REVIEW DRAFT

I-5 Columbia River Crossing Partnership: Traffic and Tolling Analysis

Identification and Threshold Analysis of HOV Lane Options

Working Paper 6.1

Prepared by

David Evans and Associates, Inc.
Parisi Associates

Date
October 21, 2004

TABLE OF CONTENTS

Page

List of Tables

List of Figures

List of Appendices

OVERVIEW

The purpose of Working Paper (WP) 6.1 is to summarize the benefits and impacts of operating high occupancy vehicle (HOV) lanes within a segment of the I-5 corridor that includes a crossing of the Columbia River.

This paper includes four sections in addition to this overview:

1. Summary of recommendations for tolling analysis and future study in the Environmental Impact Statement (EIS).
2. "Overview of HOV Facilities" provides a description of HOV benefits, HOV policies that apply to the region, and a summary of regional HOV studies.
3. "I-5 Partnership: Summary of HOV Findings" describes the I-5 HOV facilities studied as a part of the I-5 Partnership, including their potential performance based on limited modeling.
4. "HOV Potential in the I-5 Corridor" takes a look at HOV parameters including occupancy thresholds, time of day operations, reversible lane and contraflow lane considerations, and HOV lane/ truck only lanes. This section also considers tolling effects on HOV lanes.

1. SUMMARY OF RECOMMENDATIONS

The recommendations from this working paper are summarized below, with supporting information in the sections that follow.

Recommendations for HOV and tolling in the DEIS:

- HOV treatments will vary depending on whether tolls will be collected on I-5 in the Southbound, Northbound, or both directions. In general, existing HOV lanes should be terminated about a mile in advance of the toll plaza to allow a safe weaving distance both for vehicles that don't have transponders for high-speed ETC lanes to access the tollbooths, and for transponder equipped vehicles to move into the high-speed ETC lanes.

- HOV lanes are not warranted immediately downstream from the toll plaza based on an estimate of volume/capacity and lack of measurable HOV time savings. Currently, there are no HOV lanes Northbound and Southbound of the Columbia River Crossing, and future extension of the HOV system within the BIA downstream from the toll plaza should be based on meeting warrants.

- For the purpose of conducting the tolling analysis, a HOV discount rate should be applied to 3+ HOVs equipped with Electronic Toll Collection (ETC) and should be estimated at 50 percent reduction of the ETC rate. Transit should receive a 100 percent discount.
- Trucks should not be allowed to share a common HOV lane, other than lighter trucks that meet the HOV lane 10,000 Gross Vehicle Weight (GVW) and occupancy requirements.
- A reversible HOV lane should not be considered further unless revised regional and use allocations used in the DEIS provide justification.

- An evaluation of traffic operations beyond the traditional two-hour morning and evening peak will be required to assess whether peak period or continuous operation is appropriate for the existing HOV lanes on I-5. An assessment of corridor operations from 5 a.m. to 8 p.m. is likely to be needed.

2. OVERVIEW OF HOV FACILITIES

Benefits of HOV Facilities

HOV lanes benefit both the interstate and transit systems by: 1) moving more people in fewer vehicles; 2) better managing the limited freeway capacity; and, 3) providing incentives for future growth in HOV and transit.

Data from Washington State in the Puget Sound Region shows that some HOV lanes carry nearly twice the number of people than general-purpose lanes. As growth in travel continues to overwhelm the region's ability to build new capacity, HOV lanes provide a way for transit, carpool, and vanpool users to have a reliable trip. In the long run, HOV lanes will continue to provide expanded capacity as ridership continues to grow.

Regional HOV Policies

Transportation policies support consideration of HOV lanes on I-5 as part of the regional transportation strategies.

Regional Transportation Plan: In December 2003, the Metro Council approved the 2004 Federal Update to the 2000 Regional Transportation Plan (RTP). The 2004 Federal RTP will serve as the basis for making federal funding decisions until the next update in 2007.

> *Policy 19.0. Regional Transportation Demand ~~Management,~~Management* addresses objectives relating to HOV facilities. The overall policy is to "Enhance mobility and support the use of alternative transportation modes by improving regional accessibility to public transportation, carpooling, telecommuting, bicycling and walking options." Objective "f" is: "Investigate the use of HOV lanes to improve system reliability and reduce roadway congestion."

Clark County Goals and Policies: Clark County has adopted goals and policies regarding the role of HOV in the Clark County region that are consistent with State and WSDOT policies regarding HOV, and incorporated into the Metropolitan Transportation Plan.

Clark County's adopted regional HOV policies specific to freeways include:

- Provide for the management of freeway transportation corridors through the development of HOV facilities that address recurring congestion, traffic bottlenecks, and incident management;
- Implement HOV lane facilities in transportation corridors where congestion levels are high and where travel time savings for bus or carpool persons are significant;

- HOV support programs and facilities, such as carpool/vanpool programs, express bus service, and park and ride facilities, shall be in place or planned for any transportation corridor being considered for HOV use;
- Implementation of HOV lanes in the freeway corridors shall be complemented and/or preceded by congestion management strategies such as ITS and incident management, and ramp metering to maximize transportation system efficiencies;
- HOV support facilities and programs will also be in place prior to HOV lane implementation;
- The long-range goal for the implementation of freeway HOV facilities is through added capacity to accommodate HOV;
- The conversion of general purpose (GP) travel lanes for HOV use will be considered as a "phased" approach to implementing a long-range HOV system plan or other non-SOV capacity improvement strategy in the corridor;
- Freeway facilities with proposed or planned capacity improvements for traffic shall be assessed for their potential HOV use;
- Provide for the long-term management of HOV lane demand by maintaining the option for future conversion to high occupancy toll usage; and
- Spot treatments (such as ramp bypass) will be considered to provide priority access for shared ride users and to supplement HOV lane facilities.

