FINAL DRAFT

NICKERSON STREET CORRIDOR STUDY

Prepared for:
Seattle Department of Transportation

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1. INTRODUCTION

The City of Seattle is considering changing the lane configuration on West Nickerson Street from four lanes (two lanes in each direction) to three lanes (one lane in each direction plus a center two-way left turn lane). This technical report evaluates how that change could affect traffic flow along the corridor, as well as the operations at signalized intersections and of turns from unsignalized side streets or driveways along the corridor. It also addresses the effect on traffic safety, pedestrian mobility, and truck mobility. Information related to existing traffic conditions are presented first followed by the traffic analysis and Heffron Transportation's recommendations.

2. EXISTING CONDITIONS

2.1. Roadway Configuration

W Nickerson Street is a principal arterial that connects from 15th Avenue W, the arterial that crosses the Ballard Bridge, to 4th Avenue N, the arterial that crosses the Fremont Bridge. It is a four-lane roadway for its entire length from Fremont Avenue to just east of the interchange with 15th Avenue W. There are auxiliary turn lanes at the signalized intersections of 3rd Avenue W and 4th Avenue N. The interchange near 15th Avenue W is controlled by a stop sign where through movements intersect; right turn movements are controlled by yield signs. Existing roadway conditions along this section of street are illustrated on Figure 1.

2.2. Traffic Volumes

The Fremont Bridge approaches were being reconstructed during the course of this analysis. Until June 2007, the bridge was restricted to one lane in each direction, which severely affected travel capacity on the bridge. In addition, large vehicles were prohibited from crossing the bridge because of the narrow lane widths. The bridge re-opened to full traffic (two lanes in each direction) on June 2, 2007, although occasional nighttime closures continued.

Vehicle classification counts were performed on W Nickerson Street east of 6th Avenue W on June 19, 2007. These counts were performed during a three-day period when the Fremont Bridge was open to traffic 24-hours a day. These counts determined the hourly volumes by direction and the type of vehicle (passenger car or truck) by hour. These data are shown on Figures 2 and 3.

