, and annual revenue estimates. The average toll rates are calculated as the ratio between the average weekday revenue and the total average weekday tolled trips. All values are expressed in current dollars.[2] The estimates for annual revenue are based on 250 weekdays per year and 115 weekend days and holidays. It is assumed that the holiday and weekend day revenues represent 2 percent of the weekday revenue. These assumptions are identical to the ones used in previous studies for the I-405 corridor.

Transactions and Revenue by Zone and Period

In the Appendix Tables 1-7 through 1-10 the amount of transactions and the resulting revenue are shown for Option 1 for each demand model forecasting year and Tables 2-7 through 2-10 represent the numbers for the Option 4 configuration, respectively. The estimates were split by direction, forecast horizon, facility and where applicable by payment method and were aggregated into major time-of-day periods as indicated in the tables. A trip passing through a tolling zone will generate a transaction and subsequently, a trip that passes through more than one toll zone will result in two or more transactions. The tables in the appendix contain information on tolled, toll-free and total transactions, as well as gross toll revenue.

Summary of Average Weekday Traffic and Revenue Estimates

A summary with a comparison of average weekday estimates for the Base Case and the sensitivity tests is shown in Table 4-2. Due to the HOV 2+ Free designation of the Express Toll Lanes in the HOV2+Free Scenario, the revenue impact is estimated to be more than 50 percent compared to the Base Case. In the outer years travel demand at some of the peak load points during peak demand situations cannot be managed adequately with reasonable toll rates. The Express Toll Lanes at these locations have to be operated under a HOV only designation.

In the HOV3+Free Peak/HOV2+Free Off-Peak Scenario the higher amount of toll-free traffic volumes in non-peak hours impacts revenue between 6 to 9 percent. As mentioned before, the HOV 2+ free designation in non-peak hours results in a smaller share of traffic responding to pricing and the capacity that is available for tolled vehicles is getting smaller over time due to the increase in HOV2+ vehicles. Together, these two differences require higher tolls to manage the same amount of base traffic and result in higher average tolls per tolled transaction.

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[2] "current dollars" is the dollar value in the future year of the estimate

Table 4-2
Comparison of Average Weekday Traffic and Revenue Estimates

2014 - Option 1

	Average Weekday Revenue Estimates			Average Weekday Transaction Estimates			Traffic Estimates					
	Average Weekday Revenue	Average Toll per Tolled Transaction	Average Toll per Tolled Trip	Total Average Weekday Transactions	Tolled Average Weekday Transactions	Toll Free Average Weekday Transactions	Total Average Weekday Trips	Tolled Average Weekday Trips	Toll Free Average Weekday Trips	Average Number of Transactions per Tolled Trip	Average Number of Transactions per Toll Free Trip	Share of Tolled Trips
Base Case HOV3+Free Photo Billing	$54,789	$0.550	$1.113	121,902	99,690	22,212	63,182	49,241	13,941	2.02	1.59	78%
HOV2+Free Photo Billing	$26,128	$0.560	$1.144	176,398	46,655	129,743	102,754	22,834	79,920	2.04	1.62	22%
(Percent Impact versus Base Case)	-52.3%	+1.9%	+2.8%	+44.7%	-53.2%	+484.1%	+62.6%	-53.6%	+473.3%	+0.9%	+1.9%	-71.5%
HOV3+Free Peak / HOV2+Free Off-Peak Photo Billing	$49,757	$0.568	$1.150	145,585	87,526	58,058	79,654	43,276	36,378	2.02	1.60	54%
(Percent Impact versus Base Case)	-9.2%	+3.4%	+3.3%	+19.4%	-12.2%	+161.4%	+26.1%	-12.1%	+160.9%	-0.1%	+0.2%	-30.3%
HOV Discount and Photo Billing	$46,938	$0.367 (2)	$0.714 (2)	127,735	62,290	65,445 (1)	65,780	29,973	35,807 (1)	2.08	1.83 (1)	46% (3)
(Percent Impact versus Base Case)	-14.3%	-33.1%	-35.9%	+4.8%	-37.5%	+194.6%	+4.1%	-39.1%	+156.8%	+2.7%	+14.7%	-41.5%

