3. HOV LANES

This chapter summarizes studies which focused on analysis of HOV lane segments. These include an evaluation of the existing WSDOT Core HOV lane program; an evaluation of the potential for conversion of general purpose lanes to HOV lanes; an analysis of HOV lanes through the central Seattle area; and an assessment of arterial HOV treatments on SR 522 from I-5 to Bothell. Results of these analyses, including recommended additions and deletions to the core program, are presented below.

3.1. EVALUATION OF THE CURRENT WSDOT CORE HOV LANE PROGRAM

3.1.1. Introduction

In 1991, the Washington State Department of Transportation (WSDOT) identified a regional core system of freeway HOV lanes in the Puget Sound region. This core system represented the HOV lanes within the region that WSDOT would build if funding were available. In 1994, the WSDOT Office of Urban Mobility initiated the Puget Sound HOV Pre-Design Studies Project Phase I to address expansion of the core system. The project primarily focused on identifying and evaluating direct access options to freeway HOV lanes in King and Snohomish counties; however, it also assessed the potential for converting general purpose lane to HOV use and investigated safety and enforcement issues related to HOV lanes.

Phase II of the Puget Sound HOV Pre-Design Studies integrated the results from the Phase I studies and included a task to asses the existing HOV core lane program and determine the potential for adding and/or subtracting freeway segments from the core program. This section of the report summarizes the process and results of the HOV core program assessment task.

3.1.2. Study Purpose

As part of the Phase II study, the purpose of this analysis was to evaluate and recommend segments of the regional freeway system for which adding HOV lanes would be most effective. The current HOV core system includes 276 lane miles on SR 5, SR 16, SR 167, and SR 405 stretching from Lakewood in Pierce County to south Everett (SR 526) in Snohomish County, and on SR 90 and SR 520 stretching from Seattle east to Issaquah and Redmond. The segments which were evaluated as candidate HOV segments in this study (see Figure 3-1) include those which have been previously identified as part of the core system but are as yet unfunded, as well as all other freeway segments within the central Puget Sound region that are not part of the current core program. In this report, these roadways are referred to as candidate segments.

Each of the candidate segments were evaluated based on five primary criteria and three secondary criteria. The primary criteria were given the majority of consideration during the evaluation of candidate segments. The secondary criteria were referred to primarily for segments which were considered borderline with respect to the effectiveness of adding an HOV lane. Each of the criteria is discussed in the Measures of Effectiveness section below.

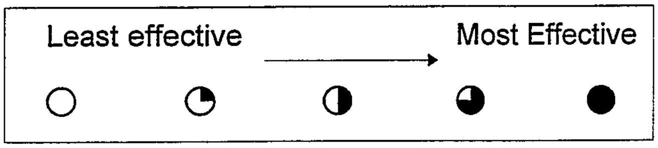
The initial list of regional highways designated as candidate segments is shown in Figure 3-1. In some cases, during the evaluation, it became apparent that some candidate segments should be divided into smaller portions to provide more cost effective HOV facilities. This is discussed as part of the discussion for each individual segment.

3.1.3. Measures of Effectiveness

Evaluation of candidate HOV facilities was conducted using Measures of Effectiveness (MOE) ratings. The MOE process was designed at the beginning of the project (see *Methodology Report*, April 1994), and was modified to fit the specific needs of the individual tasks.

MEASURE OF EFFECTIVENESS EVALUATION SCALE

Based on the measure of effectiveness (MOE) criteria, a *Consumer Reports*-style symbol is used to reflect the least effective to most effective categories to compare and rate each HOV candidate segment. A blank circle indicates the least effective and the solid circle shows the most effective. This rating is used for both primary and secondary MOEs.

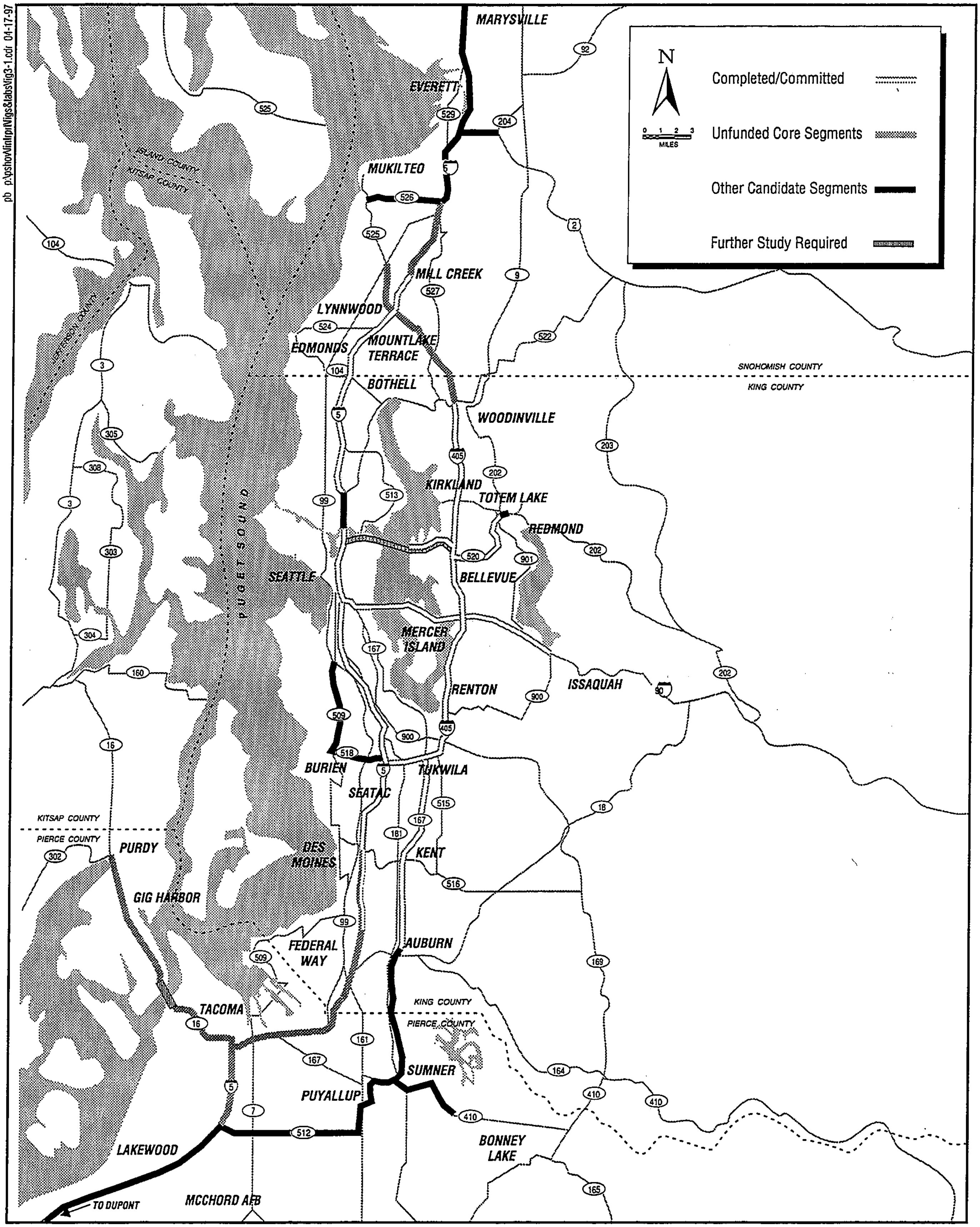


PRIMARY MEASURES OF EFFECTIVENESS

HOV Travel Time Savings

HOV travel time savings per vehicle can be calculated as a function of the estimated speed of the HOV lane and the average speed of general purpose traffic in the adjacent freeway lanes. The volume to capacity ratio of the HOV lane is a good indicator of the average speed which can be achieved by HOVs in the HOV designated lane. Adjacent general purpose traffic speeds will also affect the HOV speed achievable because drivers in the HOV lanes will reduce their average speed when general purpose traffic in adjacent lanes travel at low speed. This latter effect is due to driver discomfort and the fear of colliding with slower vehicles leaving the general purpose lanes and entering non-barrier separated HOV lanes.

Travel time savings were calculated as the difference between the travel time of an HOV on specific candidate links after application of an HOV treatment and the travel time on the same link without the benefit of an HOV improvement. In other words, the mainline HOV travel time advantage over adjacent general purpose lanes was computed by subtracting the general purpose lane travel time from the HOV lane travel time. All travel time savings calculations were evaluated assuming a 3+HOV designation on all HOV links. The 3+ designation was assumed because projected future conditions generally indicate that during peak periods a 3+ designation would be required based on WSDOT's speed and reliability policy standard.



Current and Candidate Freeway HOV Lane Segments

Puget Sound HOV Pre-Design Studies

Final Report

FIGURE 3-1

Travel time savings are presented as peak period and daily person minutes saved per mile. Conversion from vehicle travel time savings to peak period person travel time savings was computed based on an average non-transit HOV vehicle occupancy of 3.1 persons per vehicle. Peak period transit ridership estimates (i.e., for a 3 hour AM peak and 3 hour PM peak period) were developed based on input from the Pierce, King County Metro, and Community Transit agencies as documented in the *Travel Time Savings Summary Report*. HOV travel time savings were calculated separately for transit and non-transit to account for the differing occupancies of the two HOV types. The converted peak period person travel time savings estimates were then divided by the length of the candidate segments to compute minutes saved per mile and provide a consistent means of comparing competing candidate segments of differing lengths.

For evaluation purposes, an evaluation scale was developed based on the estimated travel time savings an HOV lane would provide on each of the candidate segments. The evaluation scale is based on the regional median time savings realized from the set of candidate corridors evaluated. The regional median non-transit HOV travel time savings for the candidate links for addition to the core system was estimated at 2,205 person minutes per mile, and the regional median transit travel time savings at 315 person minutes per mile. A relative ranking scale was developed for non-transit and transit separately resulting in the following categories:

- ○ Projects estimated to provide less than 40 percent of the median travel time savings provided by all the candidate corridors (lowest ranking).
- ◔ Projects providing between 40 and 80 percent of the median travel time savings.
- ◑ Projects providing between 80 and 120 percent of the median travel time savings.
- ◕ Projects providing between 120 and 160 percent of the median travel time savings.
- ● Projects providing greater than 160 percent of the median travel time savings (highest ranking).

Traffic Congestion

Existing and future year traffic congestion was measured using the basic freeway segment methodologies contained in the Highway Capacity Manual. Those facilities calculated to have LOS D or better during the AM and PM peak hours were given a lower ranking, because HOV facilities will be most successful where competing general purpose lanes are very congested. Candidate facilities with LOS E or worse were given a higher ranking for inclusion. Categories were as follows:

- ○ No traffic congestion—Level-of-Service D or better on the entire segment.
- ◔ Minimal Traffic Congestion—Small portions of segment experience Level-of-Service E or worse.
- ◑ Moderate Traffic Congestion—Significant portions of segment experience Level-of-Service E or worse.

◕ Significant Traffic Congestion—Majority of segment experiences Level-of-Service E or worse.

● Severe Traffic Congestion—Entire segment experiences Level-of-Service E or worse.

HOV System Continuity

Projects permitting connections with existing HOV lane segments to provide the user with a continuous HOV lane are given a higher ranking. Categories were as follows:

○ Provides no connections between existing or candidate HOV segments.

◔ Provides connection to the end of another HOV candidate segment.

◑ Provides connection in between two other HOV candidate segments or to the end of an existing / committed HOV facility.

◕ Provides connection between existing / committed and candidate segments.

● Provides connection in between two existing / committed HOV facilities.

Cost Magnitude

Opportunities to provide HOV facilities for minimal cost, such as the conversion of a general purpose lane ranked high for this MOE. Also, locations where there are very wide shoulders and/or medians which would result in lower cost construction also ranked high. Analysis was based on evaluation of the WSDOT 20-Year System Plan order of magnitude cost estimates supplemented with evaluation of cost potential based on site visits. Note that the cost magnitudes are in cost per mile. Hence, total cost for a candidate segment may be very expensive but the cost magnitude per mile has a higher ranking because it covers a longer length when compared to other candidates. Ranking categories were as follows:

○ Greater than $20 million per directional mile.

◔ Between $15 and $20 million per directional mile.

◑ Between $10 and $15 million per directional mile.

◕ Between $5 and $10 million per directional mile.

● Less than $5 million per directional mile.

SECONDARY CRITERIA

Potential for Public Controversy

The potential for public controversy was subjectively estimated by the study team on a segment by segment basis, ranking categories were as follows:

- ○ High potential for public controversy.
- ◔ Significant potential for public controversy.
- ◑ Moderate potential for public controversy.
- ◕ Minimal potential for public controversy.
- ● No potential for public controversy.

Consistency with Plans

Segments contained in existing regional plans, such as Vision 2020, were given a higher ranking. Three ranking categories were developed for this MOE, which are as follows:

- ○ Proposed HOV segment is not part of any existing regional plans.
- ◑ Proposed HOV segment is part of some regional plans.
- ● Proposed HOV segment is part of all regional plans.

Consistency with Regional Transit Plan Proposal

The Regional Transit Plan calls for HOV facilities in most of the proposed VISION 2020 HOV corridors. In the future, voters may decide whether rail transit will be constructed in the Puget Sound region. Once that has been decided, prioritization of HOV corridors may be changed. The HOV focus could shift to corridors where bus service will not be replaced by rail facilities, and / or to portions of the region where rail service will take longer to implement. Priority for this MOE was given to segments in potential bus corridors. The following three ranking categories were used:

- ○ Proposed HOV segment is not part of any potential major bus corridor.
- ◑ Proposed HOV segment is located in a potential major bus corridor.
- ● High potential for inclusion in the RTP plan as a major bus corridor.

3.1.4. Analysis of Individual Segments

As mentioned previously, the candidate segments which were evaluated HOV lanes, are either unfunded segments of the previously proposed core HOV system or highway segments proposed for HOV treatments taken from other regional plans. A summary of the evaluation for each of the candidate segments is described for key MOEs individually by direction. Rankings for each MOE for each segment are presented in Tabular format in Table 3-1 and Figure 3-2 at the end of this section.

SR 2 (BETWEEN SR 5 AND SR 204)

This segment of SR 2 is currently under construction. The design calls for two new lanes in the eastbound direction in addition to the two existing lanes in the westbound direction. The new eastbound facility is designed with 12-foot lanes, a 10-foot wide right shoulder and a four foot wide inside shoulder and should help mitigate some of the existing congestion resulting from high volumes, narrow lanes and minimal shoulders. However, the westbound roadway will remain with its 3-foot inside and outside shoulder effectively eliminating any potential for an interim HOV lane with deviated shoulders and lane widths. Both westbound and eastbound facilities are entirely on viaduct and would be extremely expensive to widen for an HOV lane. Traffic congestion criteria for this segment is given a moderate scale for eastbound and relatively low for the westbound facilities. As a result, this segment is not recommended for addition to the core lane system.

Recommendation

Do not include in the core lane system.

SR 5 (BETWEEN MILL CREEK / 164TH STREET SW AND SR 526)

This segment of SR 5 provides an opportunity for a relatively inexpensive HOV lane addition. The existing facility has a wide median and shoulders that could accommodate the required widening for an HOV lane with relatively few spot deviations from design standards at undercrossings. This segment also provides good HOV connectivity as it is linked on one end to an existing HOV facility. This portion of SR 5 is expected to experience a moderate level of traffic congestion in the future with at least one roadway link between interchanges operating at level-of-service E or worse in both the AM and PM peak periods. Transit and non-transit HOV travel time savings were moderate to high ranks when compared to other candidate segments.

Recommendation

Include in the core lane system.

SR 5 (SR 526 TO MARYSVILLE)

This candidate segment is divided into two links. The first segment is between SR 526 to SR 2 and the second segment is between SR 2 to Marysville. In the vicinity of downtown Everett, there are several long overcrossings including bridges over Union and Steamboat Sloughs and the Snohomish River that would require widening to accommodate an HOV lane. Hence, the preliminary conceptual cost shows high magnitude for these segments.

Overall, the first segment has equal or higher rankings across all MOEs when compared to the second segment. It also has more congestion and better HOV connections since it would connect to the end of another recommended HOV lane segment to the south.

Consistency with the RTP proposal criteria for the first segment is given the highest rating and the second to highest for the second segment.

Recommendation

Add SR 5 between SR 526 and SR 2 to the core lane system.

SR 5 (BETWEEN SEATTLE CBD AND RAVENNA BOULEVARD)

This section of I-5 was analyzed in depth as part of the Central Seattle HOV Lane Analysis Task. A more detailed description of that analysis is presented later in this chapter. What follows here is an assessment of the recommended HOV lane segment from that analysis in comparison with other HOV core lane segments.

The proposed HOV facility in this segment is a southbound contra-flow HOV lane on the express lanes roadway during the PM peak between Ravenna Boulevard and Mercer Street in downtown Seattle. Severe congestion is prevalent in this section when the express lanes are operating northbound, yet there are no HOV facilities available for southbound traffic.

This segment ranked strong in almost all MOE categories except for cost and consistency with the RTA proposal. A new RTA proposal was approved by voters on November 5, 1996, and includes a rail link between the University District and downtown Seattle. In this case, the contra flow lane would serve a less critical need for transit, yet would still provide a critical link for non-transit HOVs. If a University District to downtown rail link is not provided, then the contra flow lane would be essential as a transit link. In this case it is recommended that it be a transit only facility.

Recommendation

The southbound contra-flow HOV on the express roadway during the PM peak period should be included in the core lane system.

SR 5 (BETWEEN SR 512 AND DUPONT)

HOV lanes on this candidate segment are recommended for inclusion in the core lane system for several reasons. Heavy congestion along in this segment is anticipated in the future with the majority of the segment operating at LOS E during some portion of the peak periods. As a result of the poor level-of-service, non-transit HOV travel time savings are estimated to be moderate in the northbound direction and relatively high in the southbound direction. Transit travel time savings are expected to rank at a moderate level. This segment receives a relatively low ranking for the HOV continuity criterion as it provides connections only to other recommended HOV facilities. However, this segment of SR 5 would be a key element in the development of an integrated HOV system in Pierce County.

Recommendation

Include in the core lane system.

SR 5 (BETWEEN SR 512 AND PUYALLUP RIVER BRIDGE)

HOV lanes for this candidate segment are recommended for inclusion in the core lane system. The segment is projected to experience traffic congestion with the majority of the segment operating at LOS E or worse during the peak periods. The resulting travel time savings are also ranked very high as the northbound portion of this segment has the greatest travel time savings per mile of all the segments documented in this memorandum. The cost magnitude for this segment is also relatively high however, as it passes through an urban area. Some right of way takes would be required and numerous interchanges would need to be rebuilt to accommodate an HOV facility. This facility received a moderate ranking for HOV continuity as it provides a link in between several other recommended HOV facilities.

Recommendation

Include in the core lane system.

SR 5 (BETWEEN PUYALLUP RIVER BRIDGE AND SOUTH 320TH)

Although the congestion and travel time savings are limited, this segment would provide a connection to the existing / committed northbound HOV lanes which terminate at South 320th Street and the HOV lanes recommended between SR 512 and the Puyallup River Bridge. The physical characteristics of the segment (i.e., wide median, shoulder, few interchanges etc.) would enable its relatively inexpensive construction, resulting in a favorable ranking for cost magnitude.

Recommendation

Include in the core lane system.

SR 5 SOUTHBOUND ONLY (SOUTH 320TH TO SR 516)

HOV lanes are recommended for this candidate segment. Travel time savings for both transit and non-transit are among the highest in candidate corridors. Cost magnitude and HOV continuity are favorable. The HOV lane addition will complement the northbound HOV lane through this segment.

Recommendation

Include in the core lane system.

SR 16 (BETWEEN PURDY AND SR 5)

HOV lanes are recommended for specific sections of this overall candidate segment. The approaches leading to the Tacoma Narrows Bridge have significant levels of traffic congestion in the peak direction and hence provide the potential for significant travel time savings for vehicles in an HOV lane. Since it is one of the public-private partnership projects, the Narrows Bridge will require further study and public process before any decisions are made regarding the addition of any new lanes on the bridge. However, there is still potential for the implementation of successful HOV lanes in the SR 16 corridor due to two primary factors.

1. In the event that the Narrows Bridges is not modified, a number of strategies have been developed and evaluated that mitigate the impact of the merging activity between the vehicles in the HOV lane and the general purpose.

2. Origin and destination data obtained from a recent (1993) Washington State Ferries survey of drivers traveling on the SR 16 corridor (at the Narrows Bridge) indicated that 40-50% of the users do not travel all the way to SR 5, therefore HOV lanes facilitating movement across the bridge would still provide benefit even if they did not extend all the way to SR 5.

The segment has two portions, which provide benefits even without a new bridge: the approaches to the Narrows Bridge (both eastbound and westbound) and the Nalley Valley viaduct with direct HOV connections to SR 5.

SR 16 (Approaches to Narrows Bridge)

HOV lanes are recommended for these segments. With the elimination of the Nalley Valley viaduct portion of the overall segment, the cost magnitude for the SR 16 approaches was ranked as moderate. The segment experiences extreme levels of congestion and an HOV lane in the segment would produce the significant travel time savings in terms of allowing HOVs to bypass the queues resulting from the bridge bottle necks.

Recommendation

Add HOV lanes on the approaches to the Narrows bridge (both directions) to the core system.

SR 16 (Nalley Valley Viaduct)

This segment is analyzed as part of the freeway-to-freeway HOV connection assessment for the SR 16 / SR 5 interchange and discussed in more details in the technical memo presented in the results of that analysis[1].

Recommendation

Provide connections to/from the north at interchange.

SR 167 (BETWEEN SR 512 AND SR 18)

This candidate segment is recommended for inclusion in the core system. The segment ranked high for HOV continuity as it connects the existing HOV facility on SR 167 extending between Auburn and Tukwila to the recommended facility on SR 512. The segment is expected to experience significant levels of congestion with the majority of the segment

[1] See Puget Sound HOV Pre-Design Studies Phase II, Refinement of Direct Access and Freeway-to-Freeway Connections Evaluation, March 1996.

operating at LOS E or worse during the peak periods. The travel time criteria was ranked slightly lower than congestion as a result of the relatively low total traffic volumes on the facility. The cost magnitude was given a favorable ranking due to the physical features of the corridor and expected cost.

Recommendation

Include in the core lane system.

SR 405 (BETWEEN SR 522 AND SR 5)

This candidate segment is recommended for inclusion in the core system. HOV lanes here would provide a key segment to the regional HOV system by connecting the existing / committed HOV lanes located between Woodinville and Bellevue, north to the SR 5 / Swamp Creek interchange and the existing HOV lanes on SR 5. The level of congestion for the facility is very directional with the northbound portion of this candidate segment experiencing significant congestion with a majority of the interchange to interchange segments experiencing level-of-service E or worse conditions during the peak period. The congestion occurs primarily in the PM peak period and results in a moderate to high ranking for travel time savings.

For continuity and consistency reasons, it is recommended that HOV lanes be installed in both directions. The cost magnitude for this candidate segment is primarily affected by the need to widen long bridges in the Woodinville and Swamp Creek interchanges. The remainder of the segment has available right of way and could be constructed with minor deviations to shoulder and lane widths at selected over and undercrossings.

Recommendation

Include in the core lane system.

SR 509 (BETWEEN SR 518 AND 1ST AVENUE S. BRIDGE)

This candidate segment is not recommended to be included in the core segment. Once First Avenue South bridge is completed, existing northbound congestion should be alleviated and the segment is expected to experience minimal levels of congestion. It would therefore not be able to generate travel time savings for vehicles in an HOV lane significant enough to justify costs. The segment does not provide any needed HOV lane continuity as it is connected only to SR 518 (another candidate segment which has not been recommended for the core system). The cost magnitude for this segment is moderate to poor and does not offset any limitations in congestion and potential travel time savings.

Recommendation

Do not include in the core lane system.

(Note: If a decision is made to extend SR 509 South as a limited access facility to connect with I-5, then this recommendation would need to be reconsidered.)

SR 512 (BETWEEN SR 5 AND SR 167)

This segment received low rankings for level of congestion and travel time savings are limited for vehicles in an HOV lane. The main source of delay for this facility is the SR 512 / SR 5 interchange which currently has weaving and merging areas that are operating at level-of-service E or F. An HOV lane would not address this problem. The facility does provide HOV continuity as it links the proposed HOV facilities on SR 5 and SR 167. The cost magnitude for this facility was ranked as moderate.

Recommendation

Do not include in the core lane system.

SR 518 (BETWEEN SR 5 AND SR 509)

This candidate segment ranked low for most of the primary criteria. It is expected to experience relatively low traffic congestion in the future during the peak periods and as a result has limited potential to generate travel time savings for vehicles in an HOV lane. In addition, the segment is very constrained and has numerous factors (e.g., constrained structures as it passes under SR 5, limited right of way, narrow shoulders, no median) which result in a poor cost magnitude ranking. The segment does receive a high ranking for HOV continuity as it would provide a connection to SR 5 and SR 405 HOV facilities.

Recommendation

Do not include in the core lane system.

SR 520 EASTBOUND (EVERGREEN POINT BRIDGE TO NE 108TH STREET)

This segment is not recommended for an HOV lane at this time because it would be unnecessary until HOV lanes can be continued across the bridge. The existing westbound shoulder HOV lane leading to the bridge is extremely effective considering the current situation requiring its termination at the east end of the bridge. Note that the HOV lanes on the bridge are not considered in this analysis because they are subject to the proposed private-public partnership projects and require further study.

Recommendation

Do not include in the core lane system.

SR 525 (BETWEEN SR 5 AND SR 99)

This segment recommendation is subject to decisions on the ultimate roadway cross-section. If the current configuration of one lane in each direction on SR 525 is increased to two general purpose lanes as planned, then HOV lanes will not be effective because there would be minimal congestion on the general purpose lanes resulting in minimal travel time savings for HOVs. However, if only an HOV lane is added to the current condition, the general purpose congestion on the one lane roadway would be quite significant and the HOV lane would be extremely effective in providing HOV travel time savings. Hence, HOV lanes are recommended if the roadway will have only one general purpose lane in each direction.

Recommendation

If roadway cross section includes only one general purpose lane in each direction, inclusion in the core lane system is warranted. If there are to be two general purpose lanes in each direction, inclusion is not warranted.

SR 526 (BETWEEN AIRPORT ROAD AND SR 5)

This segment is recommended for inclusion in the core lane system. This segment connects the Boeing Plant with SR 5. HOV lanes on this segment will tie into planned HOV lanes on SR 5. Travel time savings rating for both non transit HOV and transit are very high and they also have a relatively high rating for traffic congestion. This roadway has been the subject of a separate study.[2]

Recommendation

Include in the core lane system.

3.1.5. Conclusion

Based on the measures of effectiveness evaluation as summarized in Table 3-1, in addition to the existing core HOV lane program, HOV lanes are recommended on the following segments:

- SR 526 between Airport Road and SR 5.
- SR 167 between Puyallup and SR 18.
- SR 5 between DuPont and SR 512.
- SR 5 between SR 526 and SR 2.
- SR 5 southbound contraflow, NE 65th Street to downtown Seattle (conditional recommendation).

The following segments are recommended for deletion:

- SR 16 except for bridge approaches and SR 5 interchange (contingent on bridge and SR 5 interchange vicinity decisions).
- SR 525 (unless no general purpose lanes are added).
- SR 520 eastbound, between bridge and 108th (contingent on bridge decisions).

Figure 3-2 shows the total recommended regional HOV lane system. As indicated above, the contraflow southbound HOV lane on the SR 5 express roadway between Ravenna Boulevard and downtown Seattle is conditionally recommended. It is one of the most congested in the region with the highest transit ridership in the region. As documented in the Central Seattle HOV Analysis Technical Memorandum, this proposal is only conditionally recommended because it creates some impacts to northbound PM peak period traffic which need to be further addressed prior to an ultimate recommendation, and it ties closely to a regional decision on the RTA.

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[2] SR 526 HOV Alternative Study by Parsons Brinckerhoff, Inc. August 7, 1992.

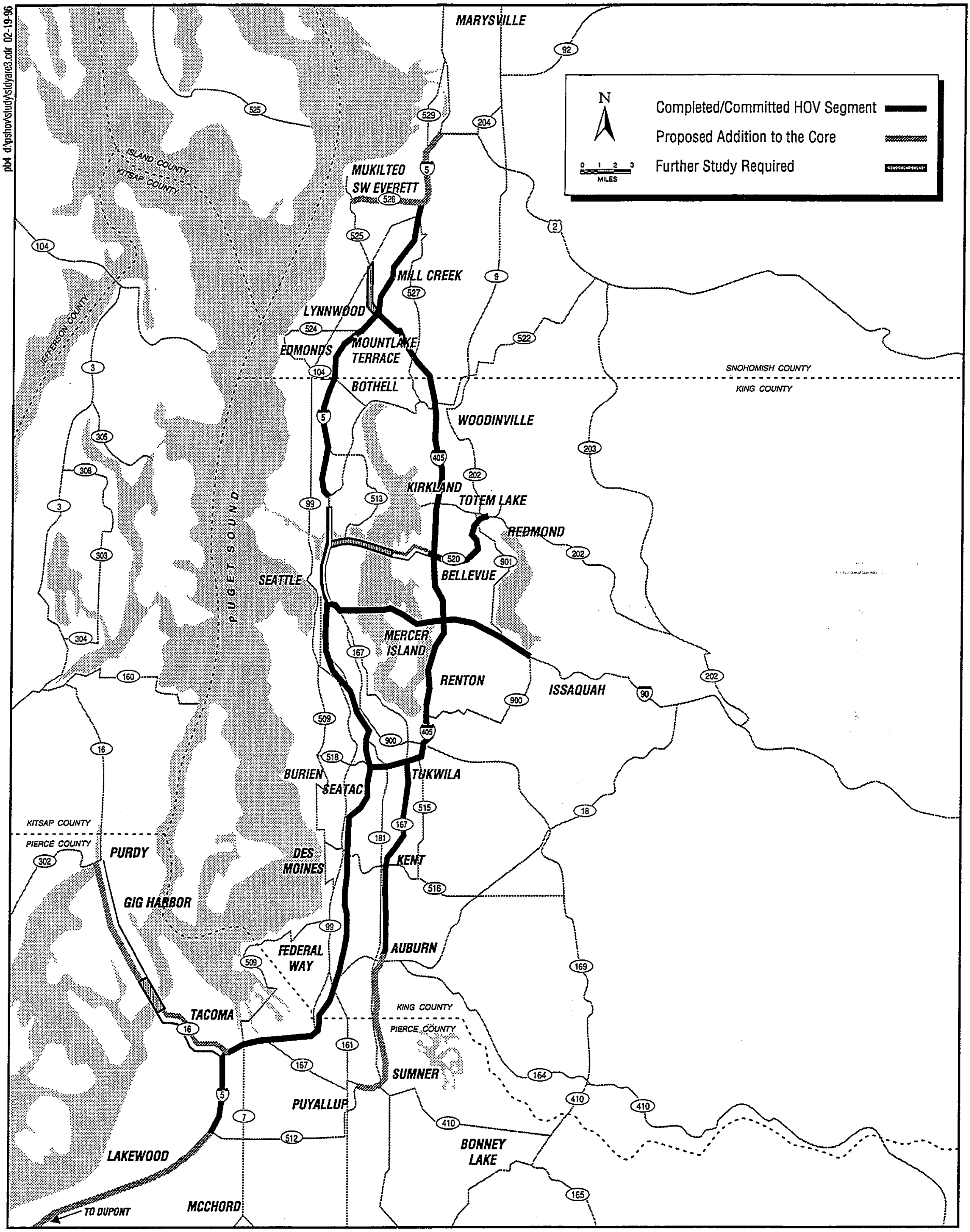
Table 3-1
Regional Freeway HOV Lane System Evaluation

CRITERIA RANKING

1	2	3	4	5
○	◔	◑	◕	●
Least Effective				Most Effective

Segment	Primary Criteria					Secondary Criteria				
	Transit Travel Time Savings	HOV 3+ Travel Time Savings	Traffic Congestion	HOV Lane Continuity	Cost Magnitude****	Potential for Public Controversy	Consistency with Plans	Consistency with RTA Proposal	Recommended for Core System	Preliminary Conceptual Cost* (Millions)
SR 2 (Between SR 5 and SR 204) - EB	◔	●	◑	◔	◔	◕	◑	◑	No	$80.0
SR 2 (Between SR 5 and SR 204) - WB	○	◕	◔	◔	◔	◕	◑	◑		
SR 5 (Between DuPont and SR 512) - SB	◔	●	◕	◔	◑	◕	◑	◑	Yes	$152.5
SR 5 (Between DuPont and SR 512) - NB	◔	◑	◕	◔	◑	◕	◑	◑		
SR 5 (Between SR 512 and Puyallup River Br.) - NB	●	●	◕	◑	○	◕	●	●	Yes	$416.6
SR 5 (Between SR 512 and Puyallup River Br.) - SB	○	◑	◕	◑	○	◕	●	●		
SR 5 (Between Puyallup River Br. and S. 320th) - NB	○	◔	○	◕	●	◕	●	●	Yes	$123.1
SR 5 (Between Puyallup River Br. and S. 320th) - SB	●	◕	○	◕	●	◕	●	●		
SR 5 (From SR 516 to S. 320th) - SB	●	●	◑	◕	◕	◕	◑	●	Yes	$40.1
SR 5 (Between NE 65th St and Downtown Seattle) - SB**	●	●	◕	●	○	◑	◑	○	Yes	$53.5
SR 5 (Between 164th and SR 526) - NB	◑	●	◑	◕	●	◕	●	●	Yes	$23.4
SR 5 (Between 164th and SR 526) - SB	●	◕	◑	◕	●	◕	●	●		
SR 5 (Between SR 526 and SR 2) - NB	●	●	◑	◑	◕	●	◑	●	Yes	$83.0
SR 5 (Between SR 526 and SR 2) - SB	●	●	◑	◑	◕	●	◑	●		
SR 5 (Between SR 2 and Marysville) - NB	○	○	◔	◔	◔	◕	◑	◑	No	$56.0
SR 5 (Between SR 2 and Marysville) - SB	○	○	◔	◔	◔	◕	◑	◑		
SR 16 (Between Purdy and Narrows Bridge) - EB	●	●	◕	◔	◔	◕	◑	◑	Yes	$38.5
SR 16 (Between SR 5 and Narrows Bridge) - WB	●	●	◕	◔	◔	◕	◑	◑		$91.7
SR 167 (Between SR 512 and SR 18) - SB	○	○	●	◕	●	◑	◑	◑	Yes	$67.8
SR 167 (Between SR 512 and SR 18) - NB	○	○	◕	◕	●	◑	◑	◑		
SR 405 (Between SR 522 and SR 5) - NB	●	◑	◕	●	●	●	●	●	Yes	$46.7
SR 405 (Between SR 522 and SR 5) - SB	●	◑	◔	●	●	●	●	●		
SR 410 (Between SR 167 and Sumner) - EB	na	○	○	◔	◕	◑	◑	○	No	$12.6
SR 410 (Between SR 167 and Sumner) - WB	na	○	○	◔	◕	◑	◑	○		
SR 509 (Between SR 518 and SR 99) - NB	na	○	○	◔	◕	◕	◑	○	No	$90.6
SR 509 (Between SR 518 and SR 99) - SB	na	○	○	◔	◕	◕	◑	○		
SR 512 (Between SR 5 and SR 167) - EB	○	○	◔	◑	◕	◕	◑	◑	No	$132.6
SR 512 (Between SR 5 and SR 167) - WB	○	◑	◔	◑	◕	◕	◑	◑		
SR 518 (Between SR 5 and SR 509) - EB	◔	○	○	◕	◑	◕	◑	◑	No	$63.3
SR 518 (Between SR 5 and SR 509) - WB	○	○	○	◕	◑	◕	◑	◑		
SR 520 (Between Evergreen Br. and 108th) - EB	●	◔	○	◕	○	◑	●	●	No	$89.7
SR 525 (Between SR 5 and SR 99) - NB (1 HOV, 1 GP Ln)***	●	◑	●	◑	◕	◑	◑	◑	Yes	$36.6
SR 525 (Between SR 5 and SR 99) - SB (1 HOV, 1 GP Ln)***	◑	○	●	◑	◕	◑	◑	◑		
SR 525 (Between SR 5 and SR 99) - NB (1 HOV, 2 GP Ln)***	○	○	○	◑	◕	◕	◑	◑	No	NA
SR 525 (Between SR 5 and SR 99) - SB (1 HOV, 2 GP Ln)***	○	○	○	◑	◕	◕	◑	◑		
SR 526 (Between Airport Rd and SR 5) - WB	●	●	◕	◔	◑	◑	◑	◑	Yes	$19.8
SR 526 (Between Airport Rd and SR 5) - EB	●	●	◕	◔	◑	◑	◑	◑		

* Cost includes both directions, unless otherwise noted.
** Permanent SB HOV lane on Express Lanes with Ravenna Blvd and Mercer Street Crossovers.
*** Includes new interchange at SR 99.
**** Cost per mile
Source: *Parsons Brinckerhoff*



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Proposed Additions to Regional Freeway HOV Lane System

Puget Sound HOV Pre-Design Studies

Final Report

FIGURE 3-2

PB 100 YEARS

3.2. GENERAL PURPOSE TO HOV LANE CONVERSION

Conversion of general purpose freeway lanes to HOV was included in this study as an economical alternative to freeway widening. It is recognized that lane conversion is a very sensitive issue and requires guidelines and broad public input.

3.2.1. Task Purpose

The purposes of this task included:

- Documentation of public opinion regarding the conversion of general purpose lanes to HOV-only use.
- Documentation of the technical advantages and disadvantages of lane conversion under various circumstances.
- Creation of policy guidelines for lane conversion.
- Development of a list of potential applications for the current study.

A collaborative process with a diverse Stakeholder Committee was used to develop the guidelines. Data presented in the *System-Wide Traffic Analysis, Traffic Data Atlas* was reviewed, and public opinion research was conducted, including organized interest groups, a random telephone survey of more than 800 King, Pierce, and Snohomish County freeway users, and a series of interviews with transportation activists, elected and public agency officials, and business leaders. The results of the telephone survey and personal interviews revealed support for HOV lanes and lane conversion, and were documented in *Working Paper #1: Public Acceptability of Lane Conversion.* Selected technical studies were then conducted to determine the expected impacts of conversion on traffic flow and travel patterns, and were documented in *Working Paper #2.* Finally, an analytical screening technique was developed and applied to identify the most promising candidates for lane conversion. A summary of these efforts is provided below; the reader is referred to the finalized document, *General Purpose to HOV Lane Conversion, Draft Task Report,* and *Potential HOV Lane Conversion Candidate Segments, Draft Task Report,* JHK & Associates, Seattle, WA, April 1995, for further detail.

Policy guidelines were developed to address the following three issues:

1. What would be the most positive conditions for successful conversion?
2. What revisions to WSDOT HOV policies should be suggested?
3. What guidelines can be created for application to specific projects?

3.2.2. Stakeholders Committee Findings

The Stakeholders Committee findings are summarized below.

Conditions under which HOV lane conversion would be most successful:

- The converted lane would carry more person-trips with faster travel times than a GP lane.
- Adjacent GP lanes would not degrade beyond LOS E.
- Traffic would not be diverted to parallel arterials.
- The converted lane would be significantly more cost-effective than a new lane.

- The converted lane could be implemented much more quickly, and with fewer disruptions, than an added lane.
- There is positive community, political, and policy (land use) support.
- The conversion is consistent with the HOV system.
- Existence of HOV support programs (van pools, etc.) within the corridor.

Suggested revisions to existing WSDOT HOV policies:

- Conversion shall be one of the alternatives to be considered for new capacity options.
- Conversion should be particularly considered under the following circumstances:
  - Conversion would not degrade GP traffic beyond LOS E;
  - Conversion is possible during other construction activities;
  - Conversion could serve as an interim HOV treatment;
  - Conversion could complete a key link of the core HOV system;
  - Public acceptability of conversion would benefit from timing with other projects (e.g., construction of the conversion is phased with other corridor construction projects);
  - Conversion could enhance the success of existing HOV / ridesharing programs.
- The converted lane would be operated consistently with other HOV lanes.
- The decision should reflect both technical implications for operations as well as a documented public preference.

Screening guidelines for evaluation of specific projects:

- **Functional Adequacy,** including HOV lane usage, GP lane usage, parallel routes, and HOV system connectivity.
- **Operational Factors,** including vehicle types, hours of operation, and occupancy requirements.
- **Financial Viability,** including comparative cost to an added lane, as well as overall cost-effectiveness.
- **Implementation Issues,** including timing and construction impacts.
- **Environmental Impacts,** including air quality, energy savings, noise levels, surface water, wetlands, and changes in corridor travel demand.
- **Public and Political Acceptability**.
- **Other Factors,** including consistency with other adopted plans, and the existence or implementation of support programs.
- **MOEs,** traditional MOEs including HOV vs. GP travel time, overall person throughput, travel time reliability, vehicle occupancy, accident rates, and other MOEs as defined by scope for each project.

These screening guidelines were applied to five examples in locations within the region with varying traffic volumes, peaking characteristics, potential HOV usage, safety conditions, and HOV system connections. These five locations were chosen to illustrate how the criteria might apply in five widely different settings.

Recommended actions as a result of this task include:

1. Adoption of refined policies by WSDOT relating to lane conversion, and
2. Preparation of lane conversion administrative guidelines to be considered by WSDOT project managers during the evaluation of future HOV corridors and design projects.

3.2.3. Potential HOV Lane Conversion Candidate Segments

DEVELOPMENT OF ANALYTICAL SCREENING TECHNIQUE

Prior to the application of the lane conversion screening technique, a set of screening criteria was established for the selection of the most promising HOV lane sections. There are many screening criteria to be considered in determining the public acceptance and feasibility of converting an existing mixed-flow lane to a HOV lane. Based on input from the stakeholder group, review of the literature, and technical discussions, the screening criteria and their threshold values were selected. Engineering judgment on the part of consultant team was an important component in selecting the threshold values. The screening criteria are listed below and described with their threshold values.

1. **Minimum Flow in the HOV Lane:** Whether the HOV lane had sufficient traffic demand was examined. The concern was that the public would view the HOV lane as not being adequately utilized. The threshold for this traffic characteristic was expressed as the lowest flow (or demand-to-capacity ratio) that would be perceived by the public as the HOV lane being adequately utilized. A minimum flow of 300 vehicles per hour in the HOV lane (a demand-to-capacity ratio of 0.20 if the capacity of the HOV lane is assumed to be 1,500 vehicles per hour) was selected as the threshold value.

2. **Maximum Flow in the HOV Lane:** Maximum flow was examined to determine whether the HOV lane would have sufficient reserve capacity for future HOV vehicles. Without sufficient reserve capacity, there could be no growth potential for the expected increase in the number of HOV vehicles. A maximum flow of 1,200 vehicles per hour in the HOV lane (a demand-to-capacity ratio of 0.80 if the capacity of the HOV lane is assumed to be 1,500 vehicles per hour) was selected as the threshold value.

3. **Maximum Flow in the Mixed-Flow Lane:** To determine whether the congestion would result in the mixed-flow lanes, those sections where demands exceeding their capacity were identified. The concern was that if the conversion of an existing mixed-flow lane to a HOV lane resulted in congestion, then this would not be acceptable to the non-HOV vehicles and would also cause HOV vehicles to have difficulty in entering and leaving the converted HOV lane. The threshold value was selected as a demand-to-capacity value of 1.00 or less.

4. **Differential in Level of Service between the Mixed-Flow Lanes and the HOV Lane:** The difference in level of service between the mixed-flow lanes and the HOV lane was examine to ensure that the level of service in the HOV lane would be better than in the remaining mixed-flow lanes. This was accomplished by establishing a threshold value as a difference in demand-to-capacity ratios between the HOV lane and the remaining mixed-flow lanes of 0.10 or more.

5. **Differential in Number of Persons Carried per Lane between the Mixed-Flow Lanes and the HOV** value as the difference in persons carried per lane between the HOV lane and the remaining mixed-flow lanes as a positive value.

6. **Minimum Travel Time Savings in the HOV Lane:** Travel time savings were calculated by comparing the travel times between vehicles in the HOV lane versus the mixed-flow lanes.

The threshold value was a travel time difference of at least one minute under near-term conditions.

7. **Secondary Considerations:** Secondary considerations were the existence of adjacent upstream and downstream HOV lanes, and an indication that converting a mixed-flow lane to an HOV lane in the other peak period and/or other direction appeared promising.

It was evident from the outset that few if any peak-period directional freeway sections would meet all the threshold values. However, the establishment and application of this set of screening thresholds would assist in identifying those that appear to be most promising. This set of screening thresholds was incorporated in the analytical screening technique.

The structure of the analytical screening technique consisted of eight interrelated major steps. These eight steps were:

1. Input the Available Basic Information
2. Predict "Day +1" Traffic Performance
3. Predict Mode Shift
4. Re-evaluate Traffic Performance after Mode Shift
5. Predict Future Growth
6. Re-evaluate Traffic Performance after Future Growth
7. Predict Further Mode Shift
8. Re-evaluate Traffic Performance after Further Mode Shift

Each of these steps are briefly described below.

Step 1. Input The Available Basic Information

The first step in the analytical screening technique was to input basic characteristics into a spreadsheet about each peak-period directional freeway section being considered for HOV lane operations. The intent was to minimize as much as possible the required input while providing sufficient information for predicting traffic performance, mode shift, and future growth.

Step 2. Predict "Day +1" Traffic Performance

Traffic performance was predicted immediately after HOV lane conversion or lane addition but before any mode shift or future growth. This was referred to as "Day +1". The existing roadway and traffic demand was divided into two parts -- HOV lane and remaining mixed-flow lanes -- and the traffic performance of each was predicted.

Step 3. Predict Mode Shift

Mode shift from the mixed-flow lanes to the HOV lane due to travel time savings as predicted. The formulation was to estimate the response (mode shift) as a function of sensitivity (a constant) and stimuli (travel time savings). The persons shifting from mixed-flow lanes to the HOV converted were removed from the mixed-flow lanes and added to the HOV lane. These mixed-flow lane vehicles were eliminated and a fewer number of HOV lane vehicles (due to a higher occupancy) were created.

Step 4. Re-Evaluate Traffic Performance After Mode Shift

The traffic performance was re-evaluated after mode shift in a manner exactly the same as in the second step except that the person and vehicle demands in the mixed-flow lanes and in the HOV lane were modified as described in the third step.

Step 5. Predict Future Growth

The anticipated growth in traffic demand was estimated for both the mixed-flow lanes and the HOV lane due to normal regional growth for a five year period of time. The five year growth factor varied from 1.07 to 1.37 depending upon the demand-to-capacity ratio. For example, freeway sections that operated at only sixty percent of their capacity or less had assumed five year growth factors of 1.37 while freeway sections that were close to capacity or over capacity were assumed to have five year growth factors of 1.07.

Step 6. Re-Evaluate Traffic Performance After Future

The traffic performance was re-evaluated after future growth in a manner exactly the same as in the second and four steps above except the person and vehicle demands in the mixed-flow lanes and in the HOV lane were modified as described in the fifth step.

Step 7. Predict Further Mode Shift

Further mode shift was estimated after the five year growth period from the mixed-flow lanes to the HOV lane. The formulation was identical to that used in the third step above except that the traffic demands in the mixed-flow lanes and the HOV lane were increased due to regional growth.

Step 8. Re-Evaluate Traffic Performance After Further

The final step was to re-evaluate the traffic performance after the further mode shift due to the five year growth period. This was undertaken exactly the same as in the second, fourth, and sixth steps described above.

SUMMARY OF RESULTS

Sections with Potential For Lane Conversion

Certain sections initially showed at least "Fair" potential for HOV lane conversion during both peak periods. Table 3-2 summarizes the evaluations of segments with potential for HOV lane conversion. Those segments with highest potential are briefly discussed below.

<u>HOV Lane Conversion: 2+ Condition</u>

- ***Section 4: I-5 SB, NE Northgate Way to SR 520***

Positive characteristics include acceptable HOV and non-HOV D/C ratios and a greater number of persons traveling in the HOV lane. However, this condition assumes that four through lanes are continuous in the section. In reality, a fourth lane is added at Ravenna and drops at SR 520, creating a lone "auxiliary" lane. Given the weaving and merging occurring, the lane conversion potential is reduced. (Note: In the AM peak hours, the southbound express lanes include an HOV lane)

- ***Section 9: I-5 SB, SR 516 to Pierce County Line***

This section shows positive benefits during the AM peak period as an HOV lane would provide for a better level of service and the mixed-flow lanes will not be congested. However, the travel time savings for HOV users will be marginal and the number of persons carried per lane will be about the same as in the mixed-flow lanes. During the PM peak period the HOV lane provides for better level of service, carries more persons per lane, and results in some travel time savings. The concern will be the operation of the mixed-flow lanes, which will be at or near capacity (i.e. will be congested) from the day of implementation.

- ***Freeway Section 10: I-5 SB, King County Line to SR 16, and Freeway Section 13: I-5 NB, SR 16 to King County Line***

These two sections exhibit fair lane conversion potential during both peak periods, although more detailed FREQ modeling indicates that conversion may be beneficial in some shorter segments, while lane addition would be desirable in other segments. Lane continuity is an important factor which would affect the designs. The relative time savings for HOV's are expected to be small, since the HOV and mixed-use lanes would operate at similar levels of service. WSDOT's HOV design project is further investigating the lane conversion options in this section.

<u>HOV Lane Conversion: 3+ Condition</u>

- ***Freeway Section 1: I-5 SB, SR 530 to SR 2***

This section shows fair potential for HOV 3+ conversion due to good levels of service in both the HOV and mixed-use lanes. However, since current congestion levels are relatively low, there would be limited early-year travel time and person-movement benefits from the HOV conversion. The segment also showed fair potential for a 2+ HOV conversion, except that the HOV lane performance during the AM peak period would be worse than in the mixed-flow lanes. This result is based upon the input data showing a very high percentage of current HOV 2+ vehicles, a statistic which should be verified with new field counts.

<u>Other Sections</u>

As indicated in Table 3-2, there are several sections that show fair or good potential during a single time period (typically the A.M. peak), but not both. Typically, during the other peak period the congestion in the current mixed-use lanes is high enough that a lane conversion would result in unacceptably high Demand/Capacity ratios for non-HOV traffic. It is likely, however, that short freeway segments within these longer sections could be converted while maintaining lane continuity and freeway performance.

Table 3-2
Freeway Segments with Potential for HOV Lane Conversion

Section	Name	2+		3+	
		AM	PM	AM	PM
1	I-5 SB, SR 530 to SR 2	○	◑	◑	◑
2	I-5 SB, SR 2 to I-405	○	○	○	○
4	I-5 SB, NE Northgate Wy to SR 520	◑	◑	○	○
9	I-5 SB, SR 516 to Pierce County Line	◑	◑	○	○
10	I-5 SB, King County Line to SR 16	◑	◑	●	○
11	I-5 SB, SR 16 to Mounts Rd	◑	○	○	○
12	I-5 NB, Mounts Rd to SR 16	◑	○	○	○
13	I-5 NB, SR 16 to King County Line	◑	◑	○	○
16	I-5 NB, I-405 to Boeing Access Rd	○	○	◑	○
18	I-5 NB, I-90 to SR 520	◑	○	○	○
19	I-5 NB, SR 520 to Lake City Way	◑	○	○	○
21	I-5 NB, SR 104 to I-405	●	○	○	○
22	I-5 NB, I-405 to SR 2	●	○	○	○
23	I-5 NB, SR 2 to SR 530	◑	○	○	◑
24	SR 520 EB, I-5 to I-405	○	○	○	○
35	I-405 NB, SR 520 to I-5	●	○	○	○
36	I-405 SB, I-5 to SR 520*	◑	○	○	○

Legend:

● Good ◑ Fair ○ Poor

Note: Segments not listed already have HOV lanes or lack sufficient data for assessment.
* Partially completed HOV lane

3.3. CENTRAL SEATTLE HOV LANE ANALYSIS

3.3.1. Phase I Corridor Concepts

Alternatives were developed in Phase I to address primary problems in the central Seattle corridor, including the lack of HOV system continuity in the southbound direction and off-peak access to express lane usage. All of the alternatives examined in this study would have significant benefits in terms of HOV travel time savings throughout the day and on weekends. These alternatives lend themselves to staging and / or interim treatments. None of the following alternatives address the existing safety and operational problems at the southern terminus of the express lanes.

These alternatives need to be considered in combination with other potential proposals, such as the previously proposed Washington Transportation Partners SR 520 Corridor Improvement and the United Infrastructure Washington Congestion Pricing. These projects could all potentially offer mitigation for any negative impacts from the alternatives. A summary of the Phase I Central Seattle HOV Lane alternatives are described below:

NORTHBOUND MAINLINE—INSIDE HOV LANE

Add northbound inside HOV lane from the Seneca Street lane drop to University Street, as well as an added GP lane between Mercer Street and University Street.

Features

- Bridge widening and replacement of shoulder paving.
- Cost: $5.8 million.

Trade-Offs and Considerations

- Provides the northbound "complement" to the existing southbound configuration.
- Travel time savings of 1.7 minute per vehicle.
- Reduction of weaving movements for HOVs.
- Increase of 17% for person-throughput capacity in northbound mainline.
- Improved HOV access to the Mercer Street corridor.
- Would reduce mainline lane width from 12 to 11 feet and result in narrower shoulders. This could result in capacity reduction as a result of incidents. Requires further evaluation.
- Conversion of the Seneca Street northbound off-ramp to HOV-only would further enhance GMA objectives and HOV operations. This requires additional analysis of impacts to GP traffic.

NORTHBOUND MAINLINE—OUTSIDE HOV LANE

Add northbound outside HOV lane from Olive Way to SR 520.

Features

- Convert one of two existing GP lanes for northbound to eastbound movement at SR 520.
- Bridge widening and replacement of shoulder paving.

- Cost: $7.8 million.

Trade-Offs and Considerations

- Would be most beneficial if a northbound express lane to eastbound SR 520 connection is not implemented.
- Provides HOV bypass of recurring congestion, particularly for transit.
- Travel time savings of 1.8 minutes per vehicle during PM peak, affecting approximately 170 eastbound buses.
- Increase of 17% in person-throughput capacity.
- Would reduce mainline lane width from 12 to 11 feet and result in narrower shoulders. This could result in capacity reduction as a result of incidents. Requires further evaluation.
- Reduction of GP capacity at the northbound to eastbound ramp at SR 520 requires further operations analysis.
- Alternative will be affected by proposed Washington Transportation Partners SR 520 corridor improvement project.

EXPRESS LANES—BARRIER SEPARATED SOUTHBOUND HOV LANE

Barrier-separated southbound HOV lane in the express lanes from Ravenna to Stewart Streets, consisting of an additional new lane through the University District, and lane conversion between the north end of the Ship Canal Bridge and Stewart Street.

Features

- Access from southbound mainline lanes at Ravenna. Egress via HOV tunnels to Mercer and Howell / Stewart Streets. Cross-over to southbound mainline lanes could be provided at Mercer Street for destinations south of downtown.
- Extensive modifications to structures and ramps at the Mercer Street interchange.
- Bridge widening and replacement of shoulder paving.
- Cost: $57.6 million.

Trade-Offs and Considerations

- Addresses recent spread of PM congestion on the southbound mainline from the University District to CBD.
- An extension of this treatment up to Northgate may be feasible, but requires further study pending evaluation of the University District to downtown Seattle segments.
- Travel time savings of approximately 7 minutes per trip.
- Increase in schedule reliability.
- Would decrease northbound capacity of reversible Express Lanes between Ravenna and the CBD. The lane to be converted, the fourth lane, is now underutilized due to imbalances in peak-period traffic demands. Northbound capacity would decrease but overall person-throughput capacity across all I-5 roadways would increase slightly.
- Further study and data collection, including an origin-destination survey, should be performed on this alternative.

EXPRESS LANES—CONTRAFLOW LANE WITH MOVABLE BARRIER

Movable barrier-separated southbound HOV lane in the express lanes from Ravenna to Stewart Streets, consisting of an additional new lane through the University District, and lane conversion between the north end of the Ship Canal Bridge and Stewart Street.

Features

- ♦ Access from southbound mainline lanes at Ravenna. Egress via HOV tunnels to Mercer and Howell / Stewart Streets. Cross-over to southbound mainline lanes could be provided at Mercer Street for destinations south of downtown.
- ♦ Approximately 13,000 linear feet of movable barrier and at least one barrier transfer vehicle and vehicle facilities.
- ♦ Bridge widening and replacement of shoulder paving.
- ♦ New structures at the proposed Ravenna and Mercer crossovers.
- ♦ Cost: $53.5 million.

Trade-Offs and Considerations

- ♦ This alternative provides similar benefits to the previous alternative, with slightly lower travel time savings and at lower cost.
- ♦ Primary impact is a reduction in the number of northbound express lanes.
- ♦ Addresses recent spread of PM congestion on the southbound mainline from the University District to CBD.
- ♦ Increase in schedule reliability.
- ♦ Allows for more flexibility in operation of the express lanes for event traffic, and for the existing AM peak operation of the express lanes to remain.
- ♦ Avoids the significant work at the Mercer Street interchange required in previous alternative.
- ♦ The crossover to the southbound mainline lanes at Mercer Street and the 13-foot width of the barrier-separated lane at the north end of the Ship Canal Bridge are of concern and require further study. Possible mitigation would include turning one of the remaining three express lanes into a drop lane at NE 42nd Street, leaving two reversible lanes between NE 42nd and Northgate. The Lake City exit would be converted to an exit rather than an add / drop lane.
- ♦ Operations and maintenance for the movable barrier also require further study. The estimate includes one barrier transfer vehicle; this $500,000 vehicle might need to be replaced up to twice a year.

3.3.2. Phase II Evaluation

The Phase II study included an additional review of the Central Seattle HOV Corridor Study alternatives developed in Phase I that related to the I-5 segment between the University District and Seattle CBD, as well as the SR 520/I-5 Express Lanes direct connector. Specifically, the alternatives were reviewed to:

- ♦ Investigate the benefits of combining alternatives.
- ♦ Identify if any of the alternatives create conflicts with other alternatives.
- ♦ Identify single or combined alternatives that would have the highest cost-effectiveness for HOV and / or transit use.

PHASE II ALTERNATIVES

The four independent alternatives considered were the following:

Express Lanes—Contraflow Lane with Fixed or Movable Barrier

Movable or fixed barrier-separated southbound HOV lane in the express lanes from Ravenna to Stewart Streets, consisting of an additional new lane through the University District, and lane conversion between the north end of the Ship Canal Bridge and Stewart Street. This alternative has three sub-alternatives:

- ♦ **1A:** Southbound HOV contraflow lane with fixed barrier.
- ♦ **1B:** Southbound HOV contraflow lane with movable barrier.
- ♦ **1C:** Southbound Transit-only contraflow lane with NE 42nd Street access and without crossover.

SR 520 HOV Connection to Express Lanes:

Reversible ramps to and from the south, connecting to the express lanes. This alternative has two sub-alternatives:

- ♦ **2W:** Direct ramp connecting to the west side of the express lanes roadway. This is the preferred connection due to cost and improved operations.
- ♦ **2E:** Direct ramp connecting to the east side of the express lanes roadway. This connection would be preferred in combination with the southbound contraflow lane alternative.

I-5 HOV-Only Southbound Express Lanes, Mercer to Cherry

Restrict the I-5 southbound express lanes to HOV-only south of Stewart Street. This alternative has two sub-alternatives:

- ♦ **3A:** GP through-traffic on the express lanes. GP through-traffic to access mainline via a cross-over ramp from the southbound express lanes to the C-D at Mercer Street.
- ♦ **3B:** No GP through-traffic on the express lanes. No cross-over provided. GP through-traffic would no longer use the express lanes.

Northbound Mainline—Outside HOV Lane

Add northbound outside HOV lane from Olive Way to SR 520.

The initial screening consisted of checking all combinations for constructability, geometric compatibility, and traffic operations. A secondary screening was then applied to the remaining six basic alternatives/combinations. The MOEs selected for this evaluation were chosen to help distinguish among the six alternatives and to identify the most effective transit and HOV improvements to achieve travel time savings.

RECOMMENDATIONS

The results of this evaluation were the two recommended alternatives listed below along with a brief summary of their significant features / benefits.

Reversible Direct Access Ramp from SR 520 to the I-5 Express Lanes:

- The single most effective improvement considered in this study.
- Significant travel time savings for Eastside Transit and HOV (a summary description and graphic of this alternative is contained in Chapter 5).

Southbound Contraflow HOV Lane on the Express Lanes (See Figure 3-3):

- Provides southbound HOV continuity through Central Seattle.
- Strong transit and HOV benefits.
- Mitigates existing northbound congestion exiting the Express Lanes at Northgate.
- Possible travel time delays to northbound PM peak traffic on the Express Lanes could be significant, disrupting both HOV and transit. Recommendation is conditional upon satisfactory mitigation, which could include:
  - ramp metering at the Stewart Street on-ramp;
  - flow restriction to between 300—400 vehicles per hour; or,
  - conversion of the Stewart Street Express Lanes on-ramp to HOV-only.
- This alternative also contingent upon RTA corridor decision. If a rail link is provided between the University District and CBD, then the recommendation would include use by both transit and non-transit HOVs. If no rail is provided, then a southbound transit-only contraflow lane with NE 42nd Street access and no crossover at Mercer Street would be recommended.
- This treatment would complement SR 520 direct access.
- Construction of a northbound outside HOV lane on I-5 from Olive Way to SR 520 would help to mitigate the loss of direct access and travel time savings for north-to-eastbound transit and HOV.

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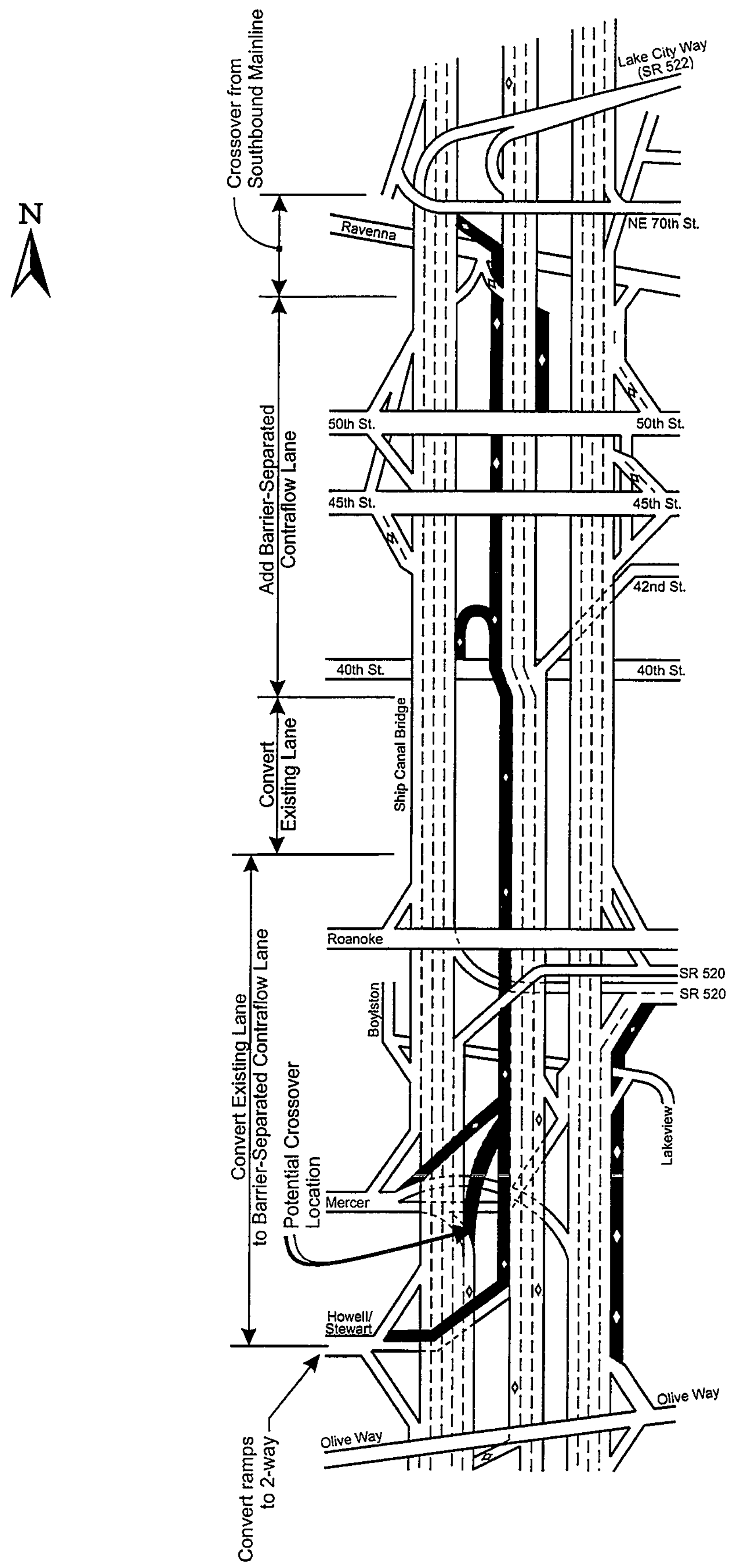


Central Seattle HOV Corridor Recommendations

Puget Sound HOV Pre-Design Studies

Final Report

FIGURE 3-3

3.4. SR 522 CORRIDOR ANALYSIS

The development of recommendations for this corridor began with an existing conditions inventory, including traffic, land use, transit, and non-motorized uses, and was presented in *Working Paper #1.* Level of service (LOS) analyses for existing conditions and year 2015 were performed for 15 intersections, as well as peak hour spread and forecasted queue by-pass alternatives, and were presented in *Working Paper #2.* Arterial HOV treatments were then inventoried for the corridor as well as seven east-west routes identified as potential alternative by-pass routes, and a fatal flaw screening conducted for all of these alternatives. Alternative development followed the fatal flaw screening; the corridor was segmented into eight homogeneous segments, with alternatives development for each segment. The results were published in *Working Paper #3.* The SR 522 corridor was divided into the following segments:

1. I-5 to 20th Avenue NE
2. 20th Avenue NE to NE 123rd Street
3. NE 123rd Street to NE 127th Street
4. NE 127th Street to NE 145th Street
5. NE 145th Street to Brookside Boulevard
6. Brookside Boulevard to 73rd Avenue NE
7. 73rd Avenue NE to Hall Road
8. Hall Road to I-405

The last step applied both qualitative and quantitative MOEs to each alternative, culminating in a preliminary recommended alternative for each corridor segment, presented in *Working Paper #4.* Stakeholder involvement was present throughout the study through a series of meetings and working paper reviews, resulting in, among other things, focus on the development of a pedestrian-friendly environment along the corridor to support transit use. A summary is provided below; the reader is referred to the finalized document, *SR 522 Corridor HOV Access Study, Final Task Report,* David Evans and Associates, Bellevue WA, May 1995, for further detail. This task was not revisited in Phase II.

3.4.1. Summary of Recommendations

The Regional Transit Plan (RTP) designates SR 522 as a regional trunk bus route. The data and analyses in the first two working papers support priority treatments for transit as the most cost-effective measure to increase person-throughput and decrease person-delay. Consistent with this, the recommended alternative is therefore to develop a continuous transit corridor on SR 522 that includes a range of HOV / pedestrian treatments. Such treatments would allow for predictable headways of transit vehicles, improved reliability, decreased travel time, and additional capacity to accommodate increases in transit service well into the future.

The recommended continuous peak period transit lanes would be accomplished by implementing peak period parking restrictions and converting the center two-way left turn lane through a residential area. The recommended alternative also includes project phasing for implementation of transit signal priority treatments throughout the corridor, and will provide for signal interconnect among all signals as well as off-peak transit signal priority benefits. Pedestrian facilities, roadway improvements, and other enhancements are also recommended throughout the corridor to improve transit accessibility and provide adequate pedestrian mobility.

In addition to recommendations for SR 522, NE 145th Street is recommended as an alternative route for carpools headed toward I-5. Other recommended treatments are made for NE 125th Street and NE Northgate Way, both of which would serve a proposed rail station in the vicinity of the Northgate Transit Center if and when rail is extended to the Northgate area. Queue by-pass lanes and signal priority treatments in the vicinity of I-5 are also recommended. SR 522 recommendations are depicted in Figure 3-4. These recommendations are detailed by segment below.

SEGMENT 1: I-5 TO 20TH AVENUE NE

Features

- Center reversible bus-only through-lane, with no left-turns during the peak periods, and no transit stops along this segment length.
- Relocation of bus routes to nearby arterials that would need to make left-turns during the peak period.
- Signal priority to assist bus re-integration into the general purpose lanes at either end of segment.
- Transit signal priority at all signalized intersections.
- Project phasing would include only transit signal priority treatments at signalized intersections.

Trade-Offs and Considerations

- Reversible lane benefits include significant travel time savings, improved reliability, increased person through-put capacity, high environmental ratings, and support of transit connectivity between regional centers in terms of through-bus traffic improvements.
- Reversible lane drawbacks include higher costs, safety concerns, neighborhood impacts and political concerns regarding the left-turn restrictions.
- Signal priority treatment is cost effective and has minimal constructability, environmental, and social impacts.

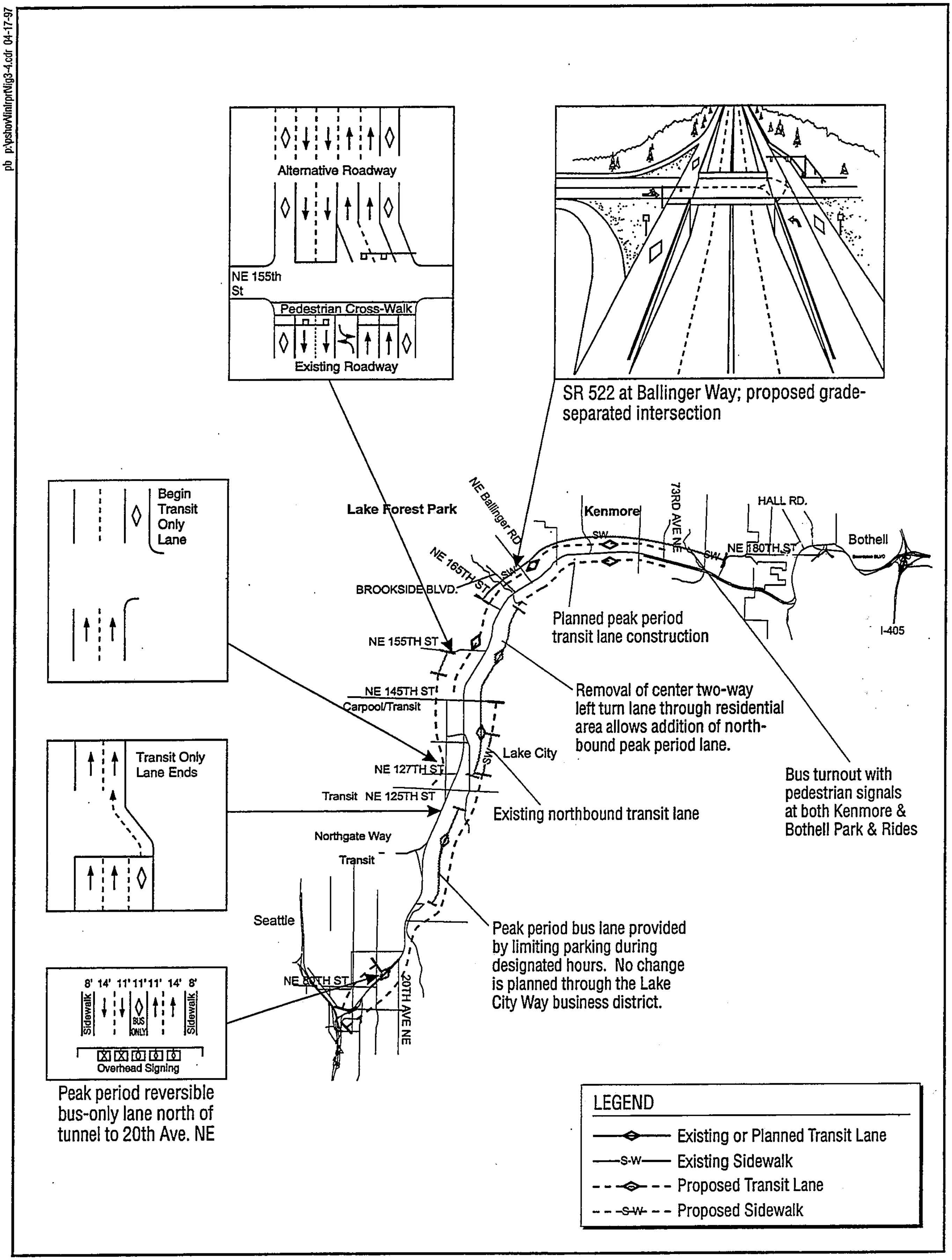
SEGMENT 2: 20TH AVENUE NE TO NE 123RD STREET

Features

- Parking lane along east side of roadway re-striped from NE 98th Street to 30th Avenue NE to be used as PM peak transit-only lane.
- Transit signal queue jump at 30th Avenue NE.
- Driveway consolidation between Northgate Way and NE 123rd.
- Transit signal priority at all signalized intersections.
- Project phasing would include only transit signal priority at all signals.

Trade-Offs and Considerations

- Increase in travel time savings, transit reliability, transit capacity, general purpose operations, and improved energy consumption and air quality impacts.
- No significant improvements for pedestrian and bicycle modes. Existing four to six foot sidewalks.
- Driveway consolidation will result in improved bus service and safety, but may be controversial with businesses.



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SR 522 Corridor Recommendations
Puget Sound HOV Pre-Design Studies
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FIGURE 3-4

SEGMENT 3: NE 123RD STREET TO NE 127TH STREET

Features

- Signal prioritization at NE 125th Street and NE 127th Street.

Trade-Offs and Considerations

- This segment contains the downtown portion of Lake City. The existing aesthetics and land use limit construction recommendations and the removal of on-street parking.
- Small improvements to transit time travel savings, reliability, and capacity.

SEGMENT 4: NE 127TH STREET TO NE 145TH STREET

Features

- Parking lane along east side of roadway re-striped from NE 127th Street (northern end of downtown) to NE 135th Avenue NE (beginning of existing transit-only lane) to be used as PM peak transit-only lane.
- Sidewalk added in above-mentioned area.
- Driveway consolidation on both sides of segment.
- Potential transit HUB in the vicinity of the NE 145th Street intersection.

Trade-Offs and Considerations

- Increase in travel time savings and transit reliability.
- Low cost.
- Minimal environmental and social impacts.

SEGMENT 5: NE 145TH STREET TO BROOKSIDE BOULEVARD

Features

- Connects existing eastbound transit lane on NE 145th to programmed transit lane starting at Brookside, for northbound only.
- Convert the two-way left turn lane (TWLTL) to a through-lane and convert the outside through-lane to a northbound transit-only lane from 155th Street to Brookside Boulevard NE. Existing TWLTL currently has low usage due to land use and heavy opposing traffic.
- Provide pedestrian-activated signal at 155th Street.
- Construct sidewalk from 145th to 155th Streets along west side.
- Transit signal priority at all signalized intersections.
- Project phasing would include: signalized pedestrian crossing, a short extension of the northbound programmed transit-only lane to begin at NE 165th Street, and transit signal priority treatments at all signals.

Trade-Offs and Considerations

- Significant improvements in transit travel time savings, transit reliability, transit capacity, transit connectivity, safely, energy consumption and air quality.
- Relatively low cost.

- Negative impacts include increased delay to GP traffic, possible political concerns with the elimination of the TWLTL.
- A speed study should be conducted through this segment to check appropriateness of 45 mph seed limit.
- The existing Burke-Gilman trail provides pedestrian an bicycle access on the east side of the corridor.

SEGMENT 6: BROOKSIDE BOULEVARD NE TO 73RD AVENUE NE

Features

- Re-design of SR 522 / SR 104 intersection to a grade-separated interchange, allowing through-traffic of SR 522 to flow freely at an undercrossing.
- SR 104 overcrossing would provide pedestrian access from the Burke-Gilman Trail to the planned pedestrian trail on Ballinger Way.
- Shopping Center at the new junction would be access via SR 104 of Brookside Boulevard NE.
- Signals would dedicate all green time to the left-turn movements with the exception of priority by an oncoming westbound bus.
- Driveway consolidation in the Kenmore area.
- New sidewalk along north side of segment.
- Transit signal priority at all signalized intersections.
- Project phasing could include driveway consolidation and the construction of a westbound sidewalk, as well as transit signal priority treatments at all signals.

Trade-Offs and Considerations

- The new junction would lessen traffic congestion, provide enhanced pedestrian access, and be aesthetically pleasing.
- The ability to maintain the current driveway access between Ballinger Way and Brookside Boulevard NE will depend on the final geometry of the junction.
- Benefits in transit travel time saving, reliability, and capacity, as well significant benefits for GP traffic. Noise impact minimal due to depression of GP lanes between retaining walls.
- No increase in person-throughput.
- High cost due to new junction, including 25% for environmental mitigation.
- Construction would entail significant detour and engineering planning.
- A speed study should be conducted through this segment to check appropriateness of 45 mph seed limit.

SEGMENT 7: 73RD AVENUE NE TO HALL ROAD

Features

- Extend the existing westbound transit lane from the west side of 73rd Avenue NE to the Kenmore Park-and-Ride lot entrance east of 73rd Avenue NE. Also provide signalized pedestrian crossing at that location.
- Construct sidewalk from 73rd Avenue NE to 83rd Avenue NE along north side.
- Construct additional pedestrian facilities at the multi-family units at 83rd and at 91st.
- Signalize intersection at 91st Avenue NE by 2015.
- Transit signal priority at all signalized intersections.

- Project phasing could include a combination of any of the recommendations.

Trade-Offs and Considerations

- Improvement consist mainly of pedestrian enhancements. These enhancements comply with comprehensive plans and have high public acceptance.
- Increased general delay due to new signalized pedestrian crossing at the Kenmore Park-and-Ride.

SEGMENT 8: HALL ROAD TO I-405

Features

- Transit signal priority at all signalized intersections.
- Project phasing identifies that the transit system should be coordinated with the proposed Bothell Branch Campus.

Trade-Offs and Considerations

- King County Metro and the City of Bothell are developing a plan for an eastbound bus turnout and signalized pedestrian crosswalk at the Bothell Park-and-Ride, including the re-routing of buses from Main Street to SR 522. Metro's improvements include signal priority treatments.
- This is the lowest segment for transit ridership forecasts. The forecasts of the proposed Bothell Branch Campus are not yet available. Alternatives for this segment should be re-evaluated during the planning and design of the campus, including a possible connection between the campus and SR 522 with signal priority treatments.