Figure 1. Existing Roadway Conditions

Figure 2. Hourly Traffic Volumes on W Nickerson Street

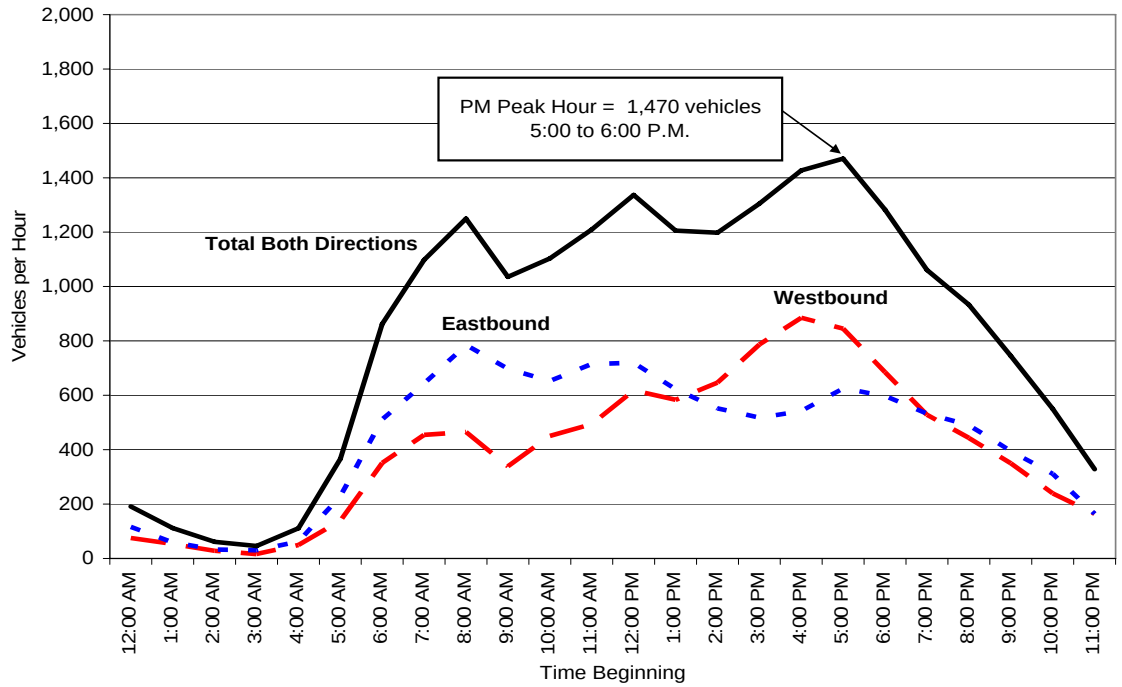
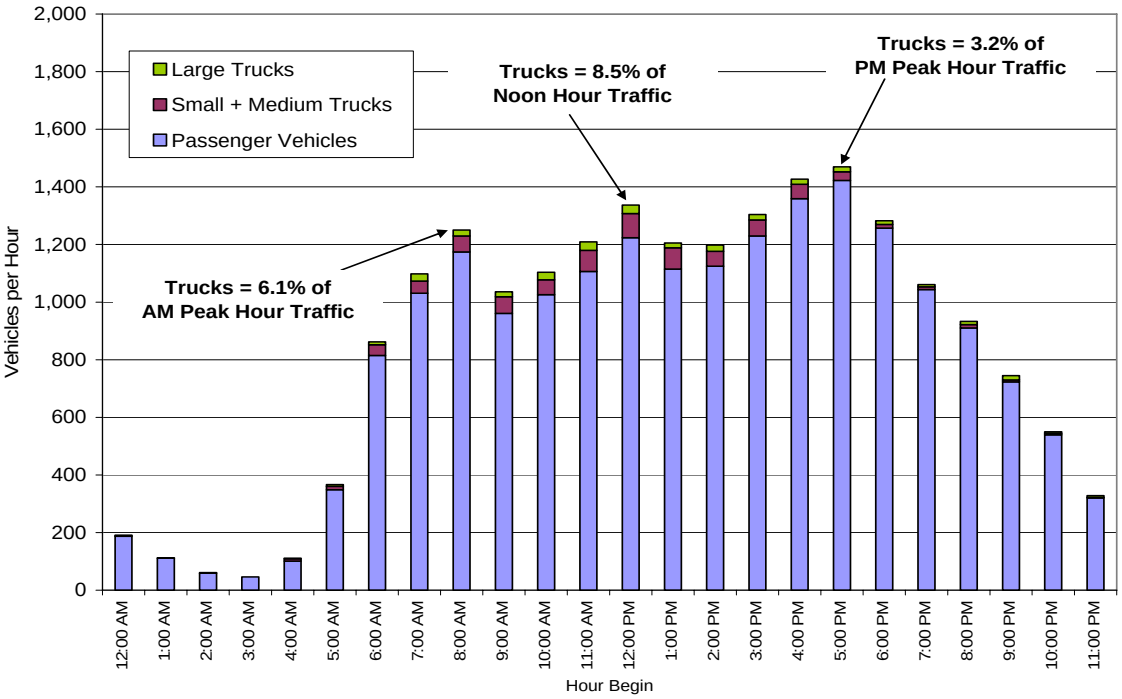


Figure 3. Type of Vehicles on W Nickerson Street



Source: Machine count performed by Traffic Count Consultants, Inc. June 19, 2007. Counts were performed east of 6th Avenue W.

Key volume information derived from these counts is summarized in Table 1. This includes the daily and peak hour volumes as well as the percentage of trucks.

Table 1. Analysis Volumes for W Nickerson Street – 2007

		Traffic Volume (All Vehicles)			Percent Trucks of All Traffic		
	Time	Westbound	Eastbound	Total	Small/Med Trucks	Large Trucks	All Trucks
Daily	24 hours	9,700	10,600	20,300	3.6%	1.6%	5.2%
AM Peak Hour	8:00 to 9:00 A.M.	465	785	1,250	4.5%	1.6%	6.1%
PM Peak Hour	5:00 to 6:00 P.M.	845	625	1,470	2.0%	1.2%	3.2%
Noon Peak Hour	12:00 to 1:00 P.M.	620	720	1,340	6.3%	2.2%	8.5%

Source: Machine count performed by Traffic Count Consultants, Inc. June 19, 2007. Counts were performed east of 6th Avenue W.