2018 - Option 1

	Average Weekday Revenue Estimates			Average Weekday Transaction Estimates			Traffic Estimates					
	Average Weekday Revenue	Average Toll per Tolled Transaction	Average Toll per Tolled Trip	Total Average Weekday Transactions	Tolled Average Weekday Transactions	Toll Free Average Weekday Transactions	Total Average Weekday Trips	Tolled Average Weekday Trips	Toll Free Average Weekday Trips	Average Number of Transactions per Tolled Trip	Average Number of Transactions per Toll Free Trip	Share of Tolled Trips
Base Case HOV3+Free Photo Billing	$83,494	$0.747	$1.506	134,142	111,740	22,402	69,635	55,424	14,211	2.02	1.58	80%
HOV2+Free Photo Billing	$38,950	$0.686	$1.413	189,838	56,813	133,025	111,325	27,560	83,765	2.06	1.59	25%
(Percent Impact versus Base Case)	-53.3%	-8.2%	-6.2%	+41.5%	-49.2%	+493.8%	+59.9%	-50.3%	+489.4%	+2.2%	+0.7%	-68.9%
HOV3+Free Peak / HOV2+Free Off-Peak Photo Billing	$76,839	$0.779	$1.568	156,723	98,642	58,081	86,277	49,002	37,275	2.01	1.56	57%
(Percent Impact versus Base Case)	-8.0%	+4.2%	+4.1%	+16.8%	-11.7%	+159.3%	+23.9%	-11.6%	+162.3%	-0.2%	-1.2%	-28.6%
HOV Discount and Photo Billing	$72,667	$0.517 (2)	$0.998 (2)	140,634	73,797	66,837 (1)	72,782	35,551	37,231 (1)	2.08	1.80 (1)	49% (3)
(Percent Impact versus Base Case)	-13.0%	-30.8%	-33.7%	+4.8%	-34.0%	+198.4%	+4.5%	-35.9%	+162.0%	+3.0%	+13.9%	-38.6%

2018 - Option 4

	Average Weekday Revenue Estimates			Average Weekday Transaction Estimates			Traffic Estimates					
	Average Weekday Revenue	Average Toll per Tolled Transaction	Average Toll per Tolled Trip	Total Average Weekday Transactions	Tolled Average Weekday Transactions	Toll Free Average Weekday Transactions	Total Average Weekday Trips	Tolled Average Weekday Trips	Toll Free Average Weekday Trips	Average Number of Transactions per Tolled Trip	Average Number of Transactions per Toll Free Trip	Share of Tolled Trips
Base Case HOV3+Free Photo Billing	$254,060	$0.944	$2.236	370,544	269,051	101,494	159,487	113,598	45,889	2.37	2.21	71%
HOV2+Free Photo Billing	$135,227	$1.051	$2.395	444,199	128,622	315,577	210,485	56,454	154,031	2.28	2.05	27%
(Percent Impact versus Base Case)	-46.8%	+11.3%	+7.1%	+19.9%	-52.2%	+210.9%	+32.0%	-50.3%	+235.7%	-3.8%	-7.4%	-62.3%
HOV3+Free Peak / HOV2+Free Off-Peak Photo Billing	$230,987	$1.012	$2.373	403,500	228,294	175,205	181,319	97,338	83,981	2.35	2.09	54%
(Percent Impact versus Base Case)	-9.1%	+7.1%	+6.1%	+8.9%	-15.1%	+72.6%	+13.7%	-14.3%	+83.0%	-1.0%	-5.7%	-24.6%
HOV Discount and Photo Billing	$231,735	$0.613 (2)	$1.429 (2)	378,037	186,082	191,955 (1)	162,218	77,272	84,946 (1)	2.41	2.26 (1)	48% (3)
(Percent Impact versus Base Case)	-8.8%	-35.1%	-36.1%	+2.0%	-30.8%	+89.1%	+1.7%	-32.0%	+85.1%	+1.7%	+2.2%	-33.1%

2030 - Option 4

	Average Weekday Revenue Estimates			Average Weekday Transaction Estimates			Traffic Estimates					
	Average Weekday Revenue	Average Toll per Tolled Transaction	Average Toll per Tolled Trip	Total Average Weekday Transactions	Tolled Average Weekday Transactions	Toll Free Average Weekday Transactions	Total Average Weekday Trips	Tolled Average Weekday Trips	Toll Free Average Weekday Trips	Average Number of Transactions per Tolled Trip	Average Number of Transactions per Toll Free Trip	Share of Tolled Trips
Base Case HOV3+Free Photo Billing	$729,516	$2.149	$5.103	474,590	339,501	135,088	201,774	142,963	58,811	2.37	2.30	71%
HOV2+Free Photo Billing	$305,993	$2.142	$4.681	538,713	142,865	395,848	250,738	65,364	185,374	2.19	2.14	26%
(Percent Impact versus Base Case)	-58.1%	-0.3%	-8.3%	+13.5%	-57.9%	+193.0%	+24.3%	-54.3%	+215.2%	-8.0%	-7.0%	-63.2%
HOV3+Free Peak / HOV2+Free Off-Peak Photo Billing	$679,998	$2.487	$5.810	495,315	273,372	221,943	218,698	117,040	101,658	2.34	2.18	54%
(Percent Impact versus Base Case)	-6.8%	+15.8%	+13.9%	+4.4%	-19.5%	+64.3%	+8.4%	-18.1%	+72.9%	-1.6%	-5.0%	-24.5%
HOV Discount and Photo Billing	$781,615	$1.649 (2)	$3.855 (2)	474,060	228,812	245,248 (1)	202,772	96,211	106,561 (1)	2.38	2.30 (1)	47% (3)
(Percent Impact versus Base Case)	+7.1%	-23.3%	-24.5%	-0.1%	-32.6%	+81.5%	+0.5%	-32.7%	+81.2%	+0.1%	+0.2%	-33.0%

Notes: (1) Values are transactions and trips at discount rate and are only toll free if the discount exceeds the transponder toll rate.
(2) Average per trip and per transaction tolls do include HOV discount transactions for the HOV Discount Scenario only.
(3) Share is shown for tolled trips at non-discounted toll rates.

Tolls and revenue are shown in future year Dollars. Transactions and revenue are average weekday estimates and do not reflect deductions for ramp-up

The HOV Discount Scenario shows an adverse revenue impact (negative 14 percent) in the earlier years. By 2030 the revenue in the HOV Discount Scenario exceeds the revenue in the Base Case Scenario by about 7 percent. In the outer years toll rates are high enough so that HOV vehicles will generate revenue even after application of the discounts. The toll rates are typically increasing at a significantly higher rate that the assumed increase of the discounts based on a 2.5 percent inflation rate.

The share of average weekday tolled trips in the Express Toll Lanes in the Base Case ranges between 78 percent in 2014 and 70 percent in 2030. Tolled trips under the HOV2+Free Scenario represent about 22 (2014) to 26 percent (2030) of total trips in the Express Toll Lanes. The average number of transactions per tolled trip remains roughly at 2.0 to 2.3 in both scenarios for each forecast year. The average number of transactions per toll-free trip increase from between 1.6 in 2014 to roughly 2.2 in 2030 in both scenarios. This lower number in comparison to tolled trips indicates that the pricing of tolled trips encourages longer trips to use the Express Toll Lanes which reduces the amount of traffic weaving in and out of the Express Toll Lanes.

The share of tolled trips will determine what part of the total Express Toll Lanes traffic will have to bear the operating cost associated with the toll-free traffic using the Express Toll Lanes. The HOV2+Free Scenario has a higher share of toll-free transactions and therefore the revenue collected from a smaller amount of tolled vehicles will have to cover the operating expenses for all users of the lanes. Revenue numbers shown in this report are gross revenue estimates and are not reflecting any reductions for such operating expenses.

The HOV3+Free Peak/HOV2+Free Off-Peak Scenario is a compromise between the goal to retain as much revenue as possible while trying to continue the current HOV2+ designation during a certain period of time within the project corridor. Revenue impacts are less severe and the potential operational problems of the HOV2+Free Scenario during the peak periods can be avoided.

The HOV Discount Scenario shows initially adverse revenue impacts due to the discount amounts that result in a large amount of low or no revenue yielding transactions in the earlier years.

Annual Revenue Streams

Tables 3-1 through 3-4 in the appendices provide estimates of annual toll revenue streams and the change in estimated toll and toll-free weekday traffic volumes between 2014 and 2030 per facility and for the total corridor. The demand model estimates were produced for 2014, 2018, and 2030 time horizons. Annual revenue is expressed in current Dollars[3] and ramp-up has been assumed for the first three years of operation. The assumed adjustment factor is 57.8% for the first year, 89.8% for the second year and 99.7% of the modeled revenue and volume estimates. This deduction is applied to new traffic movements only. Movements that would travel between an established facility (SR 167 in 2014, SR 167 and I-405 North in 2018) and a new facility would be reduced by a weighted ramp-up factor based on transactions for each facility since the operation on the established facility would already reflect a situation after ramp-up. The specific ramp-up factors for each of the tested scenarios were calculated that way with the basic ramp-up factors as described in Chapter 3. Movements and resultant revenue that remained within facilities that were considered established in the respective

[3] "current dollars" is the dollar value in the future year of the estimate

modeling year did not receive a ramp-up deduction. The detailed ramp-up calculations for each scenario are documented in Tables 4 in the appendices.

The revenue estimates represent gross revenue; no deductions for operating and maintenance cost, transaction fees, or capital costs were applied.

A comparison of the expected weekday traffic and the annual revenue, based on the projected demand data for the Base Case and the three alternative scenarios is shown in Table 4-3 and Figure 4-3.

Estimated Weekday Traffic

Figures 1-1 through 4-3 in Appendix A contain estimated traffic volumes for the project corridor under 2014 and 2018 Option 1 as well as for 2018 and 2030 Option 4 conditions for the Base Case and Appendices B through G contain the volumes for the tested Scenarios, respectively. The volumes on the Express Toll Lane sections are shown for the major aggregated operation periods (peaks, shoulders, midday and evening) and the ramp volumes are shown as day-time totals during the hours of operation from 5:00 AM to 8:00 PM. The volumes on the general purpose lanes are also daytime totals only.

A comparison of AM and PM peak-hour market shares of single occupant vehicles (SOV), vehicles with two occupants (HOV2) and vehicles with three or more occupants (HOV3+) as well as total traffic at six cross sections are provided in Table 4-4 for the AM peak period (7:00 am – 8:00 am) and the PM Peak (4:00pm – 5:00pm). The market shares shown are peak-hour directional ratios of trips between general purpose and Express Toll Lanes for the Option 1 configuration in 2014 and 2018 as well as for the Option 4 configuration for 2018 and 2030 time horizons at the following six locations:

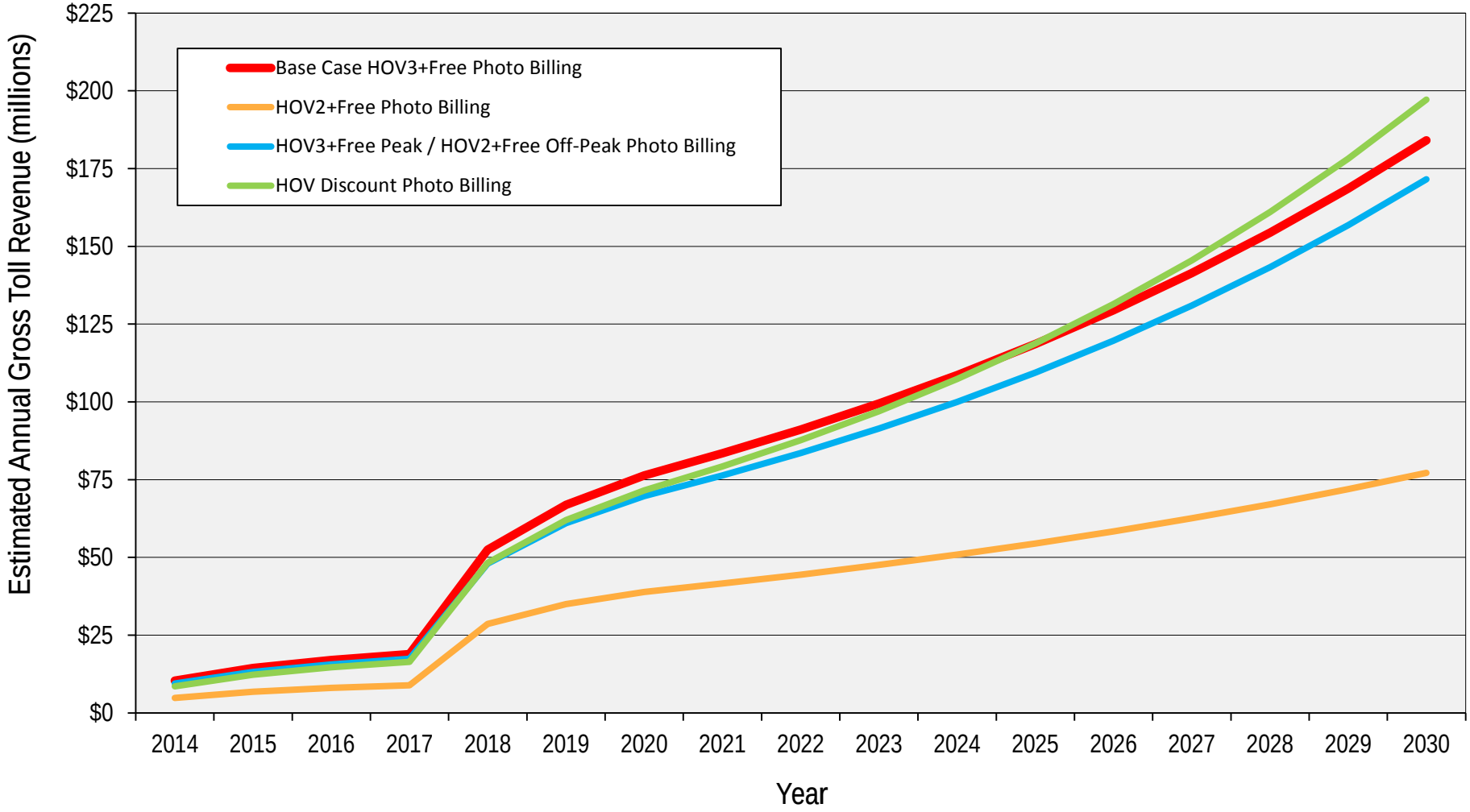
- I-405 North, South of SR 527;
- I-405 North, North of SR 520;
- I-405 South, At I-90;
- I-405 South, North of SR 169;
- SR 167, South of SW 43rd Street; and
- SR 167, South of 15th Street NW.

Since the Option 1 configuration assumes the current HOV lanes on the I-405 South portion, no SOV vehicles are allowed on this facility in 2014 and 2018. Total traffic in the general purpose lanes does include heavy trucks.

Table 4-3
Comparison of Annual Gross Toll Revenue Estimates (in Thousands)

Year	Base Case HOV3+Free Photo Billing	HOV2+Free Photo Billing	(Percent Impact)	HOV3+Free Peak / HOV2+Free Off-Peak Photo Billing	(Percent Impact)	HOV Discount Photo Billing	(Percent Impact)
2014	**$10,367**	**$4,796**	**-53.7%**	**$9,425**	**-9.1%**	**$8,500**	**-18.0%**
2015	$14,434	$6,807	-52.8%	$13,156	-8.9%	$12,309	-14.7%
2016	$17,004	$8,024	-52.8%	$15,550	-8.6%	$14,672	-13.7%
2017	$18,934	$8,885	-53.1%	$17,370	-8.3%	$16,407	-13.3%
2018	**$52,433**	**$28,597**	**-45.5%**	**$47,959**	**-8.5%**	**$48,258**	**-8.0%**
2019	$66,914	$35,000	-47.7%	$61,037	-8.8%	$61,958	-7.4%
2020	$76,316	$38,863	-49.1%	$69,679	-8.7%	$71,502	-6.3%
2021	$83,433	$41,580	-50.2%	$76,335	-8.5%	$79,222	-5.0%
2022	$91,097	$44,456	-51.2%	$83,521	-8.3%	$87,666	-3.8%
2023	$99,466	$47,554	-52.2%	$91,384	-8.1%	$97,012	-2.5%
2024	$108,604	$50,892	-53.1%	$99,988	-7.9%	$107,355	-1.2%
2025	$118,583	$54,490	-54.0%	$109,402	-7.7%	$118,802	+0.2%
2026	$129,480	$58,369	-54.9%	$119,702	-7.6%	$131,472	+1.5%
2027	$141,379	$62,552	-55.8%	$130,973	-7.4%	$145,494	+2.9%
2028	$154,373	$67,067	-56.6%	$143,305	-7.2%	$161,013	+4.3%
2029	$168,562	$71,940	-57.3%	$156,799	-7.0%	$178,190	+5.7%
2030	**$184,057**	**$77,202**	**-58.1%**	**$171,563**	**-6.8%**	**$197,202**	**+7.1%**
Cumulative Revenue	**$1,535,435**	**$707,073**	**-53.9%**	**$1,417,148**	**-7.7%**	**$1,537,034**	**+0.1%**

Note: Revenue is shown in thousands of future year Dollars and does include deductions for ramp-up.
Gross toll revenue estimates do not reflect deductions for toll operations and maintenance cost or leakage.
All scenarios with photo tolling require HOV's to have a transponder.



