Exhibit 21. Dearborn Street Interchange Peak Hour LOS Analysis Summary

Intersections	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
I-5 Southbound Off-ramp/ Dearborn Street	A	6	A	6	A	5	A	6
I-5 Northbound Off-ramp/ Dearborn Street	A	7	A	7	B	11	B	12
I-5 Northbound On Slip-ramp/ Dearborn Street	A	5	A	2	A	6	A	8

LOS denotes level of service.
sec. denotes seconds.

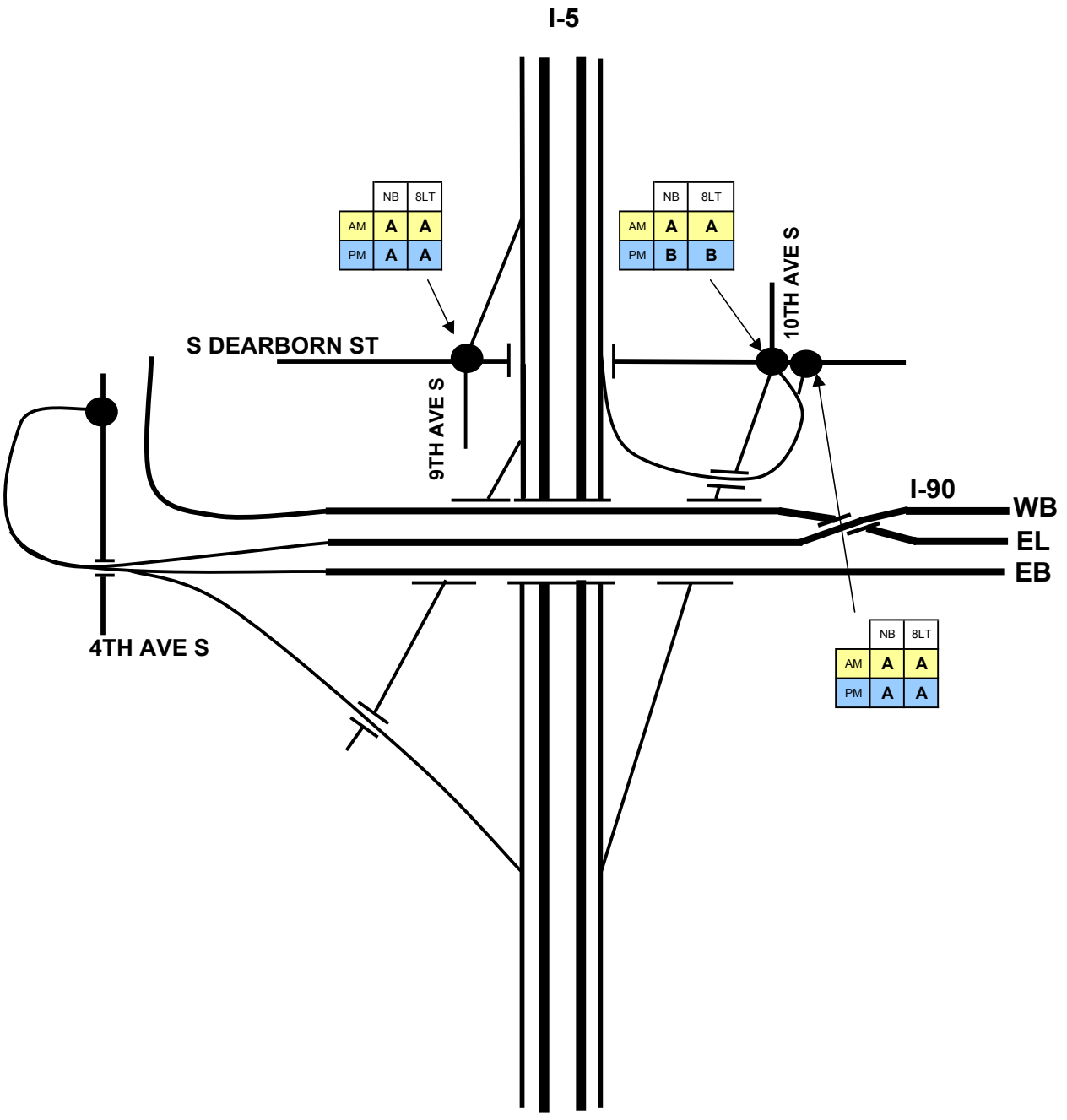
As shown in Exhibit 21, all three intersections would operate at LOS B or better for both the No Build and 8-Lane Alternatives during the a.m. and p.m. peak hours. Therefore, traffic operations at these intersections are not discussed in further detail.

Downtown Seattle Interchange Area

This area includes multiple signalized intersections, non-signalized intersections, I-5 on-ramp/off-ramp intersections, and I-5 express lane ramp intersections. The following lists the intersections analyzed within the downtown Seattle interchange area:

Signalized Intersections

- James Street and 6th Avenue
- James Street and 7th Avenue/I-5 northbound off-ramp
- Cherry Street and 5th Avenue/I-5 express lane ramps
- Cherry Street and 6th Avenue
- Cherry Street and 7th Avenue/I-5 northbound collector-distributor on-ramp
- Columbia Street and 5th Avenue/I-5 express lane ramps
- Madison Street and 7th Avenue
- Spring Street and 6th Avenue/I-5 southbound on-ramp
- Seneca Street and 6th Avenue/I-5 northbound off-ramp
- University Street and 6th Avenue
- Union Street and 7th Avenue
- Pike Street and 9th Avenue/express lane ramp



LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity

No Build — 8 Lane

	NB	8LT
AM	C	C
PM	E	F

AM Peak Hour
PM Peak Hour

No Build conditions — 8 Lane conditions

N Not to scale

Exhibit 22. **Dearborn Street Interchange Area**
SR 520 Bridge Replacement and HOV Project

Unsignalized Intersections

- Columbia Street and 6th Avenue
- Columbia Street and 7th Avenue
- Marion Street and 7th Avenue
- Spring Street and 7th Avenue
- Seneca Street and 7th Avenue
- University Street and Hubbell Place
- Pike Street and Terry Avenue
- Hubbell Place and 9th Avenue

Exhibit 23 summarizes the LOS for the downtown Seattle interchange area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 24 graphically displays the LOS results.

The following discussion describes in detail the intersection operations. The intersections listed below are omitted.

- Cherry Street/I-5 Northbound ramp. This intersection would be removed (would not exist) with the 8-Lane Alternative.
- University Street/6th Avenue. The intersection operations would be improved to LOS D or better with the 8-Lane Alternative.
- Union Street/7th Avenue. The intersection operates at LOS B or better for both the No Build and 8-Lane Alternatives.
- Pike Street/9th Avenue. The intersection operates at LOS D or better for both the No Build and 8-Lane Alternatives.

James Street/6th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS B during the a.m. peak hour and at LOS C during the p.m. peak hour. In both the a.m. and p.m. peak hours, queues would not spill into adjacent intersections.

8-Lane Alternative

Under the 8-Lane Alternative, a southbound shared through-left lane would be added and the intersection would operate at LOS D during the a.m. peak hour and at LOS F during the p.m. peak hour. This would happen mostly because the 8-Lane Alternative would carry additional

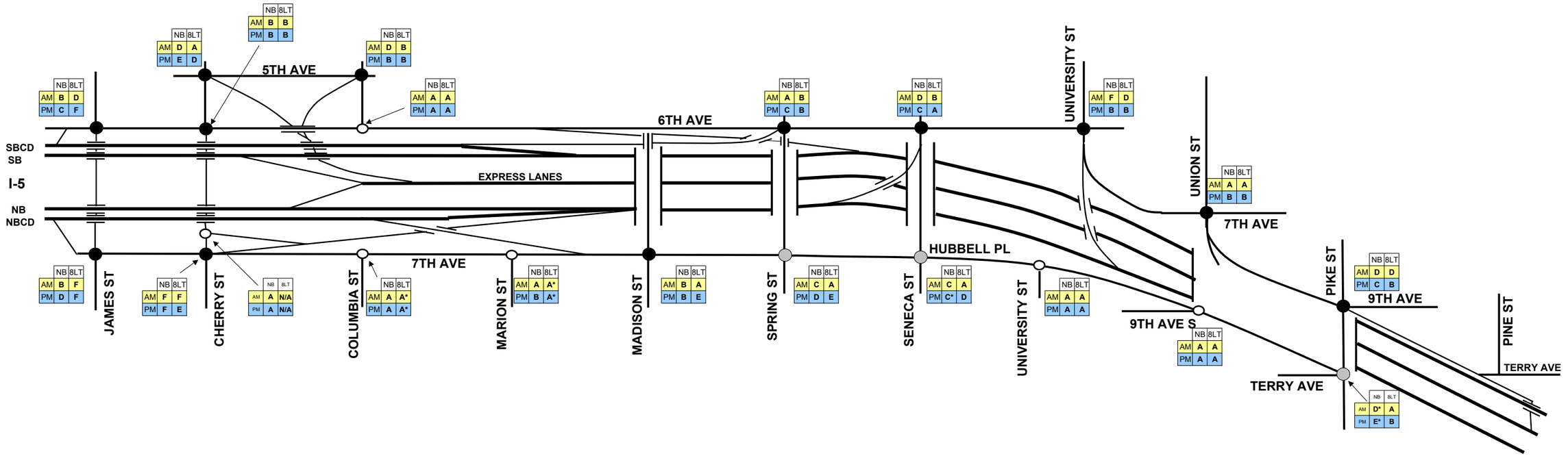
traffic down 6th Avenue because the southbound I-5 on-ramp would be closed at Spring Street and the volume increase would not be

Exhibit 23. Downtown Seattle Interchange Area Peak Hour LOS Analysis Summary

Intersections	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
James Street/6th Avenue	B	16	D	37	C	21	F	175
James Street/7th Avenue	B	19	F	163	D	45	F	239
Cherry Street/5th Avenue	D	54	A	10	E	64	D	49
Cherry Street/6th Avenue	B	19	B	12	B	14	B	19
Cherry Street/7th Avenue	F	*	F	171	F	*	E	60
Cherry Street/I-5 Northbound On-Ramp	A	3	NA	NA	A	6	NA	NA
Columbia Street/5th Avenue	D	37	B	13	B	14	B	11
Columbia Street/6th Avenue	A	0	A	0	A	0	A	0
Columbia Street/7th Avenue	A	1	A	**	A	1	A	**
Marion Street/7th Avenue	A	1	A	**	A	2	A	**
Madison Street/7th Avenue	B	19	A	7	B	16	E	72
Spring Street/6th Avenue	A	9	B	12	C	33	B	12
Spring Street/7th Avenue	C	21	A	4	D	29	E	61
Seneca Street/6th Avenue	D	35	B	19	C	23	A	9
Seneca Street/7th Avenue	C	21	A	4	F	***	D	45
University Street/6th Avenue	F	83	D	36	B	12	B	11
University Street/7th Avenue	A	1	A	0	A	1	A	1
Union Street./7th Avenue	A	8	A	8	B	20	B	15
Hubbell Place/9th Avenue	A	1	A	0	A	1	A	1
Pike Street/9th Avenue	D	39	D	39	C	21	B	18
Pike Street/Terry Avenue	D	**	A	10	E	**	B	12

* Indicates average delay per vehicle is greater than 300 seconds (5 minutes)
** Because of the configuration of this intersection, average delay per vehicle is incalculable per published *Highway Capacity Manual* methodologies for unsignalized intersections (TRB 2000). Therefore, Synchro's intersection capacity utilization LOS (Synchro 6.0) has been reported for lack of better information.
*** The volume-to-capacity ratio is too large to calculate the delay.

LOS denotes level of service.
NA denotes that this intersection is removed under the 8-Lane Alternative.
sec. denotes seconds.



LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection
- Study intersection signalized under 8 lane

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity

No Build — 8 Lane

NB 8LT

AM Peak Hour: AM | A | NA — Not Applicable

PM Peak Hour: PM | A | NA — Not Applicable

No Build conditions — 8 Lane conditions

N Not to scale

Exhibit 24. **Downtown Seattle Interchange Area**

SR 520 Bridge Replacement and HOV Project

accommodated by the widening on 6th Avenue at this intersection. Additional widening would be problematic (and probably infeasible) because of constraints in the surrounding environment (for example, I-5, major buildings).

During both the a.m. and p.m. peak hours, the southbound queue in the left/through lane group would back up through the Cherry Street/6th Avenue intersection. The volume/capacity (V/C) ratios are 1.11 and 1.75, respectively, which would be worse than under the No Build Alternative.

During the p.m. peak hour (but not the a.m. peak hour), the eastbound right-turn from James Street onto 6th Avenue/southbound I-5 on-ramp would queue back through the James Street/5th Avenue intersection and has a V/C ratio of 1.23. During the p.m. peak hour, the westbound through lane has a V/C ratio exceeding 1.0 (that is, a value of 1.05), but it would not queue back into the adjacent James Street/7th Avenue intersection because of signal coordination.

The above operational conditions would exist under the 8-Lane Alternative, despite the addition of a southbound left/through lane on 6th Avenue at this intersection.

James Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS B during the a.m. peak hour and at LOS D during the p.m. peak hour. There are no V/C ratios that exceed 1.0 during the a.m. peak hour. In both the a.m. and p.m. peak hour, only the westbound approach would operate poorly, with a V/C ratio of 1.02 (which exceeds 1.0). In both the a.m. and p.m. peak hours, queues would not spill into adjacent study intersections.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS F during both the a.m. and p.m. peak hours. This intersection would fail under the 8-Lane Alternative despite the addition of five northbound through lanes and one northbound right-turn lane on 7th Avenue. This would happen mostly because of the removal of off-ramps from northbound I-5 north of James Street through Seneca Street. In addition, the widening at this intersection would not accommodate the resulting increase in traffic volumes. The volume increases over the No Build Alternative would be:

- On the northbound approach, 2,930 vph more during the a.m. peak hour and 2,300 vph more during the p.m. peak hour
- On the eastbound approach, 90 vph more during the a.m. peak hour and 30 vph more during the p.m. peak hour
- On the westbound approach, 120 vph more during the a.m. peak hour and 60 vph more during the p.m. peak hour

Additional widening would be problematic (and probably infeasible) because of constraints in the surrounding environment (for example, I-5, major buildings).

In the a.m. peak hour, the additional capacity provided at the intersection would prevent queues from spilling into adjacent study intersections. However, during the p.m. peak hour, queues would back up in the eastbound direction for the eastbound left-turn lane and periodically queue back into the James Street/6th Avenue intersection.

V/C ratios also exceed 1.0 during the a.m. peak hour and the p.m. peak hour. During the a.m. peak hour, the westbound approach has a V/C ratio of 1.08, the northbound left/through/right lane group has a V/C ratio of 1.12, and the northbound right-turn lane has a V/C ratio of 1.11. During the p.m. peak hour, the westbound approach has a V/C ratio of 1.20, the eastbound left-turn lane has a V/C ratio of 1.44, and the northbound approach lane groups have V/C ratios of 1.19. The volumes exceed the capacity for most of the movements at the intersection. Also, because the V/C is much greater than 1.0 in the northbound direction at this intersection, queues could extend back as far as 500 feet after just two cycles. These queues would continue to build over the hour. However, it not likely that the queues would extend onto northbound I-5 because two lanes are provided on the off-ramp.

Cherry Street/5th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS D during the a.m. peak hour and at LOS E during the p.m. peak hour. The southbound approach has a V/C ratio of 1.17 during the a.m. peak hour and 1.43 during the p.m. peak hour. In both instances, the left/through lane acts as a de facto left-turn lane. During the a.m. and p.m. peak hours, the southbound approach queue would spill back into the Columbia Street/5th Avenue intersection at peak times during the

peak hours. The eastbound left-turn lane (to access the express lanes) has a V/C ratio of 1.17 during the p.m. peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during the a.m. peak hour and at LOS D during the p.m. peak hour. Both LOS conditions would be better than under the No Build Alternative because the southbound approach would have more capacity (left-turns would be allowed onto Cherry Street from the southbound left-turn lane, which currently allows left-turns only onto the I-5 express lanes). The southbound approach has at a V/C ratio of less than 1.0, which would be an improvement over the No Build Alternative. During the p.m. peak hour, the V/C ratio improves to 1.18 for the left-turn lane and 0.94 for the left/through lane group. During the a.m. peak hour and the p.m. peak hour, the southbound left/through lane group queue would not spill back into the Columbia Street/5th Avenue intersection, and the southbound left-turn lane queue would spill back to that intersection only at peak times during the p.m. peak hour.

Cherry Street/6th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS B during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS B during both the a.m. and p.m. peak hours. The addition of the southbound right-turn lane would provide additional capacity for the southbound through lane at this intersection. During peak times within the p.m. peak hour, the southbound through lanes would queue back to the Columbia Street/6th Avenue intersection. This would not occur under the No Build Alternative.

Cherry Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS F during both the a.m. and p.m. peak hours. Eastbound queues would spill back through the Cherry Street/6th Avenue intersections.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS F during the a.m. peak hour (with a noticeable reduction in delay) and at LOS E during the p.m. peak hour. Both LOS conditions would be improvements over No Build Alternative conditions. This happens because of the design improvements under the 8-Lane Alternative.

With the design modifications to the northbound and eastbound approaches, the eastbound left-turn V/C ratio improves from 7.94 and 7.02, respectively, during the a.m. and p.m. peak hours under the No Build Alternative to 0.60 and 0.90, respectively, under the 8-Lane Alternative. The northbound through lane V/C ratio drops to 0.92 and 1.01 during the am and p.m. peak hours under the 8-Lane Alternative compared to 0.90 and 0.99 with a de facto left-turning lane under the No Build Alternative. (This indicates a heavy left turning volume with no exclusive turning lane.) However, that decrease is compensated for by the improvement in the eastbound lanes V/C ratio. During both the a.m. and p.m. peak hours, eastbound queues would spill back through the Cherry Street/6th Avenue intersection (as also occurs under the No Build Alternative). However, the queues under the 8-Lane Alternative would not extend as far beyond the Cherry Street/6th Avenue intersection. Under the No Build Alternative, the queue in the a.m. peak hour could go as far behind the Cherry Street/6th Avenue intersection as 730 feet, while under the 8-Lane Alternative, the queue measures 450 feet. Under the No Build Alternative, the queue length is 430 feet in the p.m. peak hour, while under the 8-Lane Alternative it is metered at 380 feet.

Columbia Street/5th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS D during the a.m. peak hour and at LOS B during the p.m. peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS B during both the a.m. and p.m. peak hours. The a.m. peak hour LOS would improve even though the northwestbound approach is reduced by one lane because of signal phasing adjustments. However, the existing configuration works and could remain as part of the 8-Lane Alternative instead.

Columbia Street/6th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours. No delay is reported because there are no conflicting vehicle movements.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours. The creation of a southbound right-turn lane at this intersection (see the *What modifications would be made to intersections in the downtown Seattle interchange area?* section above) would remove right-turning vehicles from the path of through vehicles, allowing better movement through the intersection in the southbound direction.

Columbia Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours. A different way to calculate the LOS conditions is necessary because, with the widening of 7th Avenue to eight lanes at this intersection, the project team could not analyze the intersection using published *Highway Capacity Manual* methodologies (TRB 2000). Therefore, Synchro's intersection capacity utilization measure was used (Synchro 6.0). That analysis indicated capacity would be available at the intersection under the 8-Lane Alternative.

Marion Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours. Synchro's intersection capacity utilization measure is used (Synchro 6.0). Draft analysis

indicated that capacity would be available at the intersection under the 8-Lane Alternative.

Madison Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS B during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during the a.m. peak hour, which is an improvement over the No Build Alternative. The improvements are discussed in the *What modifications would be made to intersections in the downtown Seattle interchange area?* section above. They include the creation of a triple northbound left-turn lane and five northbound through lanes, as well as elimination of the southbound approach. These improvements would improve LOS for the northbound left-turn and through movements and the westbound approach since more green time can be allocated to this movement. Green time is the amount of time that a lane has a green light shown at an intersection. These modifications improve the overall intersection operations.

During the p.m. peak hour, this intersection would operate at LOS E. The improvements discussed in the preceding paragraph would prevent the intersection from operating at LOS F, but would not improve the LOS to better than No Build Alternative conditions. The northbound approach would operate at LOS E, which contributes in part to the LOS being worse than under the No Build Alternative. On the northbound approach, the northbound through movement would periodically queue back to the Marion Street/7th Avenue intersection and has a V/C ratio of 1.19. This happens despite having five through lanes. (The northbound through volume would higher than with the No Build Alternative by 2,170 vph). The eastbound approach also factors into the LOS degradation. This approach would operate at LOS F and has a V/C ratio of 1.44 compared with LOS C and a V/C ratio of 0.53 under the No Build Alternative. The LOS degrades because the eastbound left-turn volume is 210 vph higher compared to the No Build Alternative. (The eastbound left-turn volume is only 20 vph under the No Build Alternative.) For the 8-Lane Alternative, the green time (time the signal is green) increases for the eastbound left turn, which reduces the time the signal is green for the northbound movement.

Under the 8-Lane Alternative, LOS conditions at this intersection would improve in the a.m. peak hour but get worse in the p.m. peak hour when compared to the No Build Alternative. The eastbound left-turn volume in the p.m. peak hour increases from 20 vph under the No Build Alternative to 220 vph under the 8-Lane Alternative, while the increase is not as steep in the a.m. peak hour. Also, the high northbound through volume would not go over capacity in the a.m. peak hour, while it would exceed a V/C of 1.0 in the p.m. peak hour under the 8-Lane Alternative. These two factors would cause the LOS to deteriorate in the p.m. peak hour. The degradation in LOS in the p.m. peak hour would be more than the improvement in the a.m. peak hour.

Spring Street/6th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during the a.m. peak hour and at LOS C during the p.m. peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS B during the a.m. peak hour, which is a slight degradation from the No Build Alternative. The improvements at the eastbound approach and the removal of the southbound I-5 on-ramp benefit the eastbound approach during the a.m. peak hour. However, delays would increase for the northbound approach because of the signal settings. (A longer cycle length and a smaller portion of the signal cycle is allocated to the northbound approach.) Additionally, volumes in the northbound through/right lanes would be 40 vph higher than under the No Build Alternative, which contributes to the degradation of LOS.

During the p.m. peak hour, the improvements at this intersection under the 8-Lane Alternative would result in LOS B, an improvement compared to the No Build Alternative. Both the northbound and eastbound approaches would experience reduced delays because of the improvements, and the eastbound approach would carry 20 vph less than the No Build Alternative.

Spring Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS C during the a.m. peak hour and at LOS D during the p.m. peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, the improvements at this intersection include signalization, which would improve LOS conditions from what the conditions would be without a signal. This intersection would operate at LOS A during the a.m. peak hour, which is an improvement from the No Build Alternative because of the signalization and the additional lanes.

During the p.m. peak hour, the LOS conditions would degrade to LOS E despite the signalization and additional lanes. This happens because it is difficult to coordinate the use of the signal with the signal at Madison Street/7th Avenue. Other reasons include:

- The eastbound approach would operate at LOS C, which is a degradation from the LOS A conditions under the No Build Alternative. This degradation occurs because, under the No Build Alternative, the eastbound approach is mostly free-flow with minor delays from the eastbound left-turns and right-turns yielding right-of-way to conflicting traffic. Signalizing the intersection eliminates the free-flow operation and adds delay at the intersection.
- The heavy northbound through traffic at the 7th Avenue/Seneca Street intersection would queue back onto the 7th Avenue/Spring Street intersection. This causes delays for the northbound approach. Although there are LOS E conditions, no queues would spill back into adjacent study intersections and no V/C ratios exceed 1.0.

Seneca Street/6th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS D during the a.m. peak hour and at LOS C during the p.m. peak hour. In the a.m. peak hour, there are no V/C ratios exceeding 1.0 and queues do not spill back into adjacent study intersections or back onto northbound I-5. The same is true for the p.m. peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS B during the a.m. peak hour and at LOS A during the p.m. peak hour. Both LOS conditions are improvements over No Build Alternative conditions. This happens because of design improvements associated with the 8-Lane Alternative.

The design improvements include removing the northbound I-5 off-ramp to Seneca Street and its associated signal phase. This would simplify signal operations to two phases from three phases and free up more green time to share between the remaining two phases. These would improve the LOS. To help illustrate this, in the a.m. peak hour, the northbound approach would experience the most improvement, operating at LOS A rather than LOS C; the westbound approach would operate at LOS C under either alternative. In the p.m. peak hour, the northbound and westbound approaches would operate at LOS A rather than LOS B.

Seneca Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS C during the a.m. peak hour and at LOS F during the p.m. peak hour. In the a.m. peak hour, queues would not spill back into adjacent study intersections. However, during the p.m. peak hour, northbound and southbound queues would spill back through the University Street/7th Avenue and Spring Street/7th Avenue intersections. The V/C ratios, delays, and queues cannot be calculated using standard *Highway Capacity Manual* procedures when intersection operations degrade to this point.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at LOS A during the a.m. peak hour and at LOS D during the p.m. peak hour. The intersection operations improve during both the a.m. and p.m. peaks compared to the No Build Alternative. Operations improve with the design improvements associated with the 8-Lane Alternative that add four northbound lanes at the intersection.

Similar to the No Build Alternative, the a.m. peak hour queues would not spill back into adjacent study intersections. During the p.m. peak hour, the southbound queue would not spill back into the University Street/7th Avenue intersection. Although the northbound queue would back through the Spring Street/7th Avenue intersection, queue length would likely be shorter because of the vast improvement in LOS. The V/C ratios for the westbound through movement and northbound through movement exceed 1.0 at 1.12 and 1.07, respectively. The westbound V/C ratio degrades and the northbound V/C ratio improves when compared to the No Build Alternative operations.

The LOS improves at this intersection with the following 8-Lane Alternative design changes:

- Signalizing the intersection (which improves the LOS for the northbound and southbound traffic)
- Removing one westbound lane and allowing through movements only on the remaining lane
- On the northbound approach, replacing the single lane with two left-turn lanes, two through lanes, and a right-turn lane (which improves the LOS for the northbound movements)
- On the southbound approach, restricting the single lane southbound right-turn to right-turn only (which improves the LOS for the southbound movements)

University Street/7th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, the improvements at this intersection include the addition of a northbound through/right lane, which improves LOS conditions from what they would be under the No Build Alternative. This improvement has been included because of the additional northbound volume at this intersection under the 8-Lane Alternative. The a.m. peak hour northbound volume increases by 980 vph and the p.m. peak hour northbound volume increases by 1,510 vph.

With the 8-Lane Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours, which is the same as the No Build Alternative.

Hubbell Place/9th Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative, the improvements at this intersection include:

- Converting the southwestbound lane on Hubbell Place to northeastbound, which removes southwestbound movement on Hubbell Place at this intersection
- Restricting the 9th Avenue approach to right-turn only

These improvements serve the increases in volume on Hubbell Place heading towards the new on-ramp connection to northbound I-5, which is on 7th Avenue/Hubbell Place just to the south of Pike Street. During the a.m. peak hour, Hubbell Place would carry an additional 980 vph during the a.m. peak hour and 1,490 vph during the p.m. peak hour in the northeastbound direction compared to the No Build Alternative.