Relevant Regional HOV Studies

Within the Portland/Vancouver region, HOV operation along I-5 was studied preceding opening of the existing northbound Portland and southbound Vancouver HOV lanes. Information from several studies was considered in developing possible HOV system configurations and evaluating resulting performance during the I-5 Partnership. A listing of the key studies considered follows:

- Clark County High Occupancy Vehicle (HOV) Study, July 1999: Summarizes Clark County's vision and supportive goals and policies for a regional HOV system. www.rtc.wa.gov/reports/hov/hovfinal9906.pdf
- I-5 High Occupancy Vehicle Operational Study-Summary Document, April 2000: Summarizes the collaborative Bi-State process leading toward the preferred southbound Vancouver HOV alignment that opened in October 2001. Does not address or recommend HOV options in relation to additional I-5 Columbia River vehicle capacity. www.rtc.wa.gov/reports/hov/I5HOVfinal0004.pdf
- Vancouver HOV Lane Monitoring and Evaluation Reports 1-4: Summarizes ongoing monitoring of HOV lane performance relative to pre-HOV baseline conditions. www.rtc.wa.gov/hov/evaluation.htm
- I-5 HOV Pilot Project, Sixth Evaluation Report, ODOT, October 2002: Summarizes ongoing HOV lane and adjacent GP lane performance to pre-HOV baseline conditions.

3. I-5 PARTNERSHIP: SUMMARY OF HOV FINDINGS

I-5 Partnership Treatment of HOV Pre-BIA

In developing the *I-5 Partnership Strategic Plan*, two separate analyses were undertaken. The first occurred in the summer and fall of 2001 when five multi-modal "Build" option packages were selected for further analysis assuming~~under~~ a 2020 analysis year. The option packages were based on ideas and comments from the public and consistent with the I-5 Partnership's Problem, Vision and Values Statement. Each of the five "Build" option packages included new Columbia River crossing capacity for transit and vehicles and some level of HOV facilities along I-5 as described in Table 1.

Table 1. Pre-BIA HOV Configurations

Option Package	I-5 HOV System Assumed	Columbia River Crossing
Express Bus/ 3 Lanes	- northbound: Going St. to 134th St. - southbound 134th St. to Lombard St. - peak direction/time HOV operation	New four-lane supplemental crossing with one arterial lane and one HOV lane per direction
Light Rail/ 3 Lanes	- same as Express Bus/3 Lanes:	Same as Express Bus/3 Lanes plus LRT to Clark College
Express Bus/ 4-Lanes	- northbound: I-405 to 134th St. - southbound 134th St. to I-405 - peak direction/time HOV operation	Modeled same as Express Bus/3 Lanes
Light Rail/ 4-Lanes	- reversible HOV lane between I-405 and 134th St.	Provides reversible lanes offering five lanes of peak direction capacity. Access limited to 134th St., SR 500, SR 14, Columbia Blvd., and I-405
West Arterial	- northbound: Going St. to Marine Drive - southbound 134th St. to Mill Plain and thru Delta Park	I-5 crossing unchanged

Source: I-5 Partnership Functional Descriptions of I-5 Corridor Option Packages Report- July 18, 2001.

Each of the five multi-modal "Build" option packages was compared to three additional scenarios:

- Existing Conditions 2000–The current state of the Corridor;
- No Build 2020–What is expected to happen in the year 2020 if the Region builds only the currently funded projects; and
- Baseline 2020–What is expected to happen in the year 2020 if the Region constructs the currently funded projects in "No Build" option, as well as the other projects listed in the Region's 20-year plans.

The HOV systems were defined to be consistent with regional plans for HOV facilities at the time. The evaluation of HOV at this stage was limited to reviewing results generated by the regional travel demand forecasting model. As **Figure 1** depicts, generally similar HOV systems assumed under the Build options resulted in similar 2020 performance results at the regional scale.

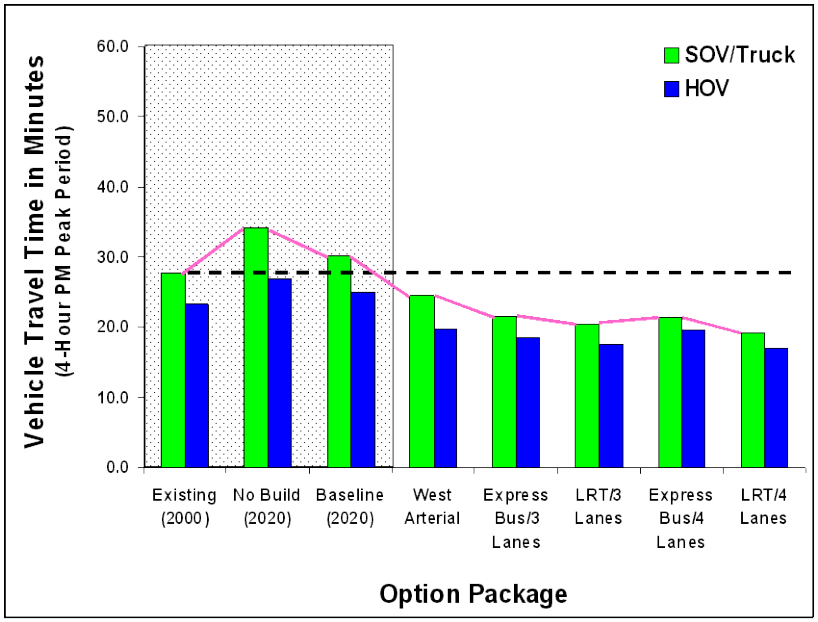


Figure 1. Vehicle Travel Times: Downtown Portland to Downtown Vancouver.
Source: Metro2020 forecasts developed for I-5 Partnership.

Increasing I-5 Columbia River crossing capacity improves travel times for both HOV and GP lane users. While HOV users would experience a travel timesavings under all option packages, improved GP operations associated with Build options diminish the relative travel time advantage for HOV users compared to No Build.

Figure 2 illustrates an increase in I-5 corridor person throughput in response to increased capacity, and specifically transit capacity, across the Columbia River. HOV demand is relatively steady across options. Each of the Build options produced similar results in arterial traffic levels and patterns in Portland and Vancouver. In general, arterial traffic levels were the same or lower under Build conditions as increased I-5 corridor capacity tended to draw trips to the freeway.

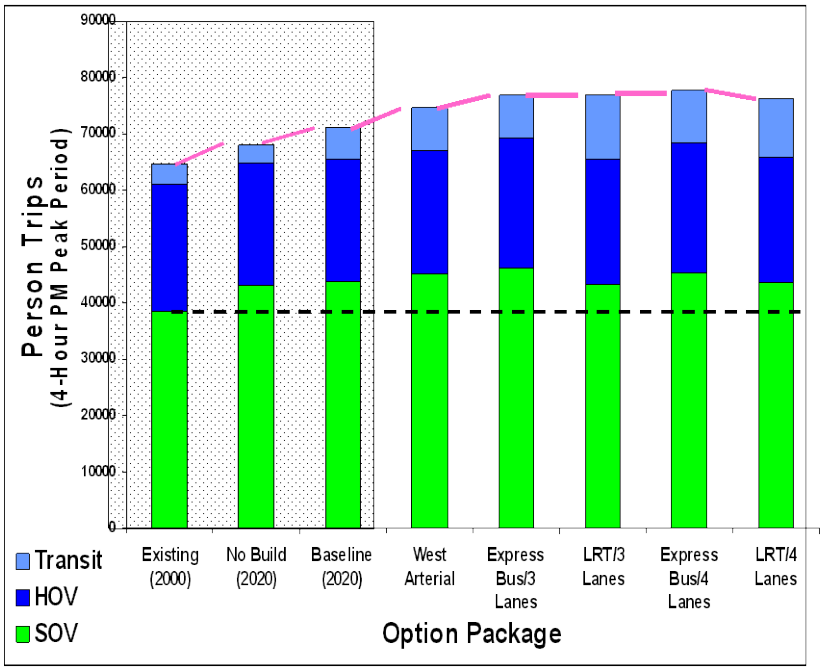


Figure 2. Person Trips Across the Columbia River.
Source: Metro2020 forecasts developed for I-5 Partnership.

Task Force Recommendations

By late January 2002, the I-5 Partnership's Governor's Task Force completed their review of the project information and issued draft recommendations for improvements:

- Three mainline through lanes in each direction on I-5 in Vancouver and Portland, including southbound through Delta Park;
- A phased light rail loop in Clark County in the vicinity of the I-5, SR 500/4th Plain and I-205 corridors;
- An additional span or a replacement bridge for the I-5 crossing of the Columbia River, with two light rail tracks and up to two additional lanes in each direction for weaving and merging; and
- Interchange improvements and additional merging lanes where needed between SR 500 in Vancouver and Columbia Boulevard in Portland, to balance traffic flow and accommodate the increased bridge capacity. These improvements include a full interchange at Columbia Boulevard.

The Task Force asked the project team to conduct additional and more detailed analysis within the BIA, extending between SR 500 in Vancouver to Columbia Boulevard in Portland, to better understand the performance characteristics and potential impacts of these recommended improvements.

The Task Force supported further exploration of HOV in the EIS, but did not recommend a specific approach to HOV facilities. According to the Task Force, "Further exploration is required in the environmental impact statement to optimize its design, particularly within the BIA; and to determine its overall effectiveness in meeting the Regional objectives for the I-5 Corridor."

HOV Access and Potential Use Levels

During the I-5 Partnership BIA analysis, eight Columbia River Crossing capacity concepts were developed representing a range of possible combinations of new and existing bridges crossing the Columbia River. Concepts 1, 4, 6, and 7 were selected for detailed design and evaluation and are shown in more detail in **Appendix A.**

Each of the four BIA Concepts involves variations in design features that affect HOV access and the resulting potential use levels. Most notably, the following design features have the greatest impact on HOV access and use in the BIA Concepts evaluated to date: 1) the use of existing, supplemental, or replacement bridges to carry HOV across the Columbia River; 2) design variations in the Vancouver C-D system; and 3) HOV treatments such as barrier separation. The potential effect of toll plaza operations is equally important but was not considered during the I-5 Partnership.

Under the BIA Concepts, not all eligible HOV users traveling on I-5 would be able to use the HOV lane. Each concept involves some level of both physical and functional restrictions on use of the HOV lane. For example, under Concept 1, the northbound HOV lane is carried across the Columbia River on the existing southbound I-5 Bridge. All northbound motorists entering I-5 from Marine Drive or Hayden Island are directed to the existing northbound I-5 Bridge and are therefore physically restricted from using the HOV lane. Under this same concept, motorists entering northbound I-5 from the high volume Denver Avenue/Victory Boulevard ramp would be required to make at least one lane change within one-quarter mile of entering the freeway to align themselves with the existing southbound I-5 bridge carrying HOV. High volumes and limited spacing on the freeway would, in our opinion, functionally restrict motorists from the Denver Avenue/Victory Boulevard ramp from accessing the HOV lane. To help visualize these examples, **Appendix A** also provides schematic diagrams of the four Columbia River crossing concepts studied within the BIA.

In assessing functional restrictions, the project team established (how was this "established" – is it a conclusion based upon statistical evidence, common engineering assumptions or some other data?) that motorists, under near free flow operating conditions, would need as much as one mile to weave across lanes from an entrance ramp to access the HOV lane. Likewise, they would need to begin their weave from the HOV lane a mile in advance to reach an exit ramp (same comment as above).

Accounting for the physical and functional restrictions to HOV access currently designed into each of the four Columbia River Crossing concepts, **Table 2** summarizes the maximum year 2020 potential HOV use at key locations along I-5 based on regional modeling performed under the I-5 Partnership. Relative to these gross numbers, actual HOV use would be lower because not all eligible HOV users take advantage of an HOV lane for various reasons such as their particular trip length and ease of access to the HOV lanes. Actual HOV use levels could be more accurately assessed through additional VISSIM modeling as mentioned previously.

Table 2 reflects differences in "potential" HOV lane use due to physical and functional restrictions designed into each of the four Columbia River crossing concepts studied within the BIA. The results are intended solely to depict the effect of HOV access on potential HOV use within the BIA. With greater access to the HOV lane designed into the corridor, one can expect greater potential HOV lane use. Previous discussion in this section of the paper regarding Concept 1 accentuates this point.

Table 2. Maximum Potential Hourly HOV (2+ Passengers per Vehicle Y 2020) Utilization at Select Locations (not including transit)

Location	Concept No.			
I-5 Location–Northbound	**1**	**4**	**6**	**7**
Northbound I-5 at Victory Blvd.	770	1490	1490	770
Northbound I-5 at Columbia River Bridge	930	880	900	770
Northbound I-5 at 4th Plain Blvd.	790	980	1010	980
I-5 Location–Southbound	**1**	**4**	**6**	**7**
Southbound I-5 at 4th Plain Blvd.	950	950	950	690
Southbound I-5 at Columbia River Bridge	940	940	990	830
Southbound I-5 at Victory Blvd.	1070	1070	980	950

(**Caution:** The values in Table 2 do not reflect estimated use of the HOV lane at the reported locations. Rather, they summarize the maximum "potential" HOV lane use if all eligible HOV users were to use the lane. Estimates of actual HOV lane use can be developed through additional modeling in the EIS process.)

The reported values are unique to (limited to or limited by?) the regional land use allocation and travel parameters built into Metro's regional model at the time of modeling in 2000 and may no longer represent a valid basis for making HOV determinations in the I-5 corridor. For evaluating HOV operations during the I-5 Draft Environmental Impact Statement (DEIS), use of the regional travel demand model is not likely to be sufficiently detailed or calibrated for I-5 use. Additional post-processing by others will ~~be~~ need~~ed~~ to be employed to better reflect potential HOV use.

Limitations of Previous Modeling

During the I-5 Partnership, the project team employed the VISSIM microsimulation traffic operations model to conduct a detailed evaluation of freeway traffic flow for four Columbia River crossing concepts. The model was set up to report performance of HOVs in general (i.e., how HOVs perform across all lanes). At that time, HOV operations were not a principal focus of the work and thus the model was not set up to isolate and specifically differentiate HOV lane operations versus general purpose lane performance factors such as:

(a) The travel time/congestion savings to HOV travelers;

(b) The travel time/congestion impact on non-HOV lane users;

(c) The amount of usage and characteristics of users of the HOV lane;

(d) Person through-put versus vehicle through-put; and

(e) The anticipated differences in the above performance factors for each of the bridge/freeway improvement options and toll rate structure options.

In preparing this WP, the intent was to assemble findings and form recommendations regarding HOV facilities from available information and not generate new information through additional modeling. Sufficient information exists to support consideration of HOV lanes. In the EIS, updated regional modeling information can be used to provide results specific to the performance factors listed above.

Summary of I-5 Partnership Findings

- Increasing I-5 Columbia River crossing capacity improves travel times for both HOV and GP lane users. While HOV users would experience a travel timesavings under all option packages, improved GP lane operations associated with Build options diminish the relative travel time advantage for HOV users compared to No Build.

- In the Final Strategic Plan June 2002, I-5 Transportation and Trade Partnership Task Force Recommendations for the BIA, the task force recommended the following "elements should be studied: …v. HOV throughout the I-5 Corridor."

- There are eight interchanges on I-5 within the four-mile section that comprises the BIA. It will be difficult for many of the HOV-eligible vehicles to access the HOV lanes when entering the I-5 system within the BIA because of the close interchange spacing, congestion during peak hours, and the likelihood the HOV lanes will be located on the inside lanes of I-5.

4. HOV POTENTIAL IN THE I-5 CORRIDOR

The following sections provide a discussion of key HOV operational parameters including: HOV occupancy thresholds, HOV time of day operations, reversible HOV lane considerations, contraflow HOV lane concepts, freight use within the HOV lanes, and implications of tolling HOV users. Each section includes recommendations for consideration in an EIS.

HOV Occupancy Thresholds

One of the ways of balancing HOV use and lane capacity while preserving adequate operations in an HOV lane is through the use of minimum occupancy thresholds. HOV eligibility criteria should be chosen to preserve reasonable traffic flow within the lane. A recognized (by whom?) minimum range that supports public perception of adequate use is about 400 to 800 vehicles per hour (vph). The upper end at where reasonable flow can be maintained is around 1,200 vph with flow becoming constrained at 1,500 to 1,800 vph.

Relating back to "potential" HOV use under the BIA concepts shown in Table 2, one would not expect to reach HOV lane use levels, even with the addition of transit, of 1,200 vph given regional travel demand forecasts to date which assumed two-person HOV occupancy levels. This is largely a function of the finding from I-5 Partnership work (see I-5 Columbia River Crossing Partnership Traffic and tolling Analysis–WP 4.3) that most trips (80 percent) have an origin or destination within

the BIA, and are thus not longer distance regional through trips that could utilize the full length of the HOV lane. However, it is likely that, with the provision of an HOV lane with direct connections to major thoroughfares, longer HOV trips would use such a facility.

If tolling is carried through the EIS, (see discussion on Implications of Tolling below), HOV lanes should end prior to entering the toll plaza. For the existing HOV lanes that remain, or if tolling is not included in the I-5 river crossing, potential use levels of a continuous HOV facility should be evaluated in the DEIS.

Time of Day Operations

There are two basic scenarios for HOV operation: during peak periods only and continuously throughout the day. At a minimum, an HOV lane should be operated during periods of peak HOV demand, which typically occurs during peak commuter hours in the morning and evening. This is particularly appropriate if the duration of congestion is generally limited to these same peak periods. Peak period-only operation can free up the HOV lane for off-peak uses and reduce possible perceptions of "empty lane syndrome."

With regard to continuous HOV operation, a prevailing philosophy is that HOV lanes should be operated to provide preferential HOV treatment whenever the freeway experiences congestion. Such operation simplifies enforcement and traffic control and may induce off-peak ridesharing.

As part of the DEIS, an evaluation of traffic operations beyond the traditional two-hour morning and evening peak will be required to assess whether peak period or continuous operation is appropriate for existing HOV lanes on I-5. An assessment of corridor operations from 5 a.m. to 8 p.m. is likely to be needed.

Reversible HOV Considerations

A reversible-flow HOV facility can be appropriate when there is a substantially higher demand traveling in one direction than in the other and when the flows reverse themselves in the other peak period. The peak/off-peak split in the design year should be at least 65 percent in one direction and 35 percent in the other to support a reversible-flow facility.

A review of year 2020 forecast demand volumes in the BIA for the LRT/3 Lanes option package, which best represents the Task Force recommendations, shows a peak/off-peak split of approximately 55/45 just south of Columbia Boulevard in Portland and a split of approximately 60/40 near 4th Plain in Vancouver. These I-5 BIA directional splits forecast for 2020 are not consistent with operation of a reversible lane system.

Those ~~Based upon the above~~ findings suggest~~,~~ reversible HOV lanes should not be considered further. However, the above findings are somewhat unique to the travel demand forecasts and underlying regional land use allocations used in 2000 by Metro for the I-5 Partnership. Revised regional and use allocations used in the DEIS may affect whether a reversible lane system should be considered further under the DEIS.

Contraflow HOV Considerations

Contraflow operation may be appropriate when the following conditions exist:

- Borrowing a lane from the off-peak direction does not induce reduced travel speeds for mixed flow;
- A minimum of 200 vph are forecast to use the lane during the first year of operation; and
- Unless the lane is safety separated using a movable barrier, use should be restricted to regular, experienced drivers (buses and possibly vanpools and taxis).

Contraflow HOV lanes were considered by ODOT and WSDOT given the existing I-5 Columbia River bridge as part of the *I-5 High Occupancy Operational Study-summary Document*, April 2000. Contraflow operation was eliminated from further consideration due to physical constraints, reduced travel speeds for off-peak mixed flow traffic, and operating and maintenance costs that were expected to be significant. For similar reasons, it is unlikely that contraflow operations would be appropriate as part of a BIA project and therefore should not be studied in an EIS.

Freight Trucks in HOV Lane

Under current policies, heavy trucks are not allowed in HOV lanes. Washington State Policy currently restricts HOV access to vehicles that are more than 10,000 gross vehicle weight (GVW). A substantial amount of freight is hauled in commercial vehicles that are less than 10,000 GVW such as United Parcel Service and other businesses' delivery vans. However, they must also meet the occupancy requirement to qualify for access to the HOV lanes. Current proposals by the Washington State Department of Transportation (WSDOT) for implementing a one-lane High Occupancy Toll (HOT) lane would allow vehicles that meet the weight standards for HOV to use the lanes. Trucks larger than 10,000 GVW would be restricted.

Allowing commercial vehicles over 10,000 GVW to have access to an HOV lane has been proposed around the country for a variety of safety and operational reasons. However, there is no record of any HOV system in the United States that allows shared use by trucks that do not meet HOV-lane weight limit and occupancy criteria. Several design, safety, and operational issues often preclude this idea such as:

(1) differing origins and destinations of commuters and truckers can be difficult to accommodate;

(2) HOV facilities often do not allow for adequate maneuvering space for large trucks; and

(3) weaving movements for trucks associated with ingress/egress of the HOV could adversely affect overall freeway operations.

The most compelling reason not to combine HOV and trucks into a shared lane is based on volume and capacity. Allowing 3+ HOV vehicles, transit, and trucks to share a lane is projected to exceed the lane capacity during peak hours. Therefore, trucks that don't meet current HOV occupancy criteria should not be permitted in the existing HOV lanes.

Implications of Tolling on I-5 HOV

Regional policies have favored increased use of carpooling, vanpooling, and transit as an option to continued reliance on the single occupant vehicle. Introduction of tolling changes most of the previous discussions of HOV within the BIA. Tolling can be used to encourage a shift to higher occupancy vehicles through price incentives. However, if there is a travel time penalty for HOV due to tolling collection methods, the incentive for HOV will be lost. And, toll plazas have the potential to substantially reduce downstream congestion and thus eliminate the benefit for HOV lanes. Therefore, toll collection scenarios will impact how dedicated HOV lanes are designated within the BIA.

HOV lanes, either one in each direction or a reversible lane, will most likely be located on the inside lanes of I-5. Under current toll plaza concepts, the two inside lanes would be reserved for high-speed electronic toll collection (ETC) with a peak hour capacity of about 1,500 vehicles per lane per hour. If one of the two exclusive high-speed ETC lanes through the toll plaza is dedicated to HOV, the lane would be slightly underutilized and could result in congestion of the remaining ETC lane. In the first several years of operation, when ETC utilization is lower and still growing, it is advisable to stop the dedicated HOV lane about one mile prior to the toll plaza and to allow all eligible ETC vehicles to use either lane through the plaza. In the long term, if ETC usage increases sufficiently, additional high-speed lanes can be added.

Existing I-5 HOV lanes are located Southbound in Vancouver and Northbound in Portland. The toll plaza will act as a mainline meter for most of the through traffic, and volume/capacity estimates downstream of the plaza indicate a near free-flow situation in the early years of operation. Thus, if the toll plaza is located either one direction or both directions, there will be no need to re-start the HOV lane downstream of the toll plaza within the BIA until warrants(? until traffic demands such an approach?) are met.

If tolling will be one direction only for I-5 and I-205, continuous HOV lanes may be warranted in the direction opposite those being tolled. Providing continuous HOV lanes across the river should be addressed in the DEIS using updated modeling to estimate benefits.

In situations where HOV eligible vehicles aren't able to access the inside I-5 HOV lanes, especially at connecting ramps close to the toll plaza, HOV enhancements such as ramp by-pass lanes can be used for priority treatment for HOV and transit. Within the toll plaza, priority lanes can be designated for ETC and HOV vehicles.

For the purpose of conducting the tolling revenue analysis, an arbitrary ETC discount is recommended for 3+ HOV eligible vehicles at 50% of the normal toll rate. In addition, transit vehicles would be free. These discounts would only be for those who purchase electronic transponders and would apply to either the high-speed ETC lanes or ETC tollbooths. HOV vehicles without electronic passes and 2+ HOV would use the manual booths and pay the regular rate.

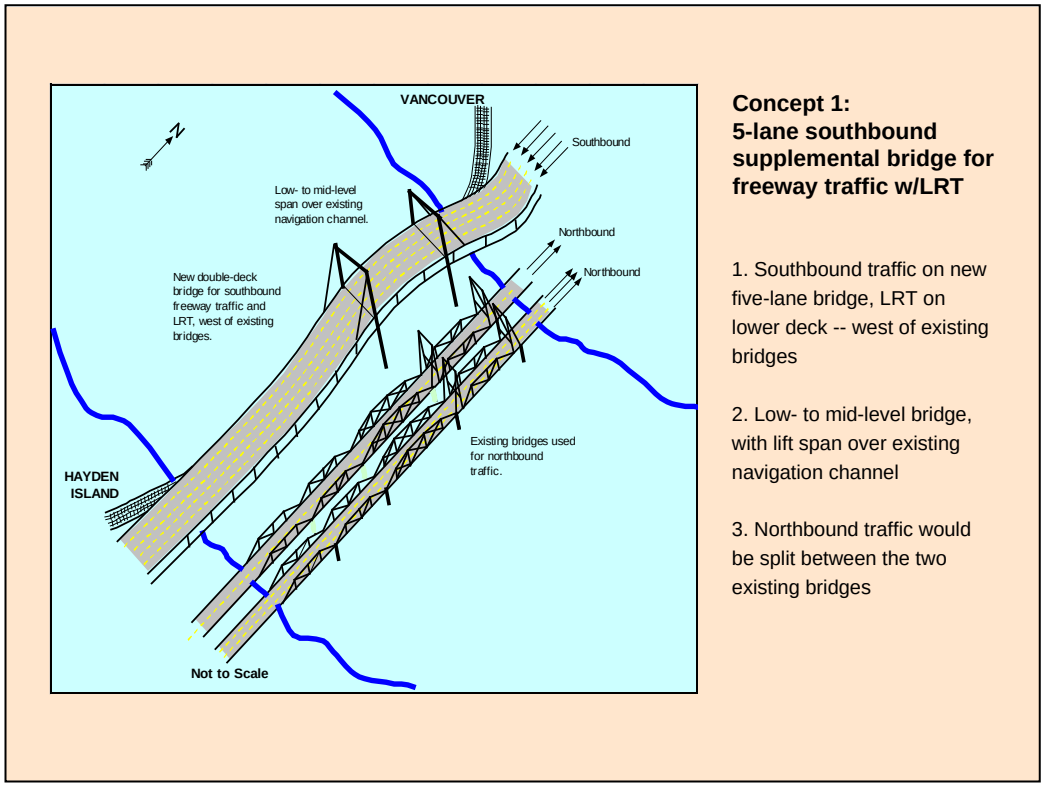
Note: The summary and recommendations are located at the beginning of this working paper.

APPENDIX A

CONCEPT LAYOUTS FOR THE BIA

Following are the four concepts that were developed in the I-5 Transportation and Trade Partnership, and are used for reference in the paper and the following sections of **Appendix A**. The concepts are four out of the eight that were originally developed, and best represent the range of crossing options. Therefore they are not numbered sequentially.

Figure A1: Bridge Concept 1



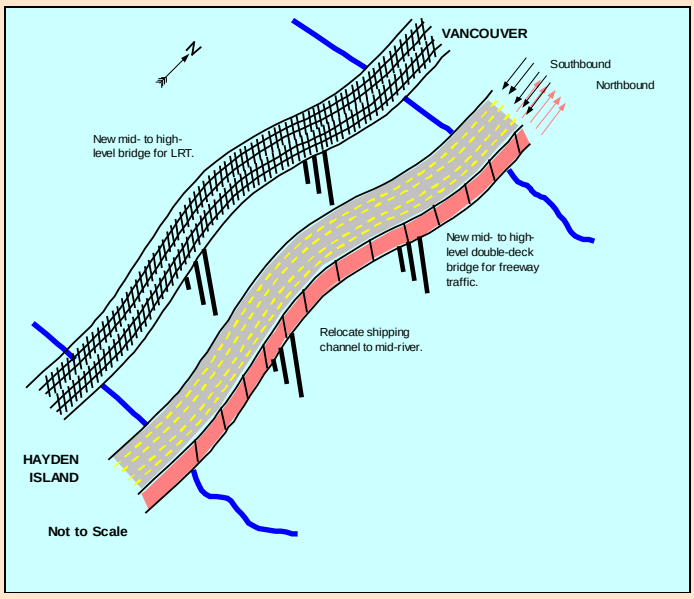
Concept 1:
5-lane southbound supplemental bridge for freeway traffic w/LRT

1. Southbound traffic on new five-lane bridge, LRT on lower deck -- west of existing bridges

2. Low- to mid-level bridge, with lift span over existing navigation channel

3. Northbound traffic would be split between the two existing bridges

Figure A2: Bridge Concept 4

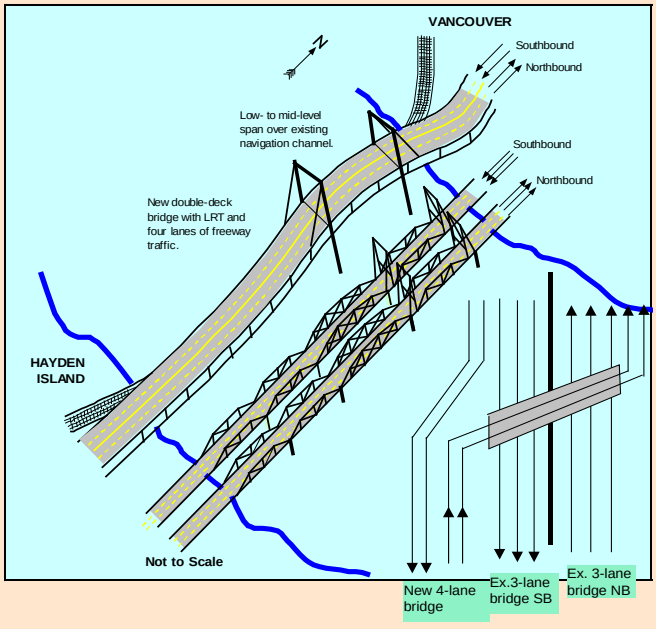


Concept 4:
10-lane double deck, replacement bridge, plus LRT on separate new bridge

1. Mid- to high-level bridges. Navigation channel relocated to center of river

2. Potential fixed spans for highway and LRT (with Coast Guard reduction of existing lift requirements), or lift spans

Figure A3: Bridge Concept 6



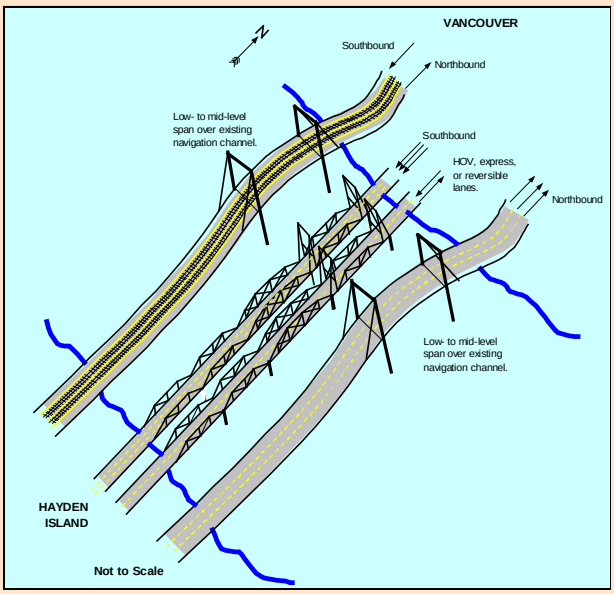
Concept 6:
4-lane supplemental collector-distributor bridge w/LRT, plus 6 lane freeway

1. Provides for new four-lane bridge with LRT west of the existing bridges

2. Low- to mid-level bridge with lift span over current navigation channel

3. Use four-lane bridge as collector-distributor (i.e., ramp access for Hayden Island, etc.). Requires fly-over ramps north and south, as shown in the schematic on the left

Figure A4: Bridge Concept 7



Concept 7:
8-lane freeway concept plus new LRT bridge with two-lane arterial

1. Provides for new four-lane bridge with LRT

2. Low- to mid-level bridges with lift spans over current navigation channel

3. Two lanes on existing northbound bridge could be used for HOV, express lanes, or (potentially) reversible lanes

HOV Features of Columbia River Crossing Concepts

During the I-5 Partnership BIA analysis, eight Columbia River Crossing capacity concepts were developed representing a range of possible combinations of new and existing bridges crossing the Columbia River. The eight bridge crossings are broadly categorized in **Table A.1**.

Table A.1. I-5 BIA Columbia River Crossing Concepts

Category 1	Category 2	Category 3
River crossings that provide five freeway lanes in each direction (Concepts 1, 2, 3, 4)	A freeway and river crossing system that provides three mainline freeway lanes in each direction, plus a four-lane collector-distributor bridge/roadway west of the freeway (Concepts 5, 6)	Four through freeway lanes in each direction plus a two-lane arterial system connecting Hayden Island to Marine Drive and downtown Vancouver (Concepts 7, 8)

Source: I-5 Partnership BIA Draft Summary April 19, 2002.

Concepts 1, 4, 6, and 7 were selected for detailed design. The configuration of HOV lanes under Concepts 1, 4, and 6 were similar in that they involved concurrent non-barrier-separated facilities. Concept 7 involved a two-lane (one lane in each direction) barrier-separated HOV facility. Key features of each of the four concepts as they affect HOV utilization, access, and operations are described in **Table A.2**.

Table A.2. I-5 BIA Columbia River Crossing HOV Features

I-5 Columbia River Crossing Concept	Key Features Related to I-5 HOV for Each Columbia River Crossing
HOV design/operational features common to each Columbia River crossing concept	• Concurrent I-5 HOV lanes (one lane in each direction) • Northbound HOV operates in median lane between Going Street and 134th Street • Southbound HOV operates in median lane between 134th Street and Lombard Street • In Vancouver, the Collector-Distributor system for interchange access effectively restricts southbound I-5 HOV lane use to trips originating north of SR 500 destined to Oregon • Northbound the HOV lane at the Columbia River bridge provides limited interchange access in Vancouver and so effectively can be used only by motorists destined to SR 500 and north
Concept 1: Five-lane southbound supplemental bridge for freeway traffic with LRT	Features specific to this Concept include: Northbound I-5: • Splits HOV and two GP lanes to existing SB I-5 Columbia River bridge providing no HOV-interchange access between Marine Drive and Mill Plain
Concept 4: Ten lanes on double-deck bridge, with LRT on separate new bridge	Features specific to this Concept include: Northbound I-5: • HOV adjacent to two GP lanes on existing NB I-5 Columbia River bridge • In Portland, HOV access is functionally limited to Marine Drive and points south • Motorists in the HOV lane at the Columbia River bridge are effectively separated from interchange access until 78th Street
Concept 6: Four-lane supplemental bridge with LRT, west of existing bridges	Features specific to this Concept include: Northbound I-5: • HOV adjacent to GP lanes on existing NB I-5 Columbia River bridge • Trips to/from Hayden Island must use parallel roadway and supplemental Columbia River crossing and effectively have no HOV lane access within the BIA
Concept 7: LRT bridge with two-lane arterial, plus new three-lane supplemental bridge for freeway	Features specific to this Concept include: • Only BIA concept that barrier separates the HOV facility in Oregon • Directional HOV facility carried on existing NB I-5 Columbia River bridge • Effectively serves through-BIA trip only with entry near Lombard and exit at Main Street and points north • Direct-connect SR 14 HOV exit to Southbound I-5 • Effectively serves through-BIA trip only with entry near Main Street and exit at Columbia Blvd. and points south

Source: Columbia River crossing schematics developed by DEA and trip origin-destination matrices developed by Metro.