Available turning movement counts were collected for the W Nickerson Street corridor. New counts were performed for the W Nickerson Street/6th Avenue W intersection on January 30, 2007 to determine the side street volumes. New traffic counts were also performed at W Nickerson Street/3rd Avenue W and at W Nickerson Street/15th Avenue W interchange were performed on July 18, 2007 (a day when the bridge was not closed to traffic for construction). All new and prior count data were then balanced against the new machine counts described above. Analyses were performed for the two highest traffic hours: AM peak hour and PM peak hour. The existing peak hour volumes are shown on Figures 4 and 5.

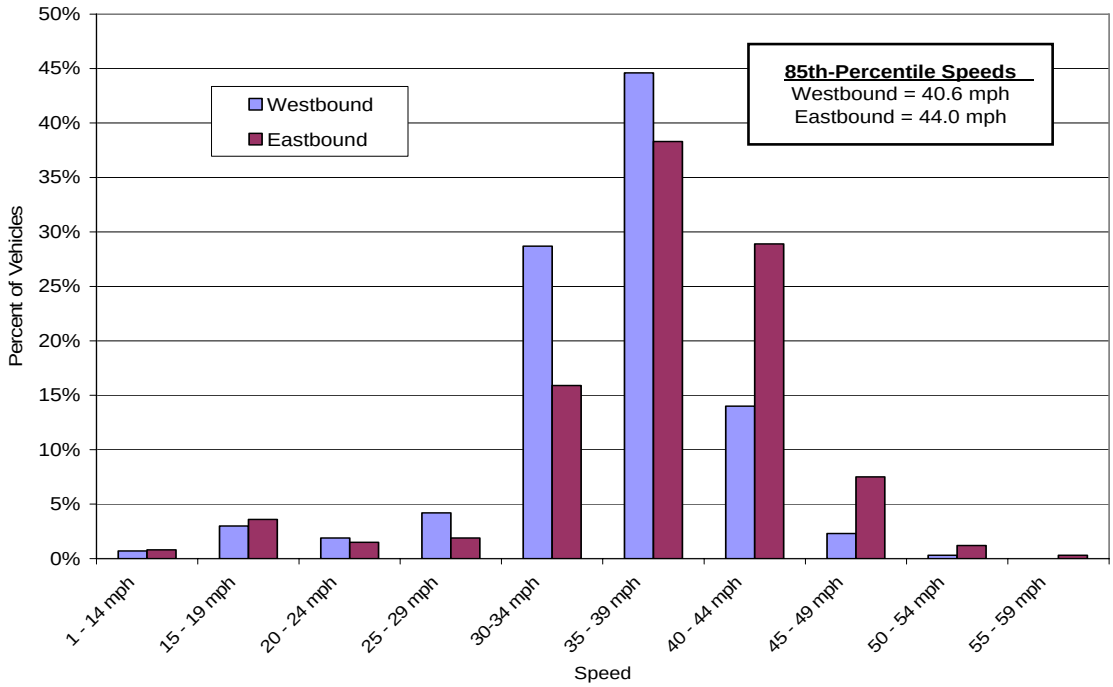
2.3. Vehicle Speeds

The traffic counting machine described above also recorded vehicle speeds. The speeds were recorded east of 6th Avenue W on June 19, 2007. To the west of this location, W Nickerson Street ascends a hill. Therefore, vehicles in the westbound direction are just starting up an incline, while vehicles in the eastbound direction are near the bottom of the hill. The collected speeds are illustrated in Figure 6. This shows that eastbound vehicles (downhill) are traveling faster than those in the westbound direction. The arterial speed limit in Seattle is 30 mph. The 85th-percentile speeds in both directions substantially exceed this limit: 40.6 mph in the westbound direction and 44.0 mph in the eastbound direction.

Figure 4. Existing (2007) Traffic Volumes - AM Peak Hour

Figure 5. Existing (2007) Traffic Volumes - PM Peak Hour

Figure 6. Vehicles Speeds on W Nickerson Street



Source: Machine survey performed by Traffic Count Consultants, Inc. June 19, 2007. Survey performed east of 6th Avenue W.

2.4. Pedestrian and Bicycle Volumes

Pedestrian count data were collected at key locations along the corridor as part of intersection turning movement counts. The highest volumes of pedestrians (and bicyclists) are located near Seattle Pacific University at 3rd Avenue W and at the south end of the Fremont Bridge, which is the connection between the Burke-Gilman Trail and the Dexter Avenue bike path. These pedestrian volumes, and the associated pedestrian signal phases, have been included in the traffic operations analysis.