CDM Smith

COMPARISON OF ANNUAL GROSS TOLL REVENUE ESTIMATES

FIGURE 4-3

Table 4-4
Comparison of Base Case Express Toll Lanes Market Shares by Vehicle Class

AM Peak Period (7:00 am - 8:00 am)

Location	Direction	2014 Phase 1				2018 Phase 1				2018 Option 4				2030 Option 4			
		SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total
I-405 North South of SR 527	GP NB	96%	82%	31%	93%	96%	77%	28%	92%	95%	76%	26%	90%	86%	62%	29%	81%
	ETL NB	4%	18%	69%	7%	4%	23%	72%	8%	5%	24%	74%	10%	14%	38%	71%	19%
	ETL SB	22%	40%	72%	26%	24%	38%	70%	27%	24%	42%	70%	28%	19%	41%	75%	23%
	GP SB	78%	60%	28%	74%	76%	62%	30%	73%	76%	58%	30%	72%	81%	59%	25%	77%
I-405 North North of SR 520	GP NB	97%	83%	32%	92%	97%	80%	26%	89%	89%	79%	18%	82%	90%	78%	23%	84%
	ETL NB	3%	17%	68%	8%	3%	20%	74%	11%	11%	21%	82%	18%	10%	22%	77%	16%
	ETL SB	13%	34%	39%	17%	14%	34%	40%	18%	15%	36%	71%	21%	16%	42%	88%	23%
	GP SB	87%	66%	61%	83%	86%	66%	60%	82%	85%	64%	29%	79%	84%	58%	12%	77%
I-405 South At I-90	GP NB	100%	35%	6%	80%	100%	37%	8%	80%	82%	57%	12%	69%	86%	55%	4%	68%
	ETL NB	0%	65%	94%	20%	0%	63%	92%	20%	18%	43%	88%	31%	14%	45%	96%	32%
	ETL SB	0%	73%	100%	16%	0%	73%	100%	19%	26%	52%	98%	39%	27%	58%	99%	40%
	GP SB	100%	27%	0%	84%	100%	27%	0%	81%	74%	48%	2%	61%	73%	42%	1%	60%
I-405 South North of SR 169	GP NB	100%	17%	0%	78%	100%	17%	1%	78%	76%	58%	18%	65%	86%	61%	8%	68%
	ETL NB	0%	83%	100%	22%	0%	83%	99%	22%	24%	42%	82%	35%	14%	39%	92%	32%
	ETL SB	0%	65%	100%	13%	0%	65%	100%	16%	26%	53%	94%	36%	25%	55%	96%	36%
	GP SB	100%	35%	0%	87%	100%	35%	0%	84%	74%	47%	6%	64%	75%	45%	4%	64%
SR 167 South of SW 43rd Street	GP NB	84%	65%	35%	80%	85%	65%	43%	82%	86%	60%	8%	78%	93%	70%	7%	80%
	ETL NB	16%	35%	65%	20%	15%	35%	57%	18%	14%	40%	92%	22%	7%	30%	93%	20%
	ETL SB	3%	15%	77%	7%	3%	16%	77%	8%	13%	24%	89%	19%	15%	27%	92%	25%
	GP SB	97%	85%	23%	93%	97%	84%	23%	92%	87%	76%	11%	81%	85%	73%	8%	75%
SR 167 South of 15th Street NW	GP NB	79%	50%	9%	74%	79%	49%	10%	74%	80%	42%	3%	70%	93%	73%	6%	83%
	ETL NB	21%	50%	91%	26%	21%	51%	90%	26%	20%	58%	97%	30%	7%	27%	94%	17%
	ETL SB	2%	14%	77%	6%	3%	16%	77%	7%	8%	19%	82%	13%	9%	19%	82%	17%
	GP SB	98%	86%	23%	94%	97%	84%	23%	93%	92%	81%	18%	88%	91%	81%	18%	83%

PM Peak Period (4:00 pm - 5:00 pm)

Location	Direction	2014 Phase 1				2018 Phase 1				2018 Option 4				2030 Option 4			
		SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total	SOV	HOV2	HOV3+	Total
I-405 North South of SR 527	GP NB	83%	49%	34%	77%	82%	49%	37%	77%	84%	50%	35%	78%	85%	52%	40%	79%
	ETL NB	17%	51%	66%	23%	18%	51%	63%	23%	16%	50%	65%	22%	15%	48%	60%	21%
	ETL SB	18%	47%	74%	24%	17%	44%	73%	23%	16%	43%	75%	22%	12%	41%	78%	20%
	GP SB	82%	53%	26%	76%	83%	56%	27%	77%	84%	57%	25%	78%	88%	59%	22%	80%
I-405 North North of SR 520	GP NB	87%	55%	33%	79%	86%	53%	26%	77%	82%	50%	10%	72%	87%	55%	6%	76%
	ETL NB	13%	45%	67%	21%	14%	47%	74%	23%	18%	50%	90%	28%	13%	45%	94%	24%
	ETL SB	5%	27%	50%	11%	6%	23%	52%	11%	7%	18%	69%	14%	8%	24%	81%	18%
	GP SB	95%	73%	50%	89%	94%	77%	48%	89%	93%	82%	31%	86%	92%	76%	19%	82%
I-405 South At I-90	GP NB	100%	47%	41%	83%	100%	52%	49%	83%	78%	57%	9%	63%	85%	57%	6%	67%
	ETL NB	0%	53%	59%	17%	0%	48%	51%	17%	22%	43%	91%	37%	15%	43%	94%	33%
	ETL SB	0%	72%	89%	29%	0%	73%	90%	28%	21%	59%	96%	40%	14%	51%	96%	34%
	GP SB	100%	28%	11%	71%	100%	27%	10%	72%	79%	41%	4%	60%	86%	49%	4%	66%
I-405 South North of SR 169	GP NB	100%	15%	1%	79%	100%	14%	1%	78%	75%	48%	9%	64%	78%	46%	4%	63%
	ETL NB	0%	85%	99%	21%	0%	86%	99%	22%	25%	52%	91%	36%	22%	54%	96%	37%
	ETL SB	0%	79%	100%	26%	0%	78%	100%	26%	23%	54%	92%	36%	24%	54%	93%	38%
	GP SB	100%	21%	0%	74%	100%	22%	0%	74%	77%	46%	8%	64%	76%	46%	7%	62%
SR 167 South of SW 43rd Street	GP NB	93%	63%	30%	88%	89%	61%	31%	85%	81%	45%	9%	71%	87%	52%	7%	73%
	ETL NB	7%	37%	70%	12%	11%	39%	69%	15%	19%	55%	91%	29%	13%	48%	93%	27%
	ETL SB	11%	44%	79%	20%	10%	43%	76%	19%	13%	44%	83%	22%	10%	39%	88%	22%
	GP SB	89%	56%	21%	80%	90%	57%	24%	81%	87%	56%	17%	78%	90%	61%	12%	78%
SR 167 South of 15th Street NW	GP NB	93%	70%	22%	88%	89%	63%	23%	84%	87%	57%	13%	79%	89%	58%	13%	79%
	ETL NB	7%	30%	78%	12%	11%	37%	77%	16%	13%	43%	87%	21%	11%	42%	87%	21%
	ETL SB	12%	41%	89%	22%	12%	41%	88%	21%	12%	37%	90%	21%	9%	32%	90%	20%
	GP SB	88%	59%	11%	78%	88%	59%	12%	79%	88%	63%	10%	79%	91%	68%	10%	80%

The volumes shown in this report are based on global demand model data and reflect the most recent PSRC travel demand model data including travel demand in the outer years. If the future growth in demand levels is lower than the expected growth rates, and/or regulatory policies or restrictions on road usage (i.e. cap on vehicle miles travelled) will be implemented, the global travel demand forecast, as well as the I-405 traffic and revenue estimates, will have to be revised to take such changes into consideration.

A more detailed study would have to be established to reflect such changes in policy, resulting in reduced congestion levels and therefore, reduced Express Toll Lane usage and a corresponding significant decrease in traffic and revenue.

Summary

Traffic and revenue estimates for the I-405 Express Toll Lanes project, included in this report, are based on travel demand data provided by WSDOT. Identical infrastructure configurations were assumed when estimating traffic and revenue for the Base Case and the alternative operating scenarios presented in this report.

The differences in toll-free designation or the provision of an HOV discount program has the following impacts on traffic and revenue estimates:

- The average toll per tolled trip is about 3 to 7 percent (2014, 2018) higher in the HOV2+Free Scenario compared to the Base Case. By 2030 the travel demand in the Express Toll Lanes cannot be managed with reasonable toll rates during the peak periods at certain peak load points. Therefore certain sections of the Express Toll Lanes will have to be operated as HOV2 only facility. These closures are reflected in a drop of average tolls per trip of about -8 percent versus the Base Case condition. This observation was made in earlier studies and confirms that in the outer years of the operation of the I-405 / SR 167 Express Toll Lanes an HOV2+Free Scenario might fail from an operational and pricing perspective. Even when operating under an HOV only situation current experience from the existing single lane HOV lanes in the project corridor suggests that this operation in itself could lead to undesirable traffic conditions causing significant delay in the Express Toll Lanes.

- Average tolls per trip in the HOV3+Free Peak/HOV2+Free Off-Peak scenario are between 3 to 14 percent higher than the Base Case. These slightly higher rates are caused by the bigger weight of peak period revenues (HOV3+Free) as compared to the non-peak revenues (HOV2+Free). The revenue impact is about negative 7 to negative 9 percent of the Base Case gross revenue estimates.

- The average toll per tolled trip in the HOV Discount Scenario is between 36 to 24 percent lower than the average tolls in the Base Case. This is caused by the fact that all vehicles are subjected to paying a toll but the discounts for HOV vehicles result in a large amount of trips with a rather low toll or even a zero toll after the discounts are applied. In the earlier years the revenue impact ranges between negative 14 to negative 8 percent and by 2030 the discount scenario shows a slight increase of 7 percent in revenue over the Base Case since the discounts are not reducing the revenue as much as in the earlier years and the majority of the trips will be paying tolls. This HOV Discount Scenario includes photo billing as the corridor toll operation scenario.

- The share of tolled trips in the Base Case ranges between 71 to 80 percent of all trips in the Express Toll Lanes. Under an HOV2+Free designation that share ranges between 22 and 26 percent of the Express Toll Lane volumes. Under the HOV3+Free Peak/HOV2+Free Off-Peak Scenario that share ranges between 54 and 57 percent and the trips in the HOV Discount Scenario that pay the full toll rate ranges between 46 and 48 percent.
- Total average weekday trips on the Express Toll Lanes in the HOV2+Free Scenario increase between 62 percent in 2014 and 24 percent in 2030 due to the higher amount of toll-free users. The HOV3+Free Peak/HOV2+Free Off-Peak Scenario shows an increase of overall trips between 26 and 8 percent and the HOV Discount Scenario total trips are 4 to 0.5 percent higher than in the Base Case Scenario.
- A lower amount of tolled trips (negative 50 to negative 54 percent) under an HOV2+Free designation has to cover operating expenses for the Express Toll Lanes. In the HOV3+Free Peak/HOV2+Free Off-Peak Scenario the tolled trips are only 11 to 18 percent lower and the HOV Discount Scenario has about 32 to 39 percent less trips paying the full toll rate.

Disclaimer

Current accepted professional practices and procedures were used in the development of these traffic and revenue estimates. However, as with any forecast of the future, it should be understood that there may be differences between forecasted and actual results caused by events and circumstances beyond the control of the forecasters. In formulating its estimates, CDM Smith has reasonably relied upon the accuracy and completeness of information provided (both written and oral) by WSDOT. CDM Smith also has relied upon the reasonable assurances of some independent parties and is not aware of any facts that would make such information misleading.

CDM Smith has made qualitative judgments related to several key variables in the development and analysis of the traffic and revenue estimates that must be considered as a whole; therefore selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underling methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit to partial information extracted from this report.

All estimates and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple agencies, including WSDOT. These estimates and projections may not be indicative of actual or future values, and are therefore subject to substantial uncertainty. Future developments cannot be predicted with certainty, and may affect the estimates or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any estimate or projection contained within this report.

While CDM Smith believes that some of the projections or other forward-looking statements contained within the report are based on reasonable assumptions as of the date in the report, such forward looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to socioeconomic and demographic forecasts, proposed residential

or commercial land use development projects and/or potential improvements to the regional transportation network.

The traffic and revenue estimates presented in this report are planning level estimates and are not intended for purposes of project financing.