Under the 8-Lane Alternative, this intersection would operate at LOS A during both the a.m. and p.m. peak hours, which is the same as under the No Build Alternative.

Pike Street/Terry Avenue

No Build Alternative

Under the No Build Alternative, this intersection would operate at LOS D during the a.m. peak hour and at LOS E during the p.m. peak hour. Since Hubbell Place and Terry Avenue are stop-controlled and tie into Pike Street on the same side of the street, the intersection takes the shape of the letter K. Synchro's intersection capacity utilization measure (Synchro 6.0) was used to determine the LOS.

8-Lane Alternative

Under the 8-Lane Alternative, the improvements at this intersection include:

- Signalizing the intersection (improves overall LOS)
- Adding a westbound left-turn lane on Pike Street for movements to Terry Avenue and removing the left-turn option from the inside through lane (which would provide better westbound approach LOS)
- Adding an eastbound right-turn lane on Pike Street for movements to Terry Avenue and removing the right-turn option from the outside through lane (which would provide better eastbound approach LOS)
- Disallowing left-turns from Terry Avenue onto Hubbell Place, because Hubbell Place would be one-way northeastbound

- Converting the southwestbound lane on Hubbell Place to a northeastbound left-turn lane and marking the existing northeastbound lane for right-turns onto Pike Street and Terry Avenue only

These improvements were done to serve the increases in volume that would occur on Hubbell Place heading towards the new on-ramp connection to northbound I-5. This intersection would operate at LOS A during the a.m. peak hour and at LOS B during the p.m. peak hour, both of which are improvements over the No Build Alternative.

Olive Way Interchange Area

Two intersections were analyzed at the Olive Way interchange area:

- Northbound I-5 off-ramp/Olive Way
- Melrose Avenue/Olive Way

Exhibit 25 summarizes the LOS for the Olive Way interchange area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 26 graphically displays the LOS results.

Exhibit 25. Olive Way Interchange Area Peak Hour LOS Analysis Summary

Intersections	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
Northbound I-5 Off-ramp/ Olive Way	B	14	B	14	C	17	D	28
Melrose Avenue/Olive Way	A	8	A	8	B	15	B	17

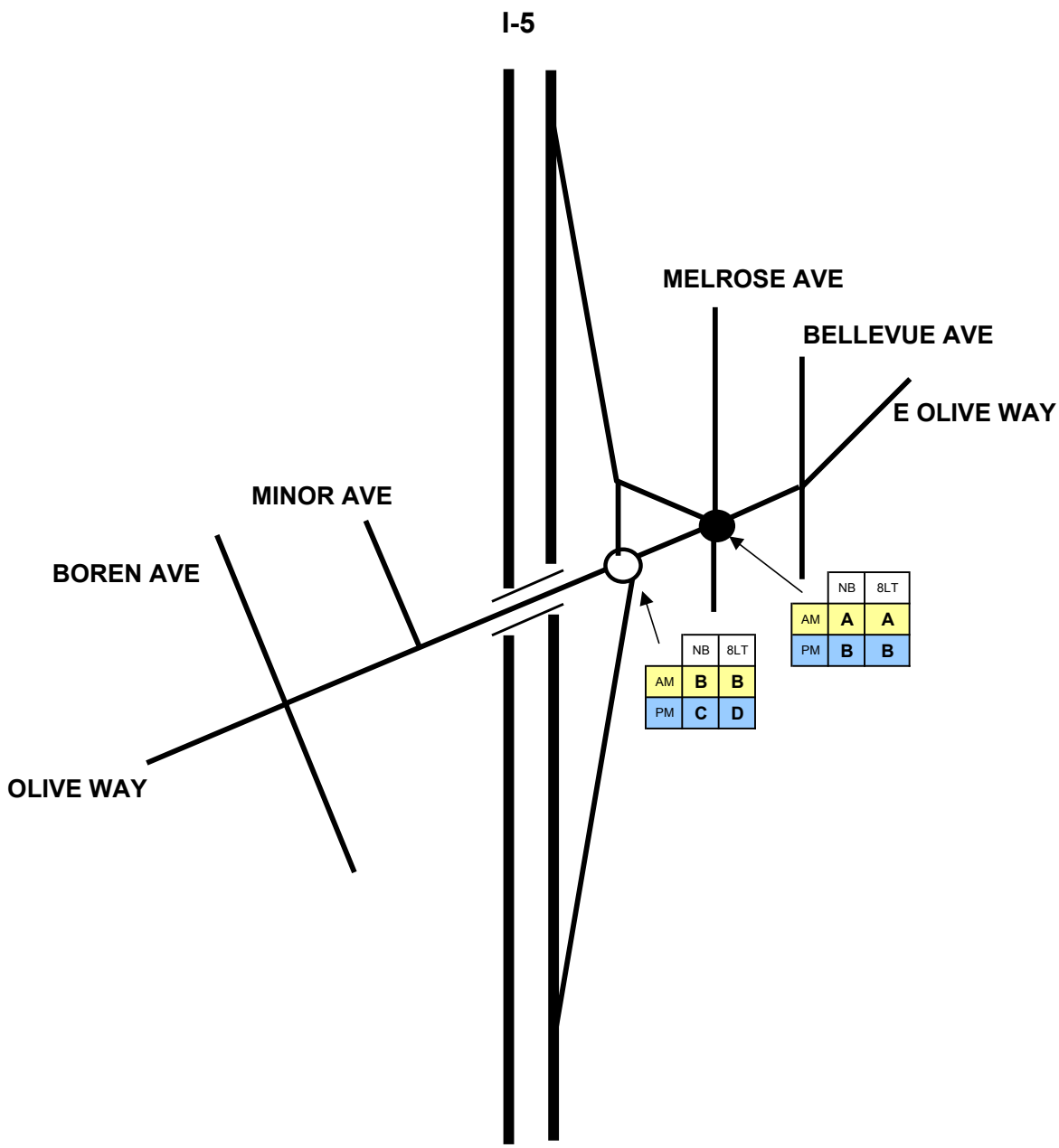
LOS denotes level of service.
sec. denotes seconds.

The Melrose Avenue/Olive Way intersection is not discussed in detail because the operations are better than LOS D.

Northbound I-5 Off-ramp/Olive Way

No Build Alternative

The northbound I-5 off-ramp/Olive Way intersection is an uncontrolled intersection where the off-ramp traffic must turn right onto Olive Way. The traffic must merge into eastbound Olive Way traffic before arriving at the signalized intersection of Melrose Avenue and Olive Way approximately 160 feet east of the northbound I-5 off-ramp.



No Build — 8 Lane

	NB	8LT
AM Peak Hour	C	C
PM Peak Hour	E	F

No Build conditions — 8 Lane conditions

LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity

N Not to scale

Exhibit 26. **Olive Way Interchange Area**
SR 520 Bridge Replacement and HOV Project

Under the No Build Alternative, the unsignalized intersection of the northbound I-5 off-ramp/Olive Way would function well for the eastbound through movement on Olive Way. However, traffic would experience some delays as it merges prior to the Melrose Avenue/Olive Way intersection. This delay could affect traffic operations at the northbound I-5 off-ramp in the p.m. peak hour. In the p.m. peak hour, the northbound off-ramp approach would operate at LOS E. The queue on the ramp would not back onto I-5. Note that Synchro analyzes the right turn from the I-5 off-ramp as starting from a stop. In actuality, this movement occurs when the ramp traffic is still in motion and requires a smaller critical gap, which would result in better operations than forecasted.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at the same LOS (LOS B) during the a.m. peak hour as the No Build Alternative. The off-ramp volume is similar (that is, only 10 vph more than with the No Build Alternative).

During the p.m. peak hour, the intersection would operate at LOS D (as compared with the No Build Alternative LOS C). This occurs because there are 100 vph more on the off-ramp than the No Build Alternative. This causes the merge movement to operate at LOS F with a V/C ratio of 1.03, as compared to the No Build Alternative's LOS E and V/C ratio of 0.88. Even with LOS F conditions, the off-ramp queue would not back onto northbound I-5 and, as mentioned above, the actual conditions would be better than LOS F.

Stewart Street Interchange Area

Four signalized intersections were analyzed at the Stewart Street interchange area:

- Stewart Street/Eastlake Avenue East
- Stewart Street/Denny Way
- Yale Avenue/Stewart Street
- Howell Street/Yale Avenue

At these ramp termini, both the I-5 mainline and a.m. express lanes terminate at the Stewart Street/Eastlake Avenue East/John Street intersection. There is an I-5 southbound on-ramp at the Howell Street/ Yale Avenue intersection. During the p.m. peak hour, I-5 northbound express lane traffic uses an on-ramp located just north of the Howell

Street/Yale Avenue intersection. This area experiences high traffic volumes as vehicles travel to and from I-5. The Stewart Street interchange area also experiences high transit and pedestrian volumes.

Exhibit 27 summarizes the LOS for the Stewart Street Interchange Area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 28 graphically displays the LOS results.

Exhibit 27. Stewart Street Interchange Peak Hour LOS Analysis Summary

Intersections	No Build-(A.M.)		8-Lane-(A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
Howell Street/ Yale Ave/I-5 Southbound On-Ramp	C	34	E	58	D	37	F	89
Yale Avenue/Stewart Street	B	16	E	64	B	11	C	24
Stewart Street/Denny Way	D	45	F	94	C	25	D	42
Stewart Street/Eastlake Avenue East	C	31	C	34	B	16	A	10

LOS denotes level of service
sec. denotes seconds

The Stewart Street/Eastlake Avenue intersection is not discussed in detail because the operations are better than LOS D.

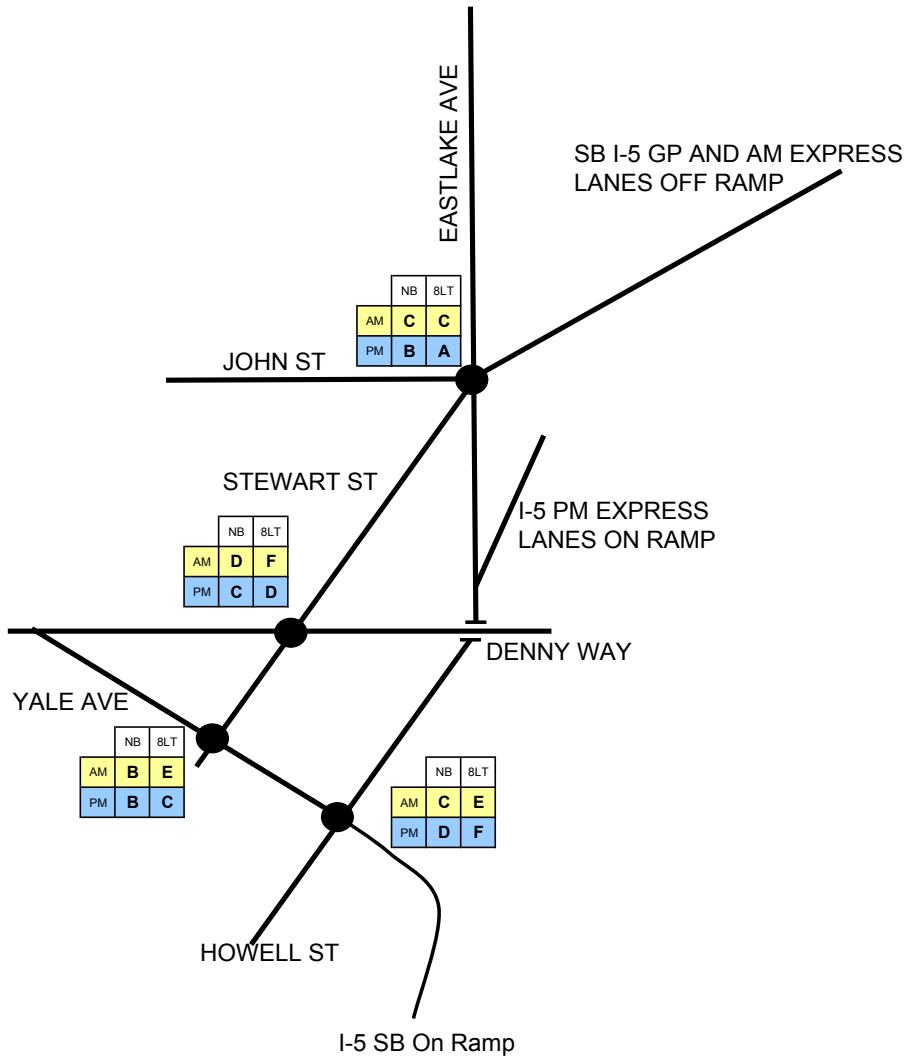
Howell Street/Yale Avenue/I-5 Southbound On-Ramp Intersection

No Build Alternative

Under the No Build Alternative, this intersection would operate at an acceptable LOS with LOS C during the a.m. peak hour and at LOS D during the p.m. peak hour. No V/C ratio is greater than 1.0 in either of the peak hours. The southeastbound Yale Avenue through/right lanes would queue back through the adjacent Yale Avenue/Stewart Street intersection during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative during the a.m. peak hour, this intersection would operate at LOS E (as compared to LOS C with the No Build Alternative). This happens because there are 240 vph more entering the I-5 southbound on-ramp than the No Build Alternative. Traffic volumes would increase because of the additional capacity available on I-5 under the 8-Lane Alternative. As with the No Build Alternative, the southeastbound Yale Avenue through/right lanes

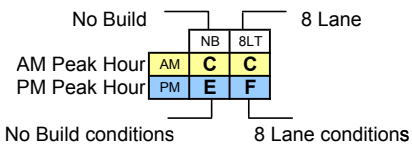


LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity



N Not to scale

Exhibit 28. **Stewart Street Interchange Area**

SR 520 Bridge Replacement and HOV Project

would queue back through the adjacent Yale Avenue/Stewart Street intersection. Under the 8-Lane Alternative (but not the No Build Alternative), the southwestbound movement queues back on Howell Street and through the Stewart Street/Eastlake Avenue intersection during the peak hour. Additionally, the southeastbound through/right lanes V/C ratio is 1.02, and the southwestbound approach V/C ratio is 1.03. Both these V/C ratios are less than 1.0 under the No Build Alternative.

During the p.m. peak hour, this intersection would operate at LOS F (as compared to LOS D with the No Build Alternative). This happens because there are 330 vph more entering the I-5 southbound on-ramp than the No Build Alternative. The southeastbound Yale Avenue through/right lanes would queue back through the adjacent Yale Avenue/Stewart Street intersection, similar to the No Build Alternative. Additionally, the southeastbound through/right lanes V/C ratio is 1.19 and the southwestbound approach V/C ratio is 1.20. Both of these V/C ratios are less than 1.0 under the No Build Alternative.

In summary, with the 8-Lane Alternative, LOS would degrade at this intersection and additional queuing would occur.

Yale Avenue/Stewart Street Intersection

No Build Alternative

Under the No Build Alternative, this intersection would operate at an acceptable LOS B during both the a.m. and p.m. peak hours.

8-Lane Alternative

Under the 8-Lane Alternative during the a.m. peak hour, this intersection would operate at LOS E (as compared to LOS B with the No Build Alternative). This happens because there are 40 vph more in the southeastbound through lanes on Yale Avenue than the No Build Alternative (20 percent more than the No Build Alternative volume). The additional traffic is destined for the southbound I-5 on-ramp. This movement would operate at LOS F with a V/C ratio of 0.93 under the No Build Alternative. When more traffic is added to an LOS F condition, LOS conditions tend to degrade dramatically. That is the case here. Under the 8-Lane Alternative, the southeastbound through movement would operate at LOS F with a V/C ratio of 1.12.

During the p.m. peak hour, this intersection would operate at LOS C (as compared to LOS B under the No Build Alternative). This happens because the southeastbound through lanes volume on Yale Avenue

would increase with the additional traffic destined for the southbound I-5 on-ramp. No V/C ratio is greater than 1.0.

Stewart Street/Denny Way Intersection

No Build Alternative

Under the No Build Alternative, while this intersection would operate acceptably at LOS D during the a.m. peak hour, southwestbound queues on Stewart Street would spill back to the Stewart Street/Eastlake Avenue East intersection. This happens because this intersection is nearby and the approach is slightly over capacity, with a V/C ratio of 1.02 during the a.m. peak hour.

During the p.m. peak hour, this intersection would operate at LOS C with very little queuing. This happens because the southwestbound through and westbound left-turn lane volumes are less than during the a.m. peak hour and other volumes at the intersection are relatively similar. The southwestbound approach would not queue into the Stewart Street/Eastlake Avenue East intersection.

8-Lane Alternative

Under the 8-Lane Alternative during the a.m. peak hour, this intersection would operate at LOS F (as compared to LOS D with the No Build Alternative). This happens because the westbound left-turn volume would increase by 90 vph and the southwestbound through volume would increase by 100 vph as compared to the No Build Alternative. The other volumes at the intersection remain relatively the same as under the No Build Alternative. The southwestbound approach V/C ratio is 1.14 under the 8-Lane Alternative as compared to 1.02 under the No Build Alternative. Additionally, the westbound left-turn lane has a V/C ratio of 1.09 under the 8-Lane Alternative. (The V/C ratio under the No Build Alternative is 0.99.) As under the No Build Alternative, the southwestbound queue would spill back to the Stewart Street/Eastlake Avenue East intersection.

During the p.m. peak hour, the intersection would operate at LOS D under the 8-Lane Alternative (as compared to LOS C under the No Build Alternative). There are 100 vph more in the southwestbound through lanes and 40 vph more in the westbound left lane compared to the No Build Alternative. The higher volumes under the 8-Lane Alternative would increase delays for these movements, operating at LOS E for the westbound left lane (instead of at LOS D under the No Build Alternative) and at LOS C for the southwestbound approach (the

same as under the No Build Alternative). The volume increases are related to the southbound on-ramp volume, which would increase from 1,350 vph under the No Build Alternative to 1,700 vph under the 8-Lane Alternative. As under the No Build Alternative, the southwestbound approach would not queue into the adjacent Stewart Street/Eastlake Avenue East intersection. V/C ratios are less than 1.0 during the p.m. peak hour under the 8-Lane Alternative, as they are under the No Build Alternative.

With the 8-Lane Alternative, LOS would degrade at this intersection.

Mercer Street Interchange Area

Three signalized intersections were analyzed at the I-5 Ramps/Mercer Street interchange area:

- Mercer Street/Fairview Avenue/I-5 Ramps
- Valley Street/Fairview Avenue North
- Fairview Avenue North/Eastlake Avenue East

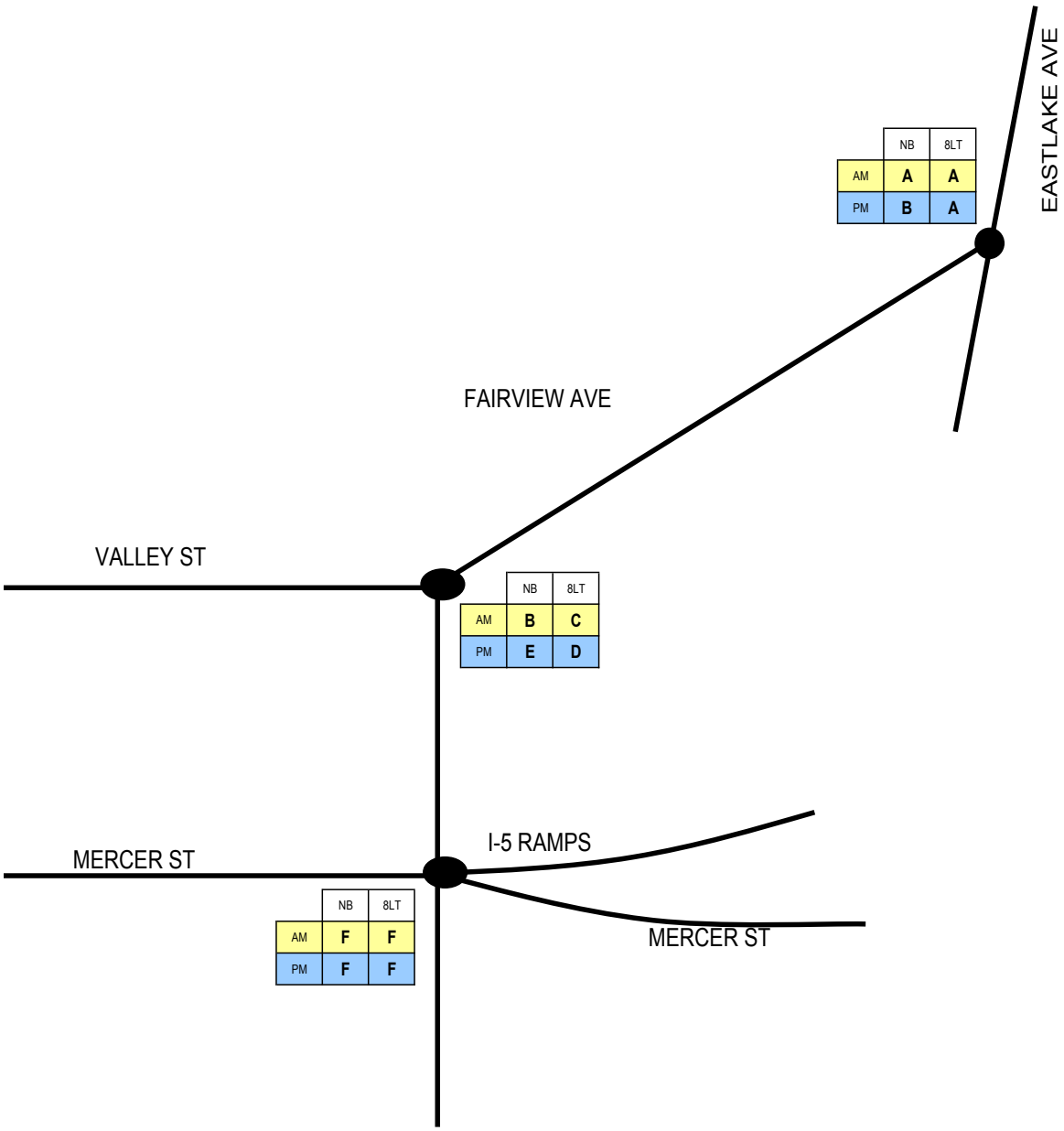
The Mercer Street I-5 off-ramp is a major gateway into downtown Seattle and the Seattle Center. Mercer Street is one-way eastbound and provides access to the I-5 mainline and express lanes. Most of the exiting I-5 traffic turns right, then left onto Valley Street one block to the north.

Exhibit 29 summarizes the LOS for the Mercer Street interchange area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 30 graphically displays the LOS results. Intersection operations for the Valley Street/Fairview Avenue and the Fairview Avenue North/Eastlake Avenue East intersections are not discussed because they operate at LOS D or better under the 8-Lane Alternative.

Exhibit 29. Mercer Street Interchange Peak Hour LOS Analysis Summary

	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
Intersections	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
Mercer Street/Fairview Avenue/ I-5 Ramps	F	141	F	110	F	251	F	330
Valley Street/Fairview Avenue North	B	17	C	25	E	68	D	40
Fairview Avenue North/Eastlake Avenue East	A	6	A	6	B	11	A	9

LOS denotes level of service.
sec. denotes seconds.



LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity

No Build — 8 Lane

	NB	8LT
AM Peak Hour	C	C
PM Peak Hour	E	F

No Build conditions — 8 Lane conditions

N Not to scale

Exhibit 30. **Mercer Street Interchange Area**

SR 520 Bridge Replacement and HOV Project

Mercer Street/Fairview Avenue/I-5 Ramps Intersection

No Build Alternative

At the present time, this ramp termini intersection would operate at LOS F during the a.m. peak hour. This happens because westbound right (V/C=1.40), westbound left (V/C=1.33), and northbound through (V/C=1.17) traffic volumes exceed capacity. Without modification, this intersection would continue to operate at LOS F under the No Build Alternative conditions for the a.m. and p.m. peak hours.

As shown in Exhibits 31 and 32, under the No Build Alternative, the eastbound through traffic volumes also exceed capacity (V/C=1.29) during the a.m. peak hour. However, the northbound through traffic volumes would be served through signal optimization and network coordination, reducing the V/C ratio to 0.79. Overall, operations at this intersection would fail because the eastbound and westbound movements are over capacity.

	No Build	8-Lane
EBT	1.29	1.09
EBR	0.95	0.64
WBL	1.21	1.23
WBR	1.35	1.25
NBT	0.79	1.17
NBR	0.27	0.39
SBT	0.19	0.28

Exhibit 31. A.M. Peak Hour V/C Ratios by Movement for the Mercer/I-5 Ramps Intersection

Queues during the a.m. peak hour are longest for westbound traffic that queues on the I-5 southbound Mercer Street off-ramp. The ramp provides approximately 2,500 feet worth of storage capacity and the queues would not exceed this distance. Therefore, the queues would not affect traffic operations on I-5.

Today, during the p.m. peak hour, this intersection operates at LOS F. This happens because eastbound through (V/C=1.75), westbound left (V/C=1.22), westbound right (V/C=1.16), and northbound right (V/C=1.78) traffic volumes exceed capacity.

	No Build	8-Lane
EBT	1.87	2.25
EBR	1.48	1.27
WBL	0.78	0.77
WBR	1.13	1.25
NBT	1.13	0.93
NBR	1.36	1.38
SBT	0.37	0.31

Exhibit 32. P.M. Peak Hour V/C Ratios by Movement for the Mercer/I-5 Ramps Intersection

Without modification, this intersection would continue to operate at LOS F under the No Build Alternative. Under the No Build Alternative, the eastbound right (V/C=1.48) and northbound through (V/C=1.13) traffic volumes would also exceed capacity. All traffic movement volumes exceed capacity during the p.m. peak hour, except for the westbound left and southbound through movements.

Queues during the p.m. peak hour would be greatest for all eastbound traffic and for northbound right-turning traffic because of vehicles entering I-5. However, these queues would not affect traffic at adjacent intersections.

8- Lane Alternative

Under the 8-Lane Alternative during the a.m. peak hour, this intersection would operate at LOS F (the same as under the No Build Alternative). However, the delay is shorter than under the No Build Alternative.

During the a.m. peak hour, the biggest V/C ratio increase (compared to the No Build Alternative) is for the northbound through traffic volumes. The V/C ratio increases from 0.79 to 1.17 because of a 60-vph increase in traffic volumes and a lower percentage of green time during the signal cycle. The biggest V/C ratio decrease (compared to the No Build Alternative) is for the eastbound through/right movement to Mercer Street or Fairview Avenue. The V/C ratio decreases from 0.95 to 0.64 because of a 10-vph decrease in traffic volumes and a greater percentage of green time during the signal cycle. Queues under the 8-Lane Alternative would be about twice as long as the No Build Alternative. This is because of the longer cycle being used under the 8-Lane Alternative (160 seconds vs. 70 seconds for the No Build Alternative) and 490 vph more than the No Build Alternative. The westbound queue may build back to I-5 during peak times within the a.m. peak hour.

There would be a large shift in traffic during the p.m. peak hour from the northeastbound through movement at the intersection of Valley Street/Fairview Avenue North to the eastbound movement at the intersection of Mercer Street/I-5 ramps. This shift in traffic is because the redesign of the I-5/SR 520 interchange and corresponding ramps would allow Mercer Street traffic traveling to northbound I-5 to access I-5 on the right side. This would provide a smoother transition to SR 520. SR 520 would be capable of accommodating more vehicles during the p.m. peak hour, making travel during p.m. peak hour more attractive.

During the p.m. peak hour, the demand that would be placed on the Mercer Street/Fairview Avenue intersection greatly increases the overall delay (60 seconds per vehicle more than the No Build Alternative). It also affects V/C ratios. The biggest V/C ratio increase is for the eastbound through traffic volumes from 1.87 (under the No Build Alternative) to 2.25 because of a 430 vph increase in traffic volumes and a lower percentage of green time during the signal cycle. The biggest V/C ratio decrease compared to the No Build Alternative is for the eastbound through/right movement to Mercer Street or

Fairview Avenue. The V/C decreases from 1.48 to 1.27 because there is a 170 vph decrease in traffic volumes, so the lower percentage of green time during the signal cycle would not have the same effect as for the eastbound through movement to the I-5 ramps. Queues would generally be similar to those of the No Build Alternative. However, with the 8-Lane Alternative, queues would extend farther back on Mercer Street than with the No Build Alternative.

In summary, under the 8-Lane Alternative, LOS would improve during the a.m. peak hour and degrade during the p.m. peak hour at this intersection.

Roanoke Street Interchange Area

Twelve intersections were analyzed at the East Roanoke interchange area:

- Lakeview Boulevard/I-5 Northbound off-ramp (unsignalized)
- Lakeview Boulevard/Harvard Avenue (unsignalized)
- Boylston Avenue/East Boston Street
- Boylston Avenue/East Lynn Street
- Boylston Avenue/East Louisa Street (unsignalized)
- Boylston Avenue/East Roanoke Street
- East Roanoke Street/Harvard Avenue East/SR 520 westbound off-ramp
- East Roanoke Street/Broadway Avenue (unsignalized)
- East Roanoke Street/10th Avenue East
- Boylston Avenue/ East Edgar Street (unsignalized)
- East Edgar Street/Harvard Avenue (unsignalized)
- Harvard Avenue/I-5 northbound On-ramp (unsignalized)

Exhibit 33 summarizes the LOS for the Roanoke Street interchange area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 34 graphically displays the LOS results.

Exhibit 33. Roanoke Street Interchange Peak Hour LOS Analysis Summary

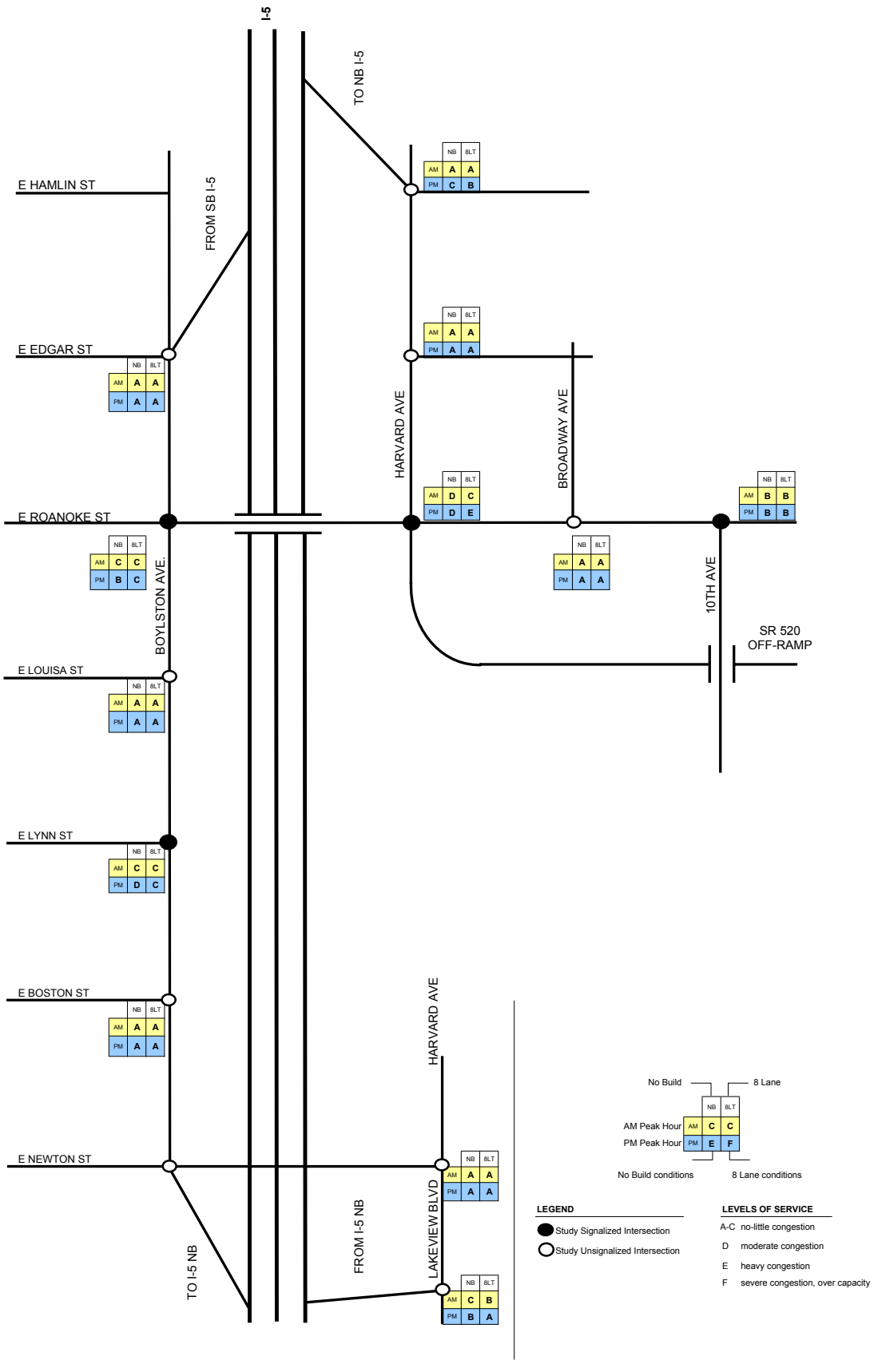
Intersections	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
Lakeview Boulevard/I-5 Northbound off-ramp	C	18	B	11	A	10	A	10
Lakeview Boulevard/Harvard Avenue	A	2	A	2	A	2	A	2
Boylston Avenue/East Boston Street	A	1	A	1	A	2	A	2
Boylston Avenue/East Lynn Street	C	34	C	20	D	41	C	35
Boylston Avenue/East Louisa Street	A	3	A	2	A	3	A	3
Boylston Avenue/East Roanoke Street	C	25	C	23	B	20	C	22
East Roanoke Street/Harvard Avenue East/SR 520 Westbound off-ramp	D	48	C	35	D	48	E	56
East Roanoke Street/Broadway Avenue	A	0.4	A	0.4	A	1	A	1
East Roanoke Street/10th Avenue East	B	15	B	12	B	16	B	15
Boylston Avenue/East Edgar Street	A	1	A	1	A	1	A	1
East Edgar Street/Harvard Avenue/	A	0.2	A	0.2	A	1	A	1
Harvard Avenue/I-5 Northbound on-ramp	A	6	A	6	C	16	C	15

LOS denotes level of service.
sec. denotes seconds.

Overall, operations at only 1 of the 12 intersections operating at LOS D or worse are adversely affected by the 8-Lane Alternative:

- East Roanoke Street/Harvard Avenue East/SR 520 westbound off-ramp

The operational changes for this intersection are discussed in the next section.



N Not to scale

Exhibit 34. **Roanoke Street Interchange Area**
SR 520 Bridge Replacement and HOV Project

The remaining 11 intersections operate at LOS D or better under the 8-Lane Alternative. Because they are not modified by the alternative, they are not discussed.

East Roanoke Street/Harvard Avenue East/SR 520 Westbound Off-Ramp Intersection

No Build Alternative

Under the No Build Alternative, during the a.m. peak hour, this intersection would operate at LOS D with an average of 48.1 seconds of delay per vehicle. Eastbound through traffic volumes exceed roadway capacity with a V/C ratio of 1.07. Because of this, eastbound traffic queues back to the Boylston Avenue East/East Roanoke Street intersection.

Southbound left/right shared lane and left-only lane volumes are approaching capacity with V/C ratios of 0.93 and 0.99, respectively.

During the p.m. peak hour, intersection operations would be very similar to a.m. peak hour operations at LOS D with an average of 48.4 seconds of delay per vehicle. In the p.m. peak hour, both the eastbound and southbound traffic volumes exceed capacity, with V/C ratios of 1.07 and 1.01, respectively. Southbound volumes in the left/right shared lane would approach capacity, with a V/C ratio of 0.96. As during the a.m. peak hour, eastbound traffic queues back to the Boylston Avenue East/East Roanoke Street intersection. Southbound traffic queues would not affect the adjacent intersection.

8-Lane Alternative

The 8-Lane Alternative performs better than the No Build Alternative due to the increase in capacity on SR 520. This would attract a greater amount of traffic, reducing the volumes on the local streets.

During the a.m. peak hour, the intersection would operate at LOS C (as compared to LOS D under the No Build Alternative) because the total traffic entering the intersection would be 340 vph less than under the No Build Alternative. The eastbound approach would be at a V/C ratio of 1.0, which is an improvement over the No Build Alternative V/C ratio of 1.07. All other V/C ratios are less than 1.0.

During the p.m. peak hour, the intersection would operate at LOS E (as compared to LOS D under the No Build Alternative). However, the delay is near the LOS D threshold. (That is, the change from LOS D to LOS E occurs at 55 seconds per vehicle.) The additional delay,

compared to the No Build Alternative, would be caused by signal coordination difficulties with the Boylston Avenue/East Roanoke Street intersection.

In both the a.m. and p.m. peak hours, traffic on the westbound SR 520 off-ramp would not queue onto SR 520. As under the No Build Alternative, eastbound traffic would queue back to the Boylston Avenue East/East Roanoke Street intersection, and southbound traffic queues would not affect the adjacent intersection.

There would be less traffic going through the interchange area under the 8-Lane Alternative than the No Build Alternative, and the LOS results at this intersection do not differ greatly.

Northeast 45th Street Interchange Area

Three signalized intersections were analyzed at the Northeast 45th Street interchange area:

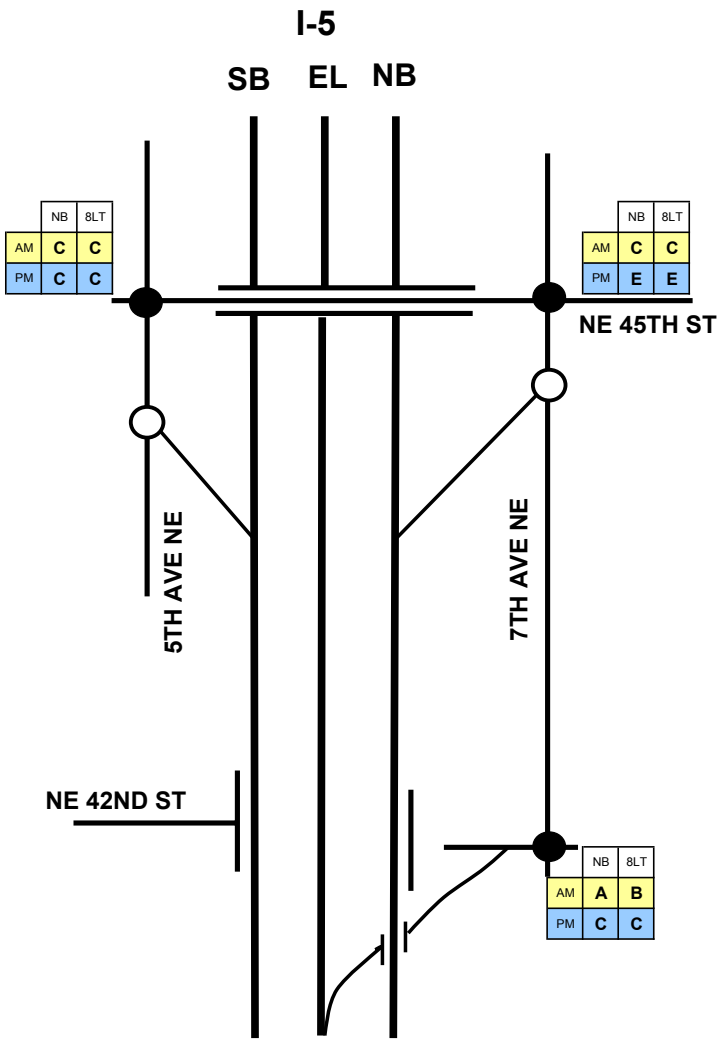
- Northeast 42nd Street/7th Avenue Northeast (express lane ramp terminus)
- Northeast 45th Street/7th Avenue Northeast
- Northeast 45th Street/5th Avenue Northeast

Exhibit 35 summarizes the LOS for the Northeast 45th Street interchange area intersections under both the No Build and 8-Lane Alternatives for the a.m. and p.m. peak hours. Exhibit 36 graphically displays the LOS results.

Exhibit 35. Northeast 45th Street Interchange Peak Hour LOS Analysis Summary

Intersections	No Build (A.M.)		8-Lane (A.M.)		No Build (P.M.)		8-Lane (P.M.)	
	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)
Northeast 42nd Street/7th Avenue Northeast	A	7	B	16	C	20	C	25
Northeast 45th Street/7th Avenue Northeast	C	20	C	29	E	56	E	72
Northeast 45th Street/5th Avenue Northeast	C	24	C	26	C	22	C	24

LOS denotes level of service.
sec. denotes seconds.



LEGEND

- Study Signalized Intersection
- Study Unsignalized Intersection

LEVELS OF SERVICE

A-C	no-little congestion
D	moderate congestion
E	heavy congestion
F	severe congestion, over capacity

No Build — 8 Lane

	NB	8LT
AM	C	C
PM	E	F

AM Peak Hour
PM Peak Hour

No Build conditions — 8 Lane conditions

N Not to scale

Exhibit 36. **Northeast 45th Street Interchange Area**

SR 520 Bridge Replacement and HOV Project

As shown in Exhibit 36, the 8-Lane Alternative would not have much effect on intersection operations at the Northeast 45th Street interchange area. The Northeast 42nd Street/7th Avenue Northeast intersection would experience a slight increase in the average delay per vehicle, shifting the LOS from A to B (compared to the No Build Alternative), which is still well within acceptable operational standards. Similarly, the Northeast 45th Street/5th Avenue Northeast intersection would operate at LOS C for both alternatives, which is within the acceptable standards, so is not discussed in detail.

Although the LOS does not shift at the Northeast 45th Street/7th Avenue Northeast intersection, traffic operations are described below because of capacity and queuing issues.

Northeast 45th Street/7th Avenue Northeast

No Build Alternative

Under No Build Alternative, this intersection would operate at LOS C during the a.m. peak hour. The northbound queue would not back into adjacent study intersections or northbound I-5.

During the p.m. peak hour, the intersection would operate at LOS E. The intersection would operate over capacity on the westbound approach, the eastbound left lane, and the northbound through lanes under the No Build Alternative. As during the a.m. peak hour, the northbound queue would not back into adjacent study intersections or northbound I-5. The eastbound left-turn queue would likely spill back through the Northeast 45th Street/5th Avenue Northeast intersection during peak times within the peak hour.

8-Lane Alternative

Under the 8-Lane Alternative, this intersection would operate at the same LOS during both the a.m. and p.m. peak hours as under the No Build Alternative.

During the a.m. peak hour, all of the V/C ratios are less than 1.0. However, during the p.m. peak hour, the westbound approach, eastbound left lane, northbound through/right lane, and the right-turn lane operate over capacity, similar to the conditions under the No Build Alternative. However, the 8-Lane Alternative has higher V/C ratios (see Exhibit 37), increasing the overall delay compared to the No Build Alternative. The larger V/C ratios are caused, in part, from the less-than-ideal network cycle length for this intersection. Additionally, compared to the

V/C > 1.0 Lane Groups	No Build	8-Lane
EBL	1.03	1.37
WBT/R	1.07	1.14
NBT/R	1.07	1.08
NB R	1.00	1.01

Exhibit 37. P.M. Peak Hour V/C Ratios by Movement for the Northeast 45th Street/7th Avenue Northeast Intersection

No Build Alternative, the eastbound left-turn volume would increase by 10 vph, the westbound through volume by 30 vph, the westbound right volume by 20 vph, and the northbound through volume by 10 vph. These are all conflicting movements.

Under the 8-Lane Alternative, during the a.m. and p.m. peak hours, the northbound queue would not back into adjacent study intersections or northbound I-5 (as happens under the No Build Alternative). The queue lengths are similar for both alternatives. As under the No Build Alternative, the eastbound left-turn queue would likely spill back through the Northeast 45th Street/5th Avenue Northeast intersection during peak times within the p.m. peak hour.

Under the 8-Lane Alternative, the effects on LOS conditions and queuing at this intersection are about the same as the No Build Alternative, although conditions would be somewhat worse during the p.m. peak hour.

Transit Operations in 2030

What is this section about?

This section describes and quantifies the 2030 No Build and 8-Lane Alternatives transit service and ridership along the SR 520 corridor. Transit characteristics and results of the travel-forecasting model are assumed for the No Build and 8-Lane Alternatives. For information on existing transit services and facilities, the reader can refer to Appendix R, *Transportation Discipline Report*.

What are some of the assumptions used for analysis purposes?

Various assumptions were made for analysis purposes. These included the following:

- The 2030 bus service on the Eastside and across Lake Washington would have the same general service pattern as today. However, there would be improved service frequencies during peak and off-peak periods and selected additional bus routes.
- The LOS (measured in annual bus hours) would be about 70 percent greater than at the present time. This reflects an annual growth rate of about 2 percent per year from the present to year 2030. This estimate is consistent with the past trends in transit service growth budgeted by transit providers.
- The growth in transit service would be more pronounced for off-peak service.
- Peak service would grow at about 1 percent per year.
- Sound Transit Regional Express and King County Metro would provide all-day bus service on SR 520.
- Service would include routes between the Eastside and Downtown Seattle and between the Eastside and the University District.
- King County Metro, Community Transit, and Sound Transit Regional Express Service would provide additional peak-only routes.

- Consistent with current routes, the transit operators would provide service to and from major activity centers in the morning and afternoon, with most routes providing morning service to Seattle and afternoon service from Seattle.
- While transit demand may shift due to the rebalancing of jobs and households in the region, commute patterns are assumed to be similar in 2030 to what they are today.

What would the 2030 transit network and operating plan include?

The transit network and operating plans for the No Build and 8-Lane Alternatives in 2030 are consistent with those identified for other corridor projects in the region. Compared to existing service levels in the Seattle, Eastside, and across the lake, the assumed 2030 operating plans include increased frequencies and one additional service route.

Exhibit 38 identifies all transit routes that currently use the SR 520 Evergreen Point Bridge, as well as transit routes that are projected to be in service in 2030. Exhibit 39 displays transit routes that were included in the transit operations analyses. It is anticipated that all of the existing transit routes would remain and that King County Metro will add Route 310 to provide additional transit service between Bothell and Seattle. Future service expansion would, for the most part, involve service frequency improvements.

For this analysis, the transit service characteristics (frequencies and service routes) would not vary between the No Build and 8-Lane Alternatives. There are, however, differences in ridership demand between the two alternatives. It is assumed that transit would be a more attractive option in the 8-Lane Alternative because of the completion of the HOV lane system on the SR 520 corridor. With a complete HOV system, transit speeds and reliability would increase while GP traffic would still be subject to congestion and tolls. Therefore, transit travel could become a more attractive travel mode.

Exhibit 38. Bus Routes Using SR 520 in 2003 and 2030

Route	Description	2003 Headway (minutes)		Assumed 2030 Headway (minutes)	
		Peak	Off-Peak	Peak	Off-Peak
242	Aurora Village-520-Overlake	24		20	
250	Redmond-520-Seattle	33		33	
252	Totem Lake-520-Seattle	24		18	
255	Totem Lake-S Kirkland-520-Seattle	20	30	15	30
256	Overlake-S Kirkland-520-Seattle	36		36	
257	Totem Lake-520-Seattle	30		30	
260	Kenmore-Juanita-520-Seattle	60		60	
261	Overlake-Bellevue-520-Seattle	30		30	
265	Redmond-Houghton-520-Seattle	23		23	
266	Bear Creek-Redmond-520-Seattle	24		20	
268	Bear Creek-Redmond-520-Seattle	40		23	
271	Issaquah-Bellevue-520-University of Washington	30	30	30	20
271	Eastgate-Bellevue-520-University of Washington	30		30	
272	Eastgate-Crossroads-520-University of Washington	36	60	30	30
277	Totem Lake-520-University of Washington	30		30	
310	Bothell-520-Seattle			45	
311	Duvall-Woodinville-520-Seattle	24		24	
CT424	Snohomish-Monroe-520-Seattle	60		30	
ST540	Redmond-520-University of Washington	20	30	20	30
ST545	Redmond-520-Seattle	15	30	15	30
ST555	Issaquah-Bellevue-520-Northgate	30		30	

Source: *SR 520 Bridge Replacement and HOV Project Travel Forecasting Analysis Results Technical Memorandum* (Parsons Brinckerhoff 2004).

Headway denotes the amount of time from start to finish of a particular bus route.

How many people would ride transit?

The travel forecasting analysis estimated average passenger loads in the a.m. peak period. These loads are the average numbers of passengers for each bus trip. These averages were then compared to available bus capacity along the corridor. This capacity is determined by the expected schedules for each bus route operating along the corridor.

The average bus capacity is assumed to be 65 passengers per bus, taking into account that bus fleets in 2030 will likely contain a mix of standard and articulated buses. When buses have more than 65 passengers per bus and/or when buses do not arrive frequently enough, people consider other travel options.

For some bus routes, the disparity between supply and demand would be substantial. For example, the westbound a.m. peak hour demand would exceed supply by over 300 percent for Metro Route 266 and Community Transit Route 424. In the eastbound direction, the demand would exceed supply by over 300 percent on Metro Route 271.

Exhibits 40 through 45 and the text below describe by route the projected a.m. peak hour transit demand as compared to expected capacities. The description is provided for the westbound and eastbound directions of three corridors:

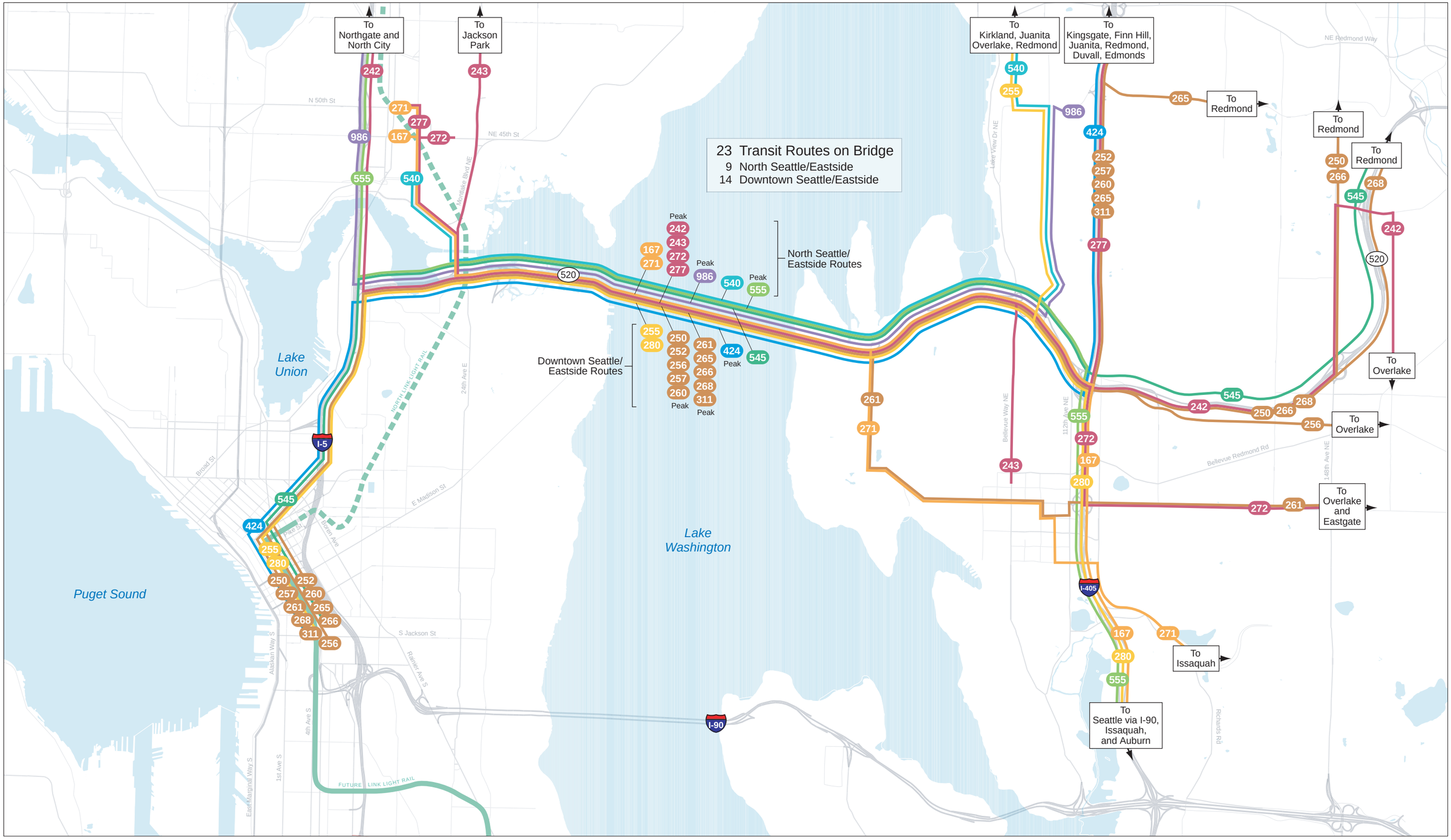
- Seattle-Kirkland
- Seattle-Redmond
- I-90/I-405

Seattle-Kirkland Corridor

For the purposes of this study, the Seattle-Kirkland corridor covers transit routes using SR 520 to travel between downtown Seattle or the University of Washington and north Puget Sound east of Lake Washington.

Westbound

Exhibit 40 shows SR 520 transit loads traveling westbound via the Kirkland corridor during the a.m. peak hour. It is projected that all buses, with the exception of Metro Route 310, would operate at levels that exceed the route capacities. The bus routes that would exceed route capacities are Metro Routes 252, 255, 257, 260, 277, and 311 and Community Transit (CT) Route 424.



N

0 2,500 5,000 Feet

METRO TRANSIT
- North Seattle/Eastside
- Peak Hour North Seattle/East Side
- Limited Service North Seattle/Eastside
- Downtown Seattle/Eastside
- Peak Hour Downtown Seattle/Eastside

SOUND TRANSIT
- North Seattle/Eastside
- Peak Hour North Seattle/East Side
- Downtown Seattle/Eastside

COMMUNITY TRANSIT
- Peak Hour Downtown Seattle/Snohomish

LINK LIGHT RAIL
- Initial Segment (Approved)
- North LINK (Proposed)

Exhibit 39. **Transit Routes Using Evergreen Point Bridge in 2030**

SR 520 Bridge Replacement and HOV Project

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Eastbound

Exhibit 41 shows SR 520 transit loads traveling eastbound via the Seattle-Kirkland corridor during the a.m. peak hour. Metro Route 255 is the only transit route that would operate in the eastbound direction in this corridor. With both the No Build and 8-Lane Alternatives, demand for transit service would be met by proposed bus frequencies on this route.

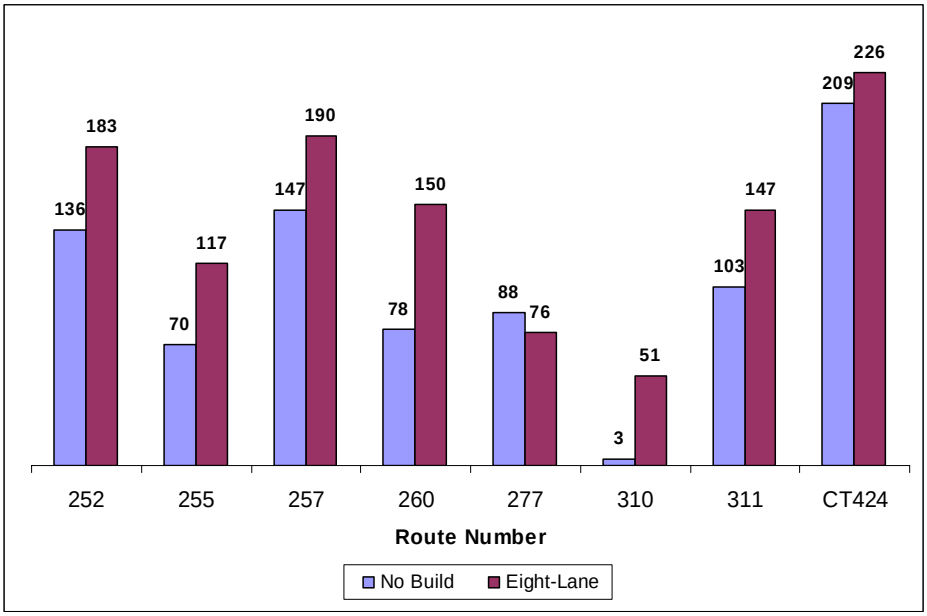

Exhibit 40. SR 520 Transit Loads — A.M. Peak Hour Westbound Kirkland-to-Seattle Corridor

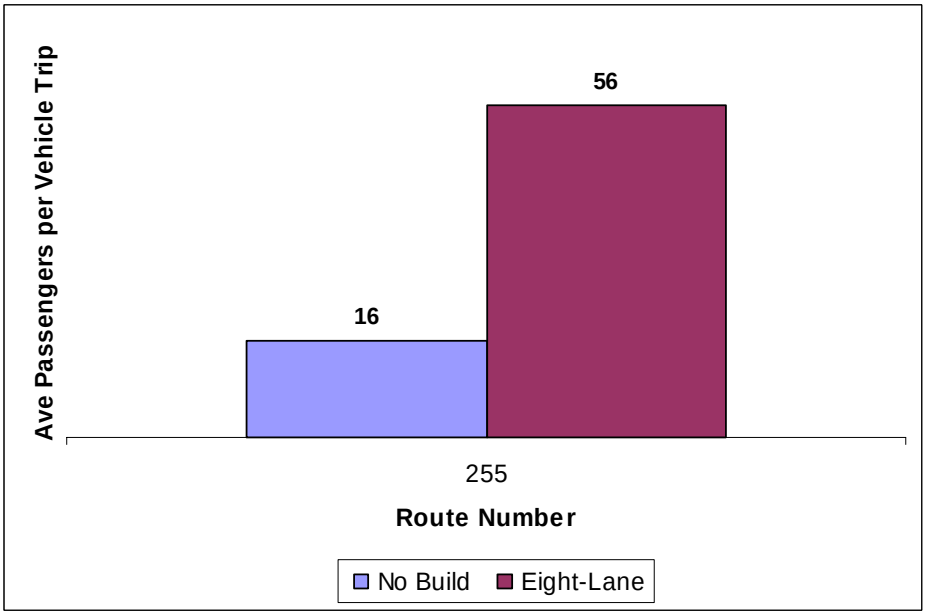

Exhibit 41. SR 520 Transit Loads — A.M. Peak Hour Eastbound Seattle-to-Kirkland Corridor

Seattle-Redmond Corridor

For the purposes of this study, the Seattle-Redmond corridor covers transit routes using SR 520 to travel between downtown Seattle or the University of Washington and northeast Puget Sound.

Westbound

Exhibit 42 shows SR 520 transit loads traveling westbound via the Seattle-Redmond corridor during the a.m. peak hour. It is projected that all Metro routes (250, 261, 265, 266, and 268) would operate at levels that exceed the proposed capacities. However, the two Sound Transit Routes that operate in this corridor (Sound Transit [ST] Route 540 and ST 545) would be adequately served by the proposed bus frequencies.

Eastbound

Exhibit 43 shows SR 520 transit loads traveling eastbound via the Seattle-Redmond corridor during the a.m. peak hour. Under the No Build Alternative, transit demand for the four eastbound bus routes would be met by service capacities. Under the 8-Lane Alternative, it is expected that demand would exceed capacity for Metro Route 256 and be just at capacity for the other three routes (Metro Route 242, ST 540, and ST 545).

I-90/I-405 Corridor

For the purposes of this study, the I-90/I-405 corridor covers transit routes using SR 520 to travel between downtown Seattle or the University of Washington and areas east of Bellevue.

Westbound

Exhibit 44 shows SR 520 transit loads traveling westbound from the I-90/I-405 corridor during the a.m. peak hour. Transit demand for Metro Route 271 (originating in Issaquah and Eastgate) would be, on average, 60 percent greater than proposed service capacity under both the No Build and 8-Lane Alternatives. The other two routes serving the corridor (Metro Route 272 and ST 555) would provide adequate bus frequencies to meet transit demand.

Eastbound

Exhibit 45 shows SR 520 transit loads for eastbound travel through the I-90/I-405 corridor during the a.m. peak hour. Metro Route 271

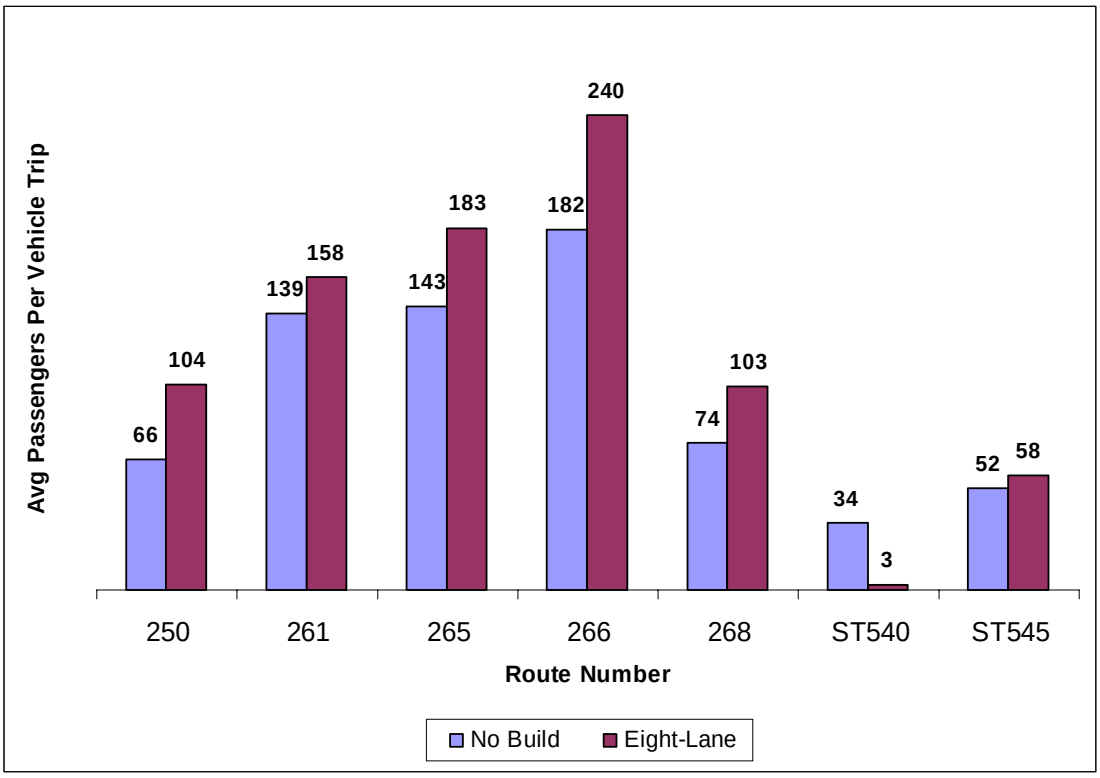

Exhibit 42. SR 520 Transit Loads — A.M. Peak Hour Westbound Redmond-to-Seattle Corridor

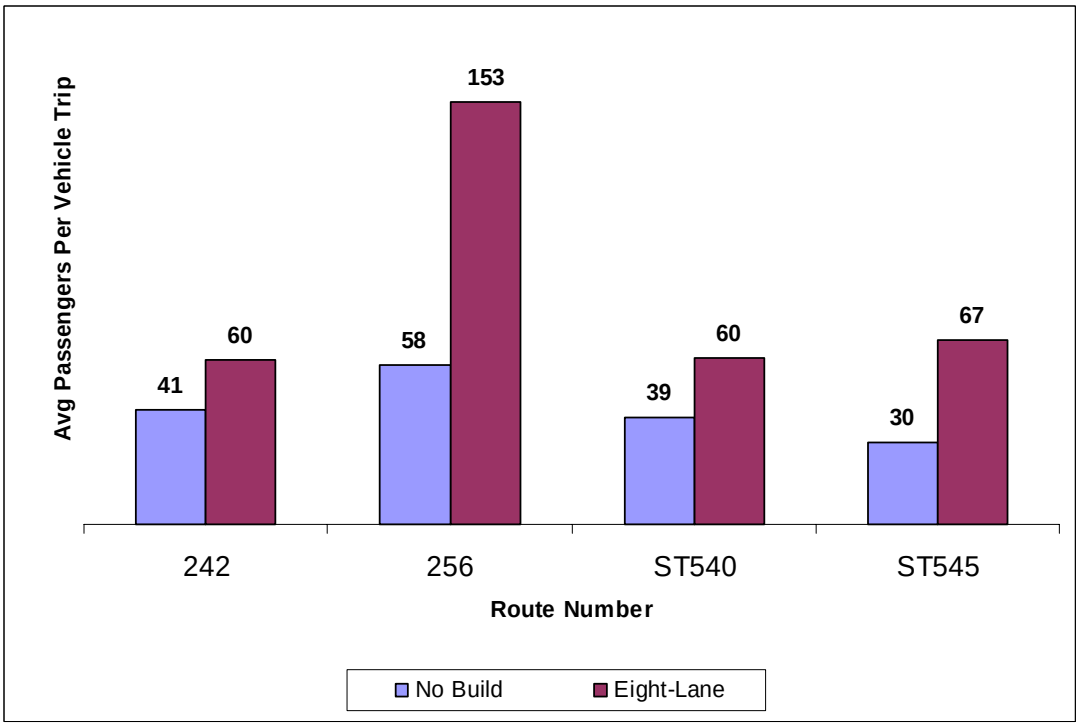

Exhibit 43. SR 520 Transit Loads — A.M. Peak Hour Eastbound Seattle-to-Redmond Corridor

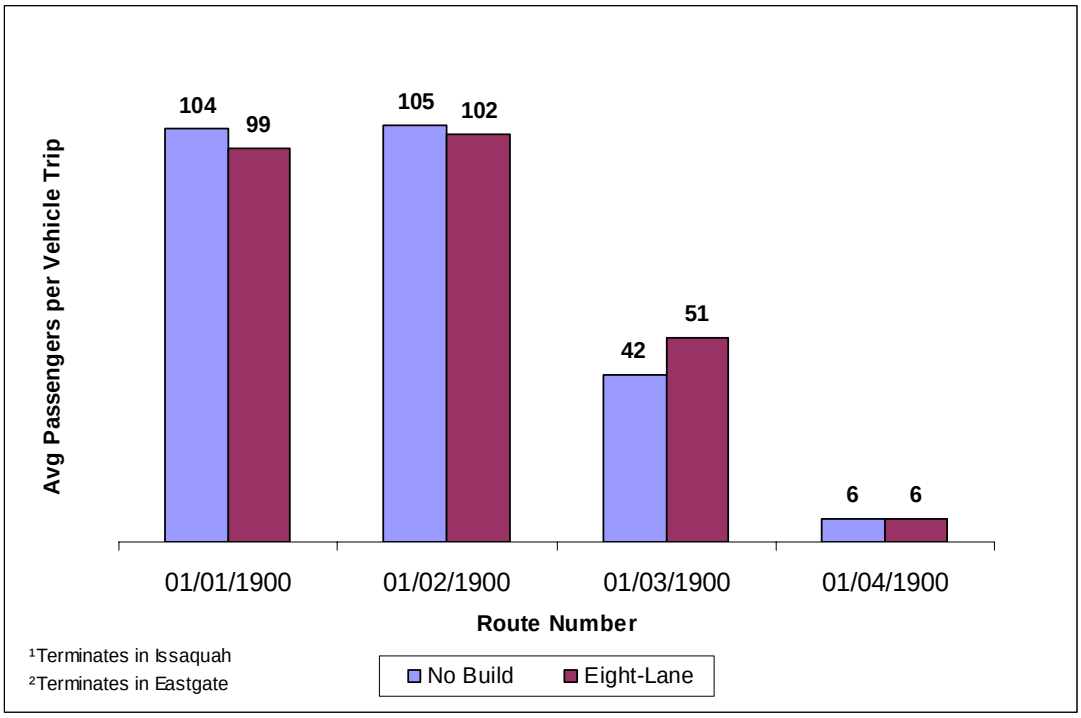

Exhibit 44. SR 520 Transit Loads — A.M. Peak Hour Westbound I-90/I-405 Corridor

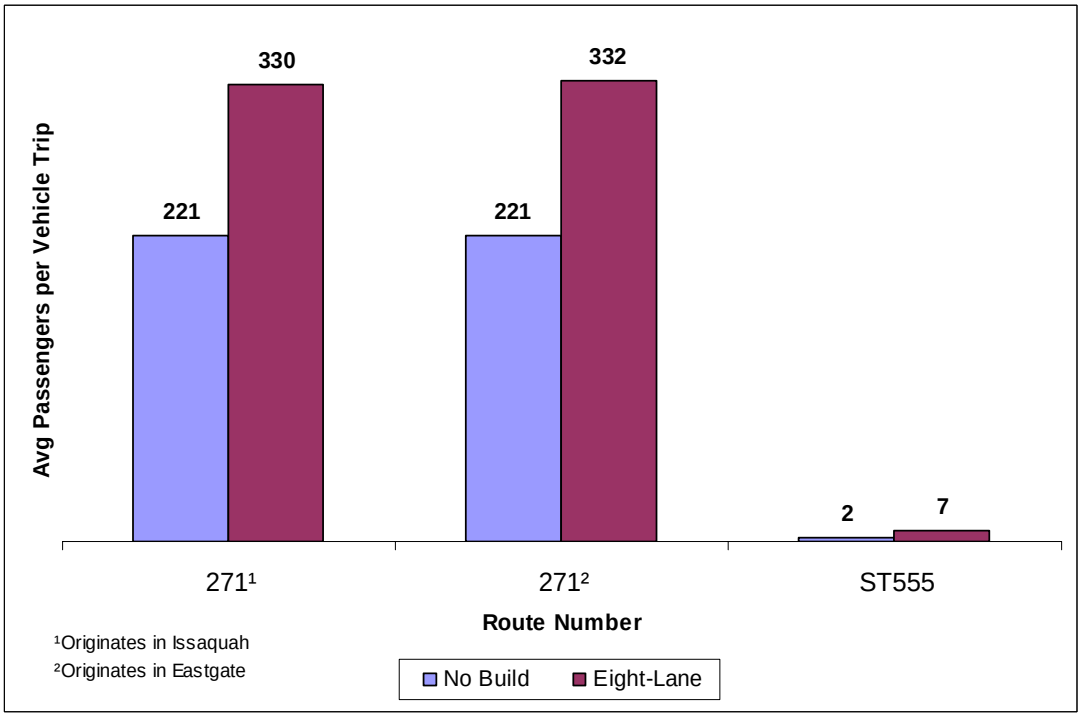

Exhibit 45. SR 520 Transit Loads — A.M. Peak Hour Eastbound I-90/I-405 Corridor

(terminating in Issaquah and Eastgate) would be substantially overloaded in the eastbound direction under both the No Build and 8-Lane Alternatives. It would have up to five times more transit demand than capacity. ST 555 is the only other transit route serving this corridor. On that route, the demand for transit service would be met by proposed bus frequencies.

Would there be enough buses for the ridership in 2030?

As indicated in the previous section, it is projected that demand levels for several bus routes operating on the SR 520 Evergreen Point Bridge would exceed supply levels. Exhibit 46 quantifies the imbalance between supply and demand for transit service in the corridor. It also estimates the number of buses that would be necessary in order to provide sufficient capacity to meet the demand.

Exhibit 46. A.M. Peak Hour Passenger and Vehicle Volumes for SR 520 Buses (1998 and 2030)

	Number of Passengers	Forecasted Buses	Avg. Bus Occupancy (ABO)	Number of Buses Needed	Adjusted ABO[a]
Baseline Conditions (1998)					
Westbound	1,542	39	39	38	41
Eastbound	191	14	14	9	21
Total	1,733	53		47	
No Build Alternative (2030)					
Westbound	4,288	45	95	76	56
Eastbound	1,354	20	66	24	56
Total	5,642	65		100	
Growth over Existing Conditions	226%	23%		113%	
8-Lane Alternative (2030)					
Westbound	5,372	45	119	94	57
Eastbound	2,290	20	111	40	57
Total	7,662	65		134	
Growth over No Build Alternative	36%	0%		34%	

[a] Based on an average bus occupancy (ABO) of 65 passengers.

To estimate the additional number of buses identified in Exhibit 44, information from the transit demand forecasting process combined

with an overall estimate of a peak period to peak-hour ratio was used. The number of peak-hour passengers was then divided by an assumed loading of 65 passengers per bus to get the number of buses that would be needed.

Passenger demand during the a.m. peak hour would be about 36 percent more under the 8-Lane Alternative than under the No Build Alternative. To accommodate the projected growth in passenger demand about 34 percent more buses would be needed under the 8-Lane Alternative than under the No Build Alternative.

What would be the travel times for transit?

Through a traffic operations analysis using the Corsim microsimulation model, travel times and speeds were identified for the No Build and 8-Lane Alternatives for GP traffic and HOV traffic. Since buses would be using the HOV lane, it is expected that transit travel times would be the same as HOV times.

Under the No Build Alternative, it is assumed that transit speeds would be the same as for GP traffic in the eastbound direction because there are no separate transit-only facilities in place. However, it is assumed that transit speeds would be slightly higher than GP speeds in the westbound direction to take into account the outside HOV lane on the Eastside of the corridor.

Exhibit 47 shows estimated travel times and speeds for 2030 on SR 520 between I-5 on the west side and 124th Avenue Northeast on the east side. The table depicts both GP travel and HOV-only travel under both the No Build and 8-Lane Alternatives.

The following sections describe estimated average GP and transit travel times for the No Build and 8-Lane Alternatives. The GP travel times are reported to demonstrate the benefit of transit use.

Exhibit 47. 2030 Average Travel Times on SR 520 Between I-5 and 124th Avenue Northeast

	Transit Travel Time		GP Travel Time	
	No Build	8-Lane	No Build	8-Lane
Westbound A.M. Peak Period				
Average Travel Time	39 min	45 min	49 min	78 min
Average Travel Time Savings Compared to GP travel	10 min savings	33 min savings		
Average Speed	11 mph	9 mph	9 mph	5 mph
Eastbound A.M. Peak Period				
Average Travel Time	19 min	8 min	19 min	8 min
Average Travel Time Savings Compared to GP travel	No change	No change		
Average Speed	23 mph	53 mph	23 mph	53 mph
Westbound P.M. Peak Period				
Average Travel Time	24 min	22 min	30 min	64 min
Average Travel Time Savings Compared to GP travel	6 min savings	42 min savings		
Average Speed	18 mph	19 mph	15 mph	7 mph
Eastbound P.M. Peak Period				
Average Travel Time	9 min	8 min	9 min	15 min
Average Travel Time Savings Compared to GP travel	No change	7 min savings		
Average Speed	48 mph	53 mph	48 mph	28 mph

Min denotes minutes
mph denotes miles per hour

No Build Alternative

The average travel time for transit traffic between 124th Avenue Northeast and I-5 is 39 minutes in the westbound direction during the a.m. peak period. This is a 10-minute savings compared to GP traffic travel time.

The average travel time for transit traffic between 124th Avenue Northeast and I-5 is 19 minutes in the eastbound direction during the a.m. peak period. This is similar compared to GP traffic travel time.

In the westbound direction during the p.m. peak period, the average transit travel time is 24 minutes, a 6-minute savings compared to GP traffic travel time.

In the eastbound direction during the p.m. peak period, the average transit travel time is 9 minutes, indicating near free-flow conditions, similar to GP traffic operations.

8-Lane Alternative

The average travel time for transit traffic between 124th Avenue Northeast and I-5 is 45 minutes in the westbound direction during the a.m. peak period. This is a 33-minute savings compared to GP traffic travel time. This is also a 6-minute savings compared to transit travel under the No Build Alternative.

The average travel time for transit traffic between 124th Avenue Northeast and I-5 is 8 minutes (which indicates free-flow conditions) in the eastbound direction during the a.m. peak period. This is similar compared to GP traffic travel time for the 8-Lane Alternative, as well as GP and transit travel times for the No Build Alternative.

During the p.m. peak period in the westbound direction, the average transit travel time is 22 minutes, a 42-minute savings compared to GP traffic travel time. However, this is a 2-minute increase compared to transit travel under the No Build Alternative.

In the eastbound direction during the p.m. peak period, the average transit travel time is 8 minutes, indicating free-flow conditions, which is a 7-minute travel time savings compared to GP traffic. The transit travel time for the 8-Lane Alternative is similar to the transit travel time for the No Build Alternative.

What would be the HOV and transit ridership for the No Build and 8-Lane Alternatives?

Exhibit 48 shows 2030 HOV and transit ridership in terms of daily person trips for the No Build and 8-Lane Alternatives. The most substantial difference between the No Build Alternative and the 8-Lane Alternative would be related to HOV usage. It is estimated that there would be 11,220 HOV daily person trips under the No Build Alternative and as many as 57,620 HOV daily person trips under the 8-Lane Alternative. There would be 46,400 HOV daily person trips (over 400 percent) more than under the No Build Alternative. The difference between the alternatives related to transit ridership would be

smaller than that for HOV usage, but it would still be considerable. Transit daily person trips would increase from 34,070 with the No Build Alternative to as much as 46,770 with the 8-Lane Alternative. That would be 37 percent more transit daily person trips with the 8-Lane Alternative than with the No Build Alternative.

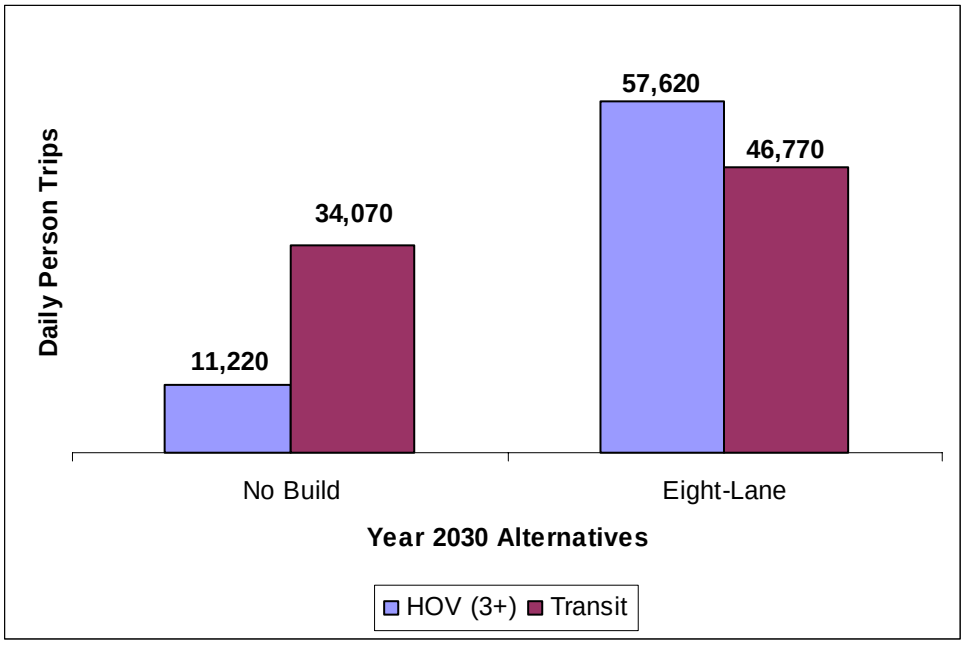

Exhibit 48. SR 520 HOV (3+) and Transit

References

Parsons Brinckerhoff. 2004. SR 520 Bridge Replacement and HOV Project Travel Forecasting Analysis Results Technical Memorandum. January 23, 2004.

SR 520 Project Team. 2004. Final Submittal of Freeway and Local Traffic Forecasts and Operations. March 30, 2004.

SR 520 Project Team. SR 520 8-Lane Alternative I-5 Options Report. March 12, 2004.

TRB. 2000. Highway Capacity Manual. Transportation Research Board, National Research Council, Washington, D.C.