2.5. Traffic Accident History

Accident data for intersections and between-intersection roadway segments along W Nickerson Street were obtained from SDOT. These data were examined to determine if there are any traffic safety conditions. Unsignalized intersections with five or more accidents per year and signalized intersections with 10 or more accidents per year are considered high accident locations by the City of Seattle. The City of Seattle data reflecting the period between January 1, 2004 and March 3, 2007 (approximately three years) are summarized in Table 2.

Table 2. Accident Summary (January 1, 2004 – March 3, 2007)

Intersection w/W Nickerson	Head-On	Rear-End	Side-Swipe	Right Turn	Left Turn	Right Angle	Ped/ Cyclist	Other	Parked Vehicle	Total for 3.2 Years
15th Avenue W Interchange	0	0	0	0	3	0	0	0	0	3
13th Avenue W	1	0	0	0	0	1	0	1	0	3
12th Avenue W	0	0	0	0	1	0	0	0	0	1
11th Avenue W	0	0	0	0	0	0	0	1	0	1
6th Avenue W	1	0	0	1	0	2	0	0	0	4
3rd Avenue W	0	0	1	0	4	0	4	1	0	10
Queen Anne Avenue	0	0	0	0	0	1	0	0	0	1
Dravus Street	0	0	0	0	0	0	1	1	0	2
Warren Avenue	0	0	0	0	1	1	0	1	0	3
Etruria Street	0	1	0	0	0	0	1	0	0	2
Florentia Street/3rd Avenue N	0	0	4	1	5	2	0	1	0	13
Westlake Avenue N	0	0	1	0	0	0	0	1	0	2
Roadway Segment Along Nickerson	**Head-On**	**Rear-End**	**Side-Swipe**	**Right Turn**	**Left Turn**	**Right Angle**	**Ped/ Cyclist**	**Other**	**Parked Vehicle**	**Total for 3.2 Years**
15th Ave W On Ramp and Emerson Nickerson Ramp	0	1	0	0	0	0	0	0	0	1
Emerson Ramp and 14th Ave W	0	0	1	0	0	0	0	1 [b]	0	2
14th Ave W and 13th Ave W	0	1	0	0	0	0	0	3	0	4
13th Ave W and 12th Ave W	0	2	0	1	2	2 [c]	0	3	0	10
12th Ave W and 11th Ave W	0	1	0	1	0	0	0	0	0	2
11th Ave W and 8th Ave W	0	1	1	0	0	0	0	3	6	11
8th Ave W and 6th Ave W	0	4	1	0	1	0	0	2	4	12
6th Ave W and 3rd Ave W	0	3	4	0	0	1	0	0	1	9
3rd Ave W and Bertona St	0	0	0	0	1	0	0	4	0	5
Bertona St and Queen Anne	0	0	0	0	0	0	0	1	0	1
Queen Anne and Cremona	0	0	0	0	0	0	0	1	0	1
Cremona St and Dravus St	0	1	0	0	0	0	1	0	1	3
Dravus St and Warren Ave N	0	3	1	0	0	1	0	0	0	5
Warren Ave N and Etruria St	0	1	0	0	0	0	0	0	2	3
Etruria St and Florentia St	0	5	4	0	1	1	0	2	0	13
Florentia St and Westlake	0	3	6	0	1	1	0	3	0	14

Source: City of Seattle Department of Transportation, March 2007.

a This includes accidents involving a moving vehicle colliding with a parked vehicle.

b Vehicle hitting an object resulted in a fatality.

c One Right Angle Accident resulted in a fatality.

The accident data show that none of the intersections in the study area would be rated as high accident locations. There are, however, some unusual accident trends in the corridor. Notably, there were many accidents where parked vehicles were struck between 6th Avenue W and 11th Avenue W. This stretch is located on a curve, which may contribute to that type of accident. There were also a high number of rear-end collisions occurring between intersections. Although no definitive cause was listed with the accident data, these types of accidents are more common on four-lane roadways when vehicles may stop in the travel lane while waiting to turn left across oncoming traffic.

2.6. Future Traffic Volumes

Future traffic conditions along W Nickerson Street were evaluated for two future years: year 2012 (a short-term horizon, five years from today) and year 2027 (a long-term horizon, 20 years from today). Future traffic volumes for this corridor were estimated by increasing existing traffic volumes by 1% per year. This growth rate is consistent with the growth rate used for the Fremont Circulation Study. It is slightly higher than the rate used for analysis in the 15th Avenue W corridor for projects in Interbay (0.8% per year for the PM peak hour and 0.6% per year for the AM peak hour).

There is one major development project being proposed for the corridor—the West Ewing Street Development—located north of W Nickerson Street on W Ewing Place. The main access to six parcels of land would be from 6th Avenue W. A separate traffic analysis was performed for the cumulative projects: *Transportation Impact Analysis for the West Ewing Street Development* (Heffron Transportation, Inc. August 2007.) Overall, about 500,000 square feet of office space is proposed, which is projected to generate an estimated 3,680 vehicle trips per day, 490 vehicle trips during the AM peak hour, and 470 vehicle trips during the PM peak hour. The traffic from this development was added to the W Nickerson Street corridor for both future conditions.

Future traffic volumes used in this analysis are shown on Figures 7 through 10.

Figure 7. Year 2012 Traffic Volumes - AM Peak Hour

Figure 8. Year 2012 Traffic Volumes - PM Peak Hour

Figure 9. Year 2027 Traffic Volumes - AM Peak Hour

Figure 10. Year 2027 Traffic Volumes - PM Peak Hour

3. EFFECT OF LANE CONFIGURATION CHANGE

The City of Seattle's consideration for changing the lane configuration on W Nickerson Street from four lanes to three lanes would not extend through the major signalized intersections at 4th Avenue N or N Florentia Street. This analysis will be used to test whether the lane configuration could be changed west of N Florentia Street, including through the intersection at 3rd Avenue W. The most likely sections where the change would be made would be from about Queen Anne Avenue W to 13th Avenue W.

The primary traffic operations effect of the lane change would be to the through capacity of traffic on W Nickerson Street and the ability to turn left or right from a side street. In addition, it is possible that a future signal could be installed along the corridor for either pedestrians or vehicles. The effect of the lane change on a signal is also evaluated. All of these potential effects are described in the following sections of this report.

3.1. Lane Configuration Change Effect on Through Capacity

Local examples of former four-lane roads that have been converted to three lanes include Phinney Avenue N, 8th Avenue NW, N 45th Street through Wallingford, and Dexter Avenue N north of Mercer Street. Traffic volumes for these various three-lane road segments were compiled from the City of Seattle's historic traffic count database and are summarized in Table 3.

Table 3. Existing Traffic Volumes on Three-Lane Arterials in Seattle

Other 3-Lane Road Segments	Count Location	Date of Count	AM Peak Hour Volume	PM Peak Hour Volume	AWDT[a]
N 45th Street	at Eastern Avenue	May 2006	1,401	1,548	24,160
8th Avenue NW	at NW 65th Street	Nov 2006	1,092	1,222	12,670
Phinney Avenue	at NW 65th Street	May 2006	855	974	11,980
Dexter Avenue N	south of Westlake Avenue	Nov 2003	758	1,007	8,540

a Average weekday traffic volume.

Peak hour traffic volumes on these other three-lane roadways ranged from about 760 vehicles per hour on Dexter Avenue N to about 1,550 vehicles per hour on N 45th Street. Average weekday traffic volumes (AWDT) ranged from 8,500 vehicles per day on Dexter Avenue N to 24,200 vehicles per day on N 45th Street. The existing traffic volumes on W Nickerson Street range up to 1,470 vehicles per hour during the PM peak hour, and 20,300 per day. These volumes are at the upper range of what is accommodated on other three-lane arterials in Seattle. The through capacity on these arterials is most affected by signalized intersection where through traffic must occasionally stop. The effect that a lane change would have on the capacity of a traffic signal is presented in Section 3.3 of this report.

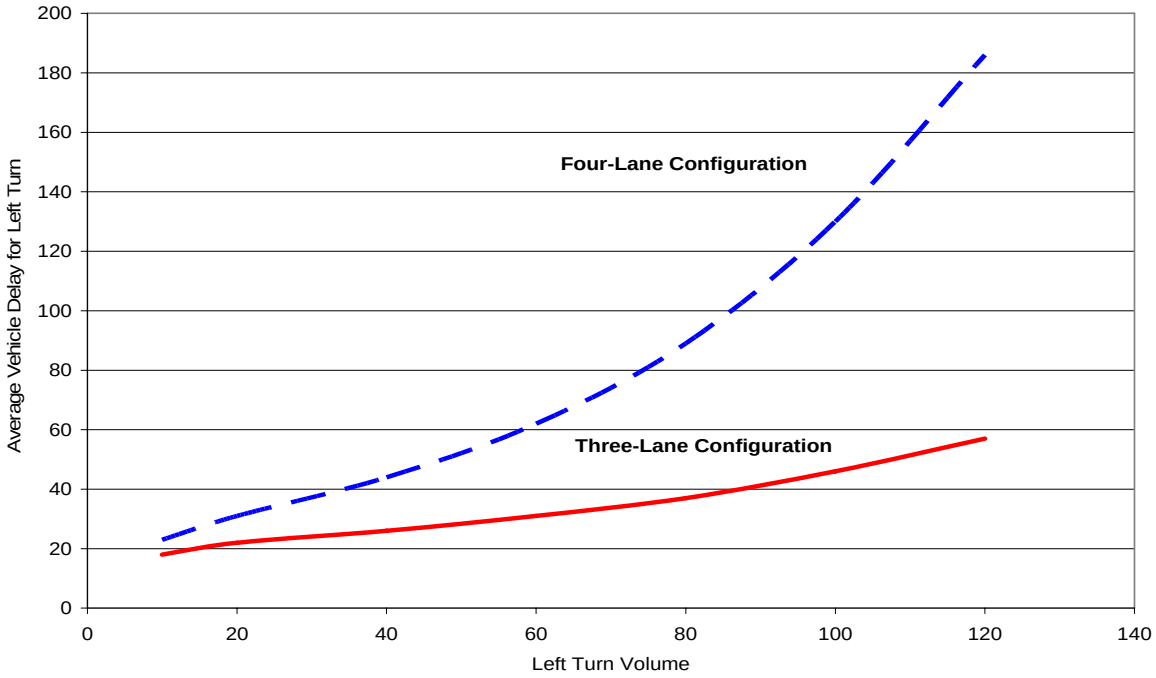
3.2. Lane Configuration Change Effect on Side Street Turns

Left turns from side streets controlled by stop signs (or implied stops as in the case of a driveway) are the most difficult to make. These types of turns require a motorist to find a gap in both directions of traffic on the main street. With the existing four-lane configuration, the gap in the traffic streets must occur in both directions simultaneously. However, if a center left turn lane is provided (as proposed with the three-lane configuration), then a motorist can accept gaps in each direction of main street

separately. For example, a motorist would first need a gap in traffic arriving from the left, and would turn into the center turn lane. Then, they would need a gap in traffic arriving from the right (or behind them when pausing in the left turn lane) to merge into the traffic stream. Delay experienced with this two-step left turn is almost always less than the delay experienced by having to make the left turn movement in one step.

To test this theory, Year 2027 PM peak hour volumes along the corridor were evaluated with different volumes of side-street left turn volumes. Through volumes listed previously in Table 1 with the 1% per year growth rate were used. The delay for both the four-lane and three-lane configuration were determined, and are shown on Figure 11. The analysis shows that changing the lane configuration from four lanes to three lanes would improve operations for side street traffic.

Figure 11. Delay for Vehicle Turning Left onto W Nickerson Street from Stop Sign
PM Peak Hour (Year 2027)

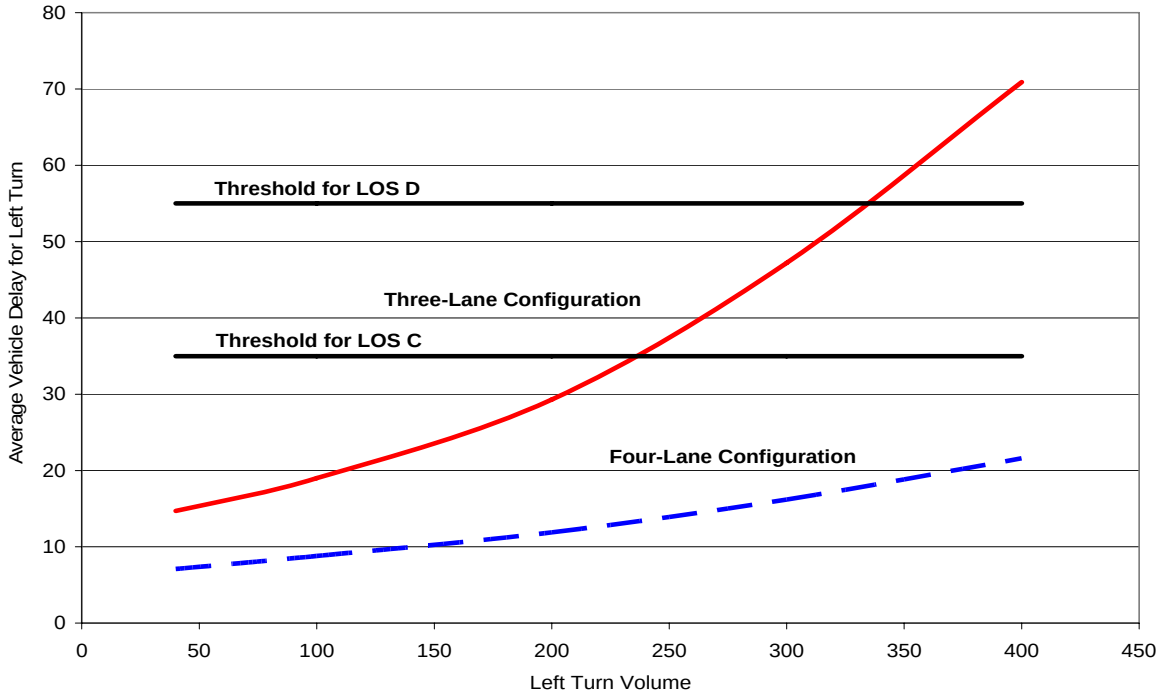


Source: Delay determined using methodology for unsignalized intersections in the Highway Capacity Manual. The chart reflects a generic intersection located along W Nickerson Street.

3.3. Lane Configuration Change Effect on Signalized Intersections

The effect of the lane change on a signalized intersection was also tested. This analysis was performed to determine if the lane change could be made to existing signalized intersections in the corridor, such as that at 3rd Avenue W or signalized pedestrian crossings. The lane change may also affect any future signals installed along the corridor. A similar analysis to that described above was performed for a generic signal. In this case, both the side street traffic volume and the signal timing were adjusted to determine the overall intersection delay. It was assumed that a signalized side street would have two approach lanes (a left turn and a thru-right lane). Therefore, the total side street volume could be double that assumed for the left turn without substantially affecting operations (e.g., the right turn volume could equal the left turn volume). The results of this analysis are presented in Figure 12.

Figure 12. Delay for Signalized Intersection on W Nickerson Street
PM Peak Hour (Year 2027)



Source: Delay determined using Synchro 6.0 methodology based on the 2000 Highway Capacity Manual. The chart reflects a generic intersection located along W Nickerson Street.

The above analysis shows that the three-lane configuration would result in higher overall intersection delays than with the four-lane configuration. This is due to the fact that traffic on W Nickerson Street would need more green time when only one through lane is available. However, overall levels of service would still be below LOS D conditions (an acceptable level) for side-street volumes with up to about 350 left turning vehicles (or 700 vehicles overall). The actual levels of service for corridor intersections related to the lane change are presented in *Section 6. Operations with Changes*.

3.4. Lane Configuration Change Effect on Transit

The biggest disadvantage of a three-lane configuration is the effect that it has on transit. Current practice at SDOT is to only allow buses to stop in a traffic lane if there are two or more lanes in each direction. If a bus stops in the lane of traffic where there is only one travel lane, it causes vehicles to queue behind the bus or pass the bus in the center two-way-left-turn lane, which can be dangerous to oncoming motorists and pedestrians. If the bus pulls to the curb to load and unload passengers, the bus may have difficulty re-entering the traffic stream. Therefore, a three-lane alternative would be worse for transit than the current four-lane configuration.

If the three-lane option is implemented, it should incorporate measures to minimize delays to transit. This could include features such as near-side transit stops with a queue-jump at signals or increasing the acceleration distance on the far side of a stop where no signal is present.

3.5. Lane Configuration Change Effect on Traffic Safety

The accident analysis presented previously indicated that none of the intersections in the study area exceeded the thresholds to be classified as a high-accident location. However, some unusual accident trends in the corridor were noted including a relatively high occurrence of accidents involving parked vehicles as well as rear-end collisions between intersections. The addition of a center, two-way left turn lane may reduce the rear-end collisions. Pulling the curb line away from the parking lane will also likely reduce the occurrence of accidents involving parked vehicles.

3.6. Lane Configuration Change Effect on Pedestrian and Bicycle Mobility

It is easier and generally safer for a pedestrian to cross a three-lane arterial than a four-lane arterial. As with side-street vehicular traffic, a pedestrian must find a gap in the traffic through which to cross. On a four-lane arterial, the gap must occur in both directions of traffic simultaneously. On a three-lane arterial, a pedestrian can use the center turn lane as a refuge and then find a gap in each direction of traffic separately. Also, on a four-lane arterial, if a motorist stops in one lane to let a pedestrian cross, there is a chance that a motorist in the adjacent through lane will not stop. This dangerous condition is reduced on a three-lane arterial because there is only one through lane.

Bicycle mobility can also be improved when a four-lane arterial is converted to three lanes since there would be additional space to create bicycle lanes.

3.7. Lane Configuration Change Effect on Truck Mobility

The effect on truck mobility can differ for through trucks and turning trucks. As described in Section 3.2, small trucks that can utilize the center left turn lane would experience improved operations when turning left from an unsignalized side street onto a three-lane arterial compared to a four-lane arterial. This benefit does not likely extend to larger vehicles that cannot make a two-step turn (due to the width of the turn).

Right turns are the hardest turn to make in a truck because the lane where the turn starts is closer to the curb. In other words, the radius provided for most right turns is smaller than the radius provided for a left turn. This right turn radius will increase when a four-lane arterial is converted to three lanes since the through lane will be further from the curb.

On arterials with long and/or steep uphill grades, operations could be affected by slow moving trucks. On a four-lane arterial, faster-moving vehicles can pass the truck in the second through lane. On a three-lane arterial, the passing lane is eliminated, which may tempt some motorists to pass trucks in the center, two-way left turn lane. Such passing could be hazardous to other motorists who use the center turn lane to make a two-step turn or for pedestrians who use the center lane as a refuge during a crossing. There is a hill on W Nickerson Street that is long enough to affect the speed of a large truck. Therefore, if the lane configuration is converted to a three-lane section, center median islands could be considered on this hill (near 8th Avenue W and near the pedestrian crosswalk at 11th Avenue W) to prevent motorists from using the center turn lane as a passing lane.

3.8. Summary of Lane Change Effects

Table 4 summarizes the potential advantages and disadvantages of the two lane configurations being evaluated for the W Nickerson Street corridor.

Table 4. Summary of Benefits and Disadvantages of 3- and 4-Lane Configurations

Effect on:	Three Lanes	Four Lanes
Capacity	Improves operations for turns to and from unsignalized side streets and driveways because motorists can make a two-step turn. Reduces capacity at signalized intersections. Can provide protected left turn phasing that is not possible with four-lane configuration.	Improves capacity at signalized intersections. Reduces operations at unsignalized side streets and driveways because motorists must find gap in both directions of traffic.
Pedestrian Crosswalks	Allows unsignalized crosswalks to be retained with the addition of raised medians in center of street.	Unsignalized crosswalks are not recommended. Three existing crosswalks on W Nickerson Street may need to be removed.
Transit	Buses can have difficultly merging back into through traffic lane. Where bus cannot pull out of through traffic lane, it will block traffic.	Buses can stop in the outside through lane without blocking all traffic in that direction.
Vehicle speeds	Typically have lower vehicle speeds.	Typically have higher vehicle speeds.
Traffic safety	Typically have reduced left turn and rear-end accidents along through sections of roadway. Along W Nickerson Street, three lanes may also reduce the occurrence of vehicles striking parked vehicles because the through lane will be further from the parking lane.	Can have higher number of rear-end collisions since left-turning vehicles stop in the through lane.
Bicycles	Allows provision of a bike lane.	No bike lane.
Truck Mobility	Can increase right-turn radii at intersections and driveways. May decrease through capacity on uphill grades because trucks will decelerate.	Provides for passing lane around slow-moving trucks on uphill grade. Reduced right-turn radii at intersections and driveways.

Source: Heffron Transportation, Inc. August 2007.

4. PEDESTRIAN IMPROVEMENTS

There are three unsignalized, marