Interim Report

Research Project T9233, Task 8
HOV Lane Evaluation

HOV LANE EVALUATION AND MONITORING

by

Cy Ulberg
Research Assiciate Professor
Graduate School of Public Affairs, JE-10
University of Washington
4507 University Way NE, Suite 204
Seattle, Washington 98105

Gary Farnsworth
Research Assistant
School of Engineering
University of Washington
Seattle, Washington 98195

Washington State Transportation Center (TRAC)
University of Washington, JE-10
The Corbet Building, Suite 204
4507 University Way N.E.
Seattle, Washington 98105

Prepared for

Washington Department of Transportation
Technical Monitor
Leslie N. Jacobson
FAME Project Engineer

Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration

August 1992

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Transportation Commission, Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

TABLE OF CONTENTS

LIST OF FIGURES

INITIAL STUDY (1991—1992)

Over the past year, we have concentrated our data collection and evaluation efforts on both the I-5 North 2+ Demonstration and the I-5 South Interim Project. The data were collected by field observations, WSDOT detector systems, and traveller opinion surveys. The State Patrol, WSDOT, METRO, Pierce Transit, Community Transit, and the Texas Transportation Institute have also provided relevant information and assistance.

EFFECTIVENESS MEASURES

Preliminary analysis has included an application of the various data to standard effectiveness measures. The standard effectiveness measures that TRAC is testing for the evaluation and monitoring program, have been developed through other research[1] and are generally accepted as appropriate for evaluating HOV facilities. The following is a list of those standard measures that have been used up to the point of this study:

- HOV Lane Volumes — number of HOVs using the HOV lanes
- Congestion Impacts — of HOV lanes on the overall highway section
- Safety Impacts — effects of HOV lanes on highway safety
- Travel Times Savings and Reliability — advantages provided by the HOV lanes
- Average Vehicle Occupancy (AVO) — in all lanes of each highway section
- Person Throughput — based on AVO
- HOV Enforcement — number of vehicles violating the "3+" restriction
- Public Perception — including traveller support of the HOV facility

TRAFFIC DATA

The following types of traffic data, which represent the peak periods of 6-9:00 a.m. and 3-6:00 p.m., were collected from both the North and South Corridors:

---

[1]Turnbull, K., et al., Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities, Technical Report No. 925-2, Texas Transportation Institute, College Station, Texas, February, 1991.

- Lane Volumes — number of vehicles travelling in each lane, applied to measures of *HOV volumes* and *congestion*
- Accidents — number recorded by State Patrol, before and after HOV lanes opened, applied to measures of *safety impacts* and *congestion impacts*
- Persons per Vehicle — for each lane in the highway section, applied to the measures of *AVO*, *person throughput*, and *HOV enforcement*
- Travel Times — of vehicles in each corridor (HOV lanes vs. regular lanes), applied to measure of *travel time savings and reliability*

Lane volume data were collected both by induction loop detectors and by manual field counts. Also, *travel time* data and *persons per vehicle* data were collected by manual (visual) observations from field sites. Because many unique traffic conditions or causes cannot be understood by traffic data analysis alone, the manual observations during data collection resulted in many important discoveries about vehicle interaction. However, because some of the manual data collection was made during the winter months, the findings are often limited by lack of daylight during parts of the peak periods. Another limitation is the lack of available historical data (AVO data is the exception), such as *travel times* or *lane volumes*, for most of the targeted corridors.

TRAVELLER OPINION DATA

The data also include responses to questionnaire surveys. Questionnaires were distributed to auto travellers who were observed (vehicle license plate numbers were recorded) in the HOV corridors. The travellers were separated into different categories; first according to corridor, and then according to who did or did not use the HOV as opposed to general purpose lanes. Surveys were also given to bus riders and operators. The questionnaires asked travellers for perceptions and opinions about HOV lane effects on safety, effects on travellers using both HOV and general purpose lanes, ways to improve each respective corridor, and HOV lane enforcement. These survey data were applied to the measure of public perception.

STUDY PLANNED FOR 1992—1993

STUDY CORRIDORS

Because this is a regional project, we will expand our data collection beyond Interstate 5 north and south to other corridors in King County in the coming year. We will continue to expand through the region, to Pierce and Snohomish Counties, in the summer of 1993. The following is a list of the corridors we will target in the coming year:

- I-5 North, from Northgate to the King/Snohomish County line. This is the 2+ Demonstration Corridor, where HOV lanes have been in place since the early 1980s.
- I-5 South, from the Southcenter Hill to S. 272nd Street. This is the Interim HOV Corridor for south King County, opened in the Summer of 1991.
- I-5 Central, from Downtown Seattle to the I-5 South Corridor. This corridor is in various stages of HOV lane development and opening to traffic.
- I-90, from the Mount Baker Tunnel to E. Mercer Way. Currently, interim HOV lanes are open in the westbound direction. The reversible HOV roadway is scheduled to open in 1994.
- I-405 South, from Southcenter to I-90. This corridor is temporarily divided by the Renton "S-curves," but data should be collected throughout. Lanes will be opened in Renton as new construction is completed on the "S-curves."
- I-405 North, from I-90 to Kirkland. This corridor does not currently contain HOV lanes, but construction has begun. Therefore, "before" data should be collected.
- SR 520, from Medina to SR 908. The existing westbound lanes in this corridor are very short, but construction is continuing eastward. Therefore, we plan to collect data at various points out to 148th Avenue.

LANE VOLUME/OCCUPANCY

WSDOT lane volume data, taken from loop detector stations, are readily available in computerized format at the Transportation Systems Management Center (TSMC). WSDOT's system of data stations is quite comprehensive, and reasonably adequate volume data can be obtained for each of the targeted corridors. However, volume data from before

1990 are stored on microfiche, making the data more difficult to obtain and analyze. For the sake of efficiency, as more corridors are explored, we will choose a minimal number of stations for which to compare older data. Without the older data, it is difficult to observe and assess the actual impacts of HOV lanes on volume trends.

We will continue to collect current volume data from the TSMC, for the targeted corridors. In particular, we will look for changes in HOV lane volume levels in the current facilities.

ACCIDENTS

The Washington State Patrol has been very helpful in supplying us with accident data for the I-5 corridors. With their continued assistance, we will expand our data collection to include the other corridors, looking for changes in accident trends that are potentially related to HOV lane operation. We will also continue to work with the State Patrol on concerns about HOV enforcement, particularly those related to hazardous geometric conditions.

VEHICLE OCCUPANCY

In terms of the manual data collection process, we believe that vehicle occupancy provides the most valuable and cost-effective information. Therefore, we will concentrate most of our observation efforts on vehicle occupancy. Average vehicle occupancy information is used in several areas of analysis, including person throughput, violation rates, and the level of effectiveness that HOV lanes provide for attracting carpools.

Over the past year, vehicle occupancy data have been collected from the highway mainlines, with observers entering data into lap-top computers at cross-street bridge locations. However, as noted earlier, lack of daylight limits our ability to collect data over the entire peak period (both a.m. and p.m.). Therefore, in the past several months we have experimented with vehicle occupancy data collection at freeway ramp locations. The ramp

locations have overhead lighting, which may make it possible for observers to see and record vehicle occupancy in the winter (hours of darkness).

In each corridor, we will develop vehicle occupancy analysis from both the mainline and the ramps. So, for each mainline data collection point, we have chosen approximately three corresponding ramp locations. For each corridor, we will provide a minimum of ten half-hour observations per lane, in the mainline. And at times, we will collect mainline and ramp data within the same corridor simultaneously, for comparative analysis (see Appendix A for the data collection points).

TRAVEL TIME SAVINGS

Travel time savings provided by HOV lanes should play an important role in evaluating the effectiveness of HOV facilities. However, we have discovered a few significant problems in the process of travel time data collection and analysis. In order for travel time data to be completely effective, they should represent all days over the entire length of each corridor, and over the entire peak period. Daily counts in each corridor would be too expensive, and lack of daylight during the winter months limits our ability to collect peak-period data manually. Therefore, we will collect travel time data randomly among all of the targeted corridors, where they will be represented by each weekday — approximately two times per month, or approximately ten total counts per corridor per month. (see Appendix A for the data collection points).

In the meantime, we will also explore the possibility of using electronic means to collect travel time data. Possibilities include the use of sensors, where vehicles that commute on a regular basis (such as buses and vanpools) are equipped with an identification device. The vehicles of randomly selected individual commuters may also be used. In our study, we will attempt to estimate the cost of such a system and will request additional funding for initial investment in the prototype. This system will be coordinated with the projected titled "Test and Analysis of AVI for Congestion Management and Travel Information."

TRAVEL TIME RELIABILITY

All of the concerns about travel time savings, as mentioned above, also apply to travel time reliability. However, we also understand that most commuters are just as concerned about consistent daily travel times (especially when carpooling, vanpooling, or bus-riding) as they are about the amount of travel time they can save per commute.

Unfortunately, as other HOV researchers have found, it is extremely difficult to quantify the threshold levels that an HOV facility should reach in order to be effective as a priority treatment. We will explore possible methods for determining the appropriate threshold levels of travel-time reliability by reviewing literature from other research, studying survey responses, and following trends of lane use and average vehicle occupancy.

PUBLIC OPINION SURVEYS

As Washington State continues to develop its regional HOV system, we believe that the need to monitor public perception very closely is critical. Over the past year we have concentrated on those who travel in the highway corridors where HOV lanes already exist. We believe that these individuals provide us with the best points of view in terms of relevant public perception. Therefore, we will continue to collect survey data, through mail-out questionnaires for motorists and on-board questionnaires for bus riders.

In the past, we have picked out single weeks from which several hundred motorists were randomly selected, and a single mail-out was done for each corridor. However, for the coming year, we will develop a program to randomly select motorists each day, accumulate about 200 license plates per week, and send out weekly surveys. This work will include our continued development of the questionnaire (used for the I-5 corridors last year) so that it may be used as a standard form for all of the target corridors. We will also provide for some flexibility within this questionnaire, so that unique questions can be presented on issues that may exist (or arise) within a given corridor.

This strategy will provide us with a more comprehensive view of traveler perception. We will have to coordinate with the Department of Licensing to obtain auto-owner addresses from observed license plate numbers in a routine manner. We will also work with the major regional transit services to develop a routine program of on-board bus surveys.

BUS TRANSIT

In the coming year, input from the transit agencies (METRO, Pierce Transit, and Community Transit) will continue to increase. Beyond rider and driver surveys, we will gather information on the ability of each HOV facility to provide effective bus service. Such information may include increasing/decreasing ridership trends and data pertaining to route schedule adherence. Perceptions and opinions from agency managers may also be assessed.

CONCLUSION

Due to the urgent need to collect data for the 2+ demonstration in the North corridor, and WSDOT's concern about the effective operation of the South interim corridor, we have studied the I-5 North and South corridors intensely over the past year. These intensive studies have provided us with some valuable insight as to how to experiment with and study the other regional HOV corridors. Nonetheless, our experimentation is on-going as we continue to make valid critical evaluations of existing HOV operations, and as we develop a broad database for the long-term program.

APPENDIX A

DATA COLLECTION LOCATIONS

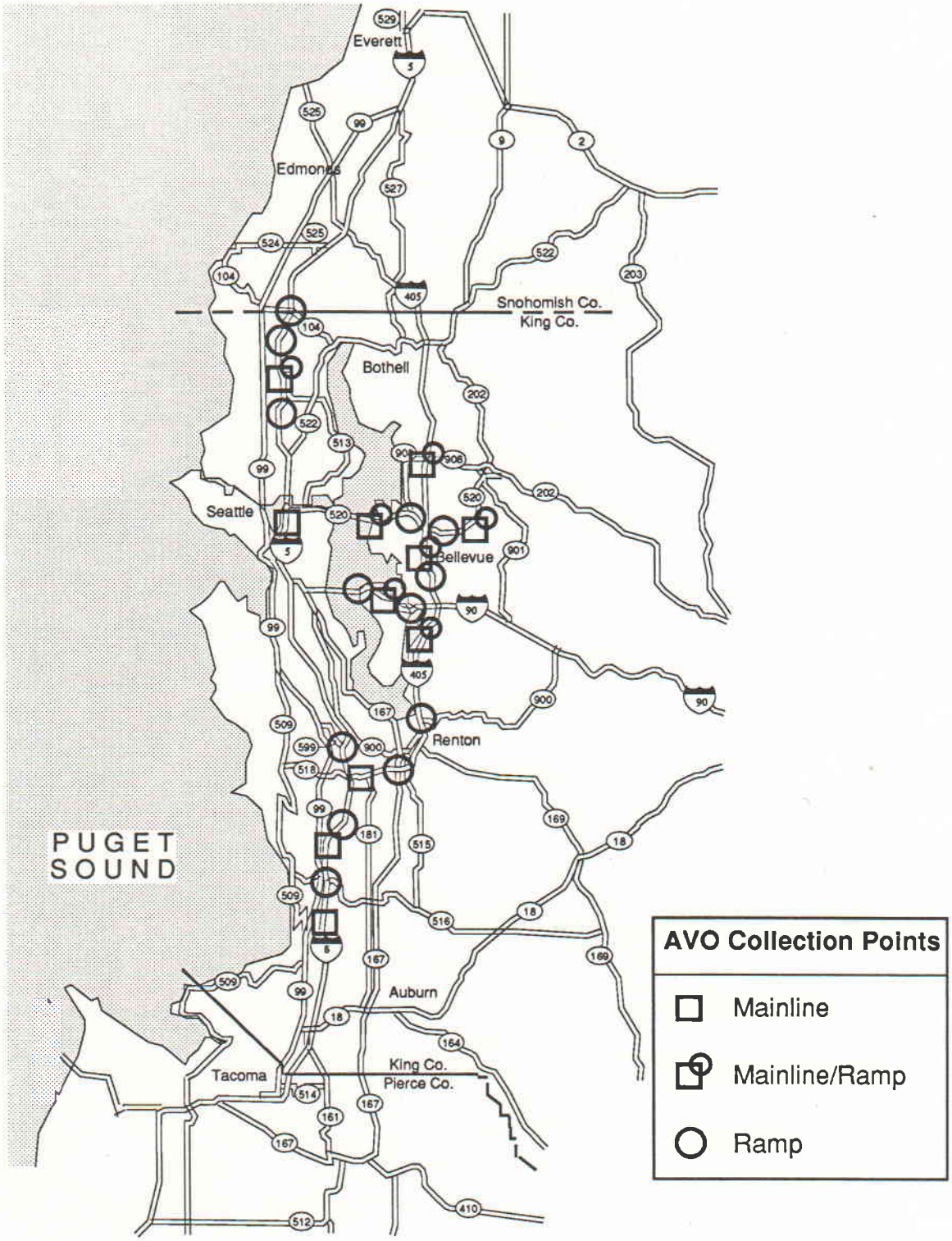

Figure A-1. Vicinity Map – AVO

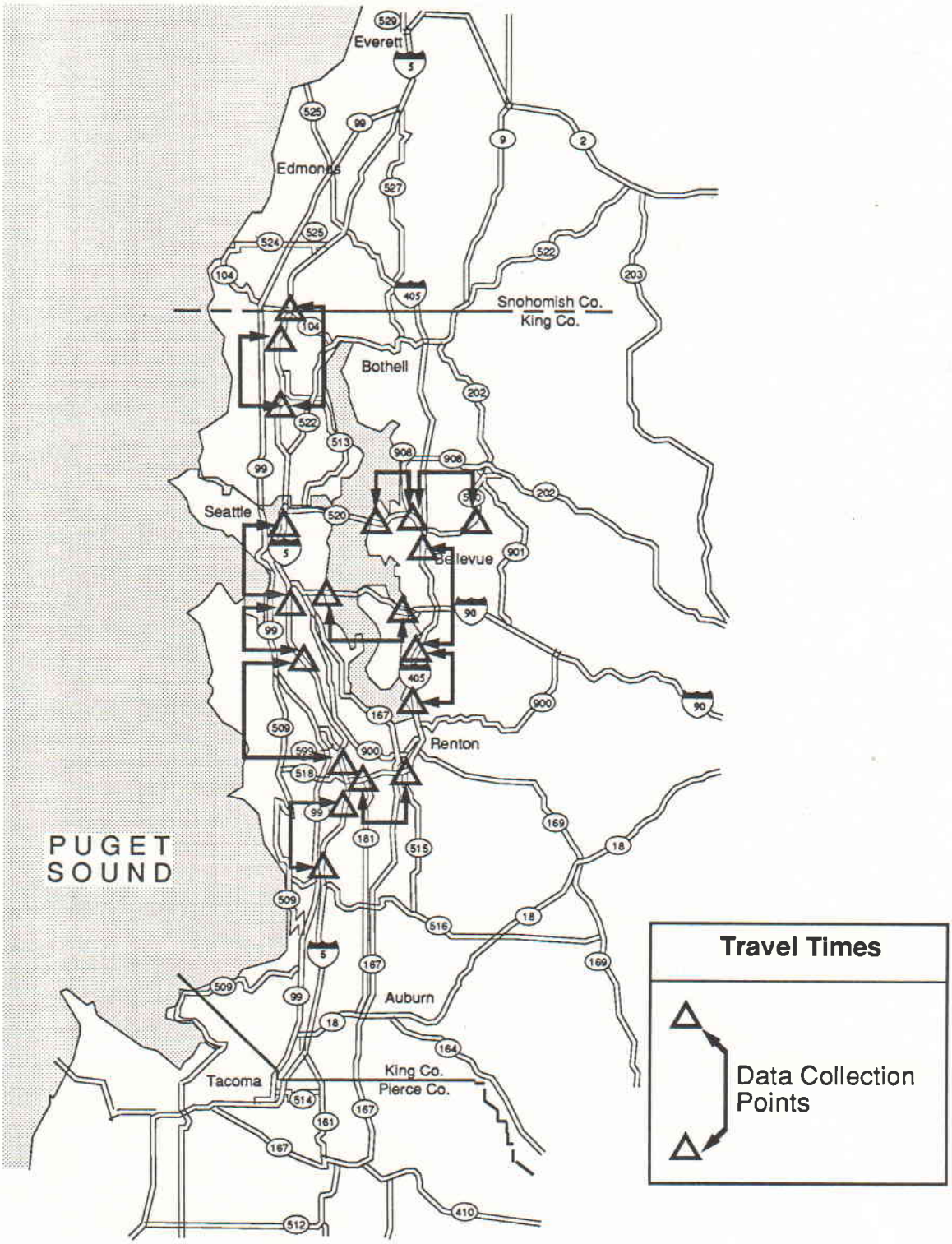

Figure A-2. Vicinity Map – Travel Times

TRAVEL TIMES

SW 236th St. (Snohomish County)
Travel Times SB (a.m.)

to

117th St. NE
Travel Times SB (a.m.) and NB (p.m.)

to

N 185th St.
Travel Times NB (p.m.)

VEHICLE OCCUPANCY

N 145th St.
Mainline (Primary)
Ramp Entering SB (a.m.) and exiting NB (p.m.)

SW 236th St. (Snohomish County)
Ramp Entering SB (a.m.) and exiting NB (p.m.)
Mainline SB (secondary)

N 175th St.
Ramp Entering SB (a.m.) and exiting NB (p.m.)

Northgate
Ramp Entering SB (a.m.) and exiting NB (p.m.)

117th St. NE
Mainline SB (secondary)

TRAVEL TIMES

Lakeview Blvd E
Travel Times SB (a.m.) and NB (p.m.)

to/from

Holgate St. - Beacon Ave. S
Travel Times SB (a.m.) and NB (p.m.)

Holgate St. - Beacon Ave. S
Travel Times SB (a.m.) and NB (p.m.)

to/from

Albro Place
Travel Times SB (a.m.) and NB (p.m.)

to/from

S 144th St.
Travel Times SB (a.m.) and NB (p.m.)

VEHICLE OCCUPANCY

Holgate St. - Beacon Ave. S
Mainline (Primary)

Lakeview Blvd E
Ramp-Mercer St. exiting SB (a.m.) and entering NB (p.m.)

Michigan St
Ramp entering NB (a.m.)

Corson Ave S
Ramp exiting SB (p.m.)

Albro Place
Mainline (secondary)

S 144th St.
Mainline (Primary)

TRAVEL TIMES

S 178th St.
Travel Times SB (p.m.)

to

S 216th St.
Travel Times NB (a.m.)

to

S 260th St.
Travel Times NB (a.m.)

VEHICLE OCCUPANCY

S 216th St.
Mainline (Primary)

S 188th St. & Orillia Rd.
Ramp Entering NB (a.m.) and exiting SB (p.m.)

S 200th St.
Ramp Entering NB (a.m.) and exiting SB (p.m.)

Highway 516 - Kent/Des Moines Rd.
Ramp Entering NB (a.m.) and exiting SB (p.m.)

S 272nd St.
Ramp Entering NB (a.m.) and exiting SB (p.m.)

TRAVEL TIMES

23rd Ave S - west end of Mt. Baker tunnel
Travel Times EB (p.m.)

to

East Mercer Way
Travel Times EB (p.m.) and WB (a.m.)

to

35th Ave S - east end of Mt. Baker tunnel
Travel Times WB (a.m.)

VEHICLE OCCUPANCY

Island Crest Way
Mainline (Primary)
Ramp entering WB (a.m.) and exiting EB (p.m.)

60th Ave SE - west end of Mercer Island tunnel
Ramp entering WB (a.m.) and exiting EB (p.m.)

East mercer Way
Ramp entering WB (a.m.)
Mainline (Secondary)

TRAVEL TIMES

Tukwila Parkway (Southcenter)
Travel Times

to/from

Benson Rd S
Travel Times

Lake Washington Blvd SE
Travel Times NB (a.m.) and SB (p.m.)

to/from

NE 12th St.
Travel Times NB (a.m.) and SB (p.m.)

VEHICLE OCCUPANCY

Tukwila Parkway (Southcenter)
Mainline (Primary)

I-405 at Highway 167 (Renton)
Ramp entering NB and exiting SB

S Park Dr.
Ramp NB (a.m.) and SB (p.m.)

Lake Washington Blvd SE
Mainline (Primary)

SE 8th St (Bellevue)
Ramp SB and NB

NE 12th St.
Mainline (Secondary)

Highway 908-Kirkland (Central Way) and Redmond (NE 85th)
Ramp entering SB (a.m.) and exiting NB (p.m.)

TRAVEL TIMES

Hunt's Point
Travel times WB (a.m.) and EB (p.m.)

to/from

SR 9087 Bellevue-Kirkland
Travel times WB (a.m.) and EB (p.m.)

to/from

148th Ave NE
Travel times WB (a.m.) and EB (p.m.)

VEHICLE OCCUPANCY

Hunt's Point
Mainline (Primary)
Ramp entering WB (a.m.)

Yarrow Point
Mainline (Secondary)

SR 908 Bellevue-Kirkland
Ramp WB from Kirkland (a.m.) and EB to Kirkland (p.m.)

148th Ave NE
Mainline EB (p.m.) (Primary)
Ramp WB (a.m.) and EB (p.m.)

124th Ave NE
Ramp WB (am and EB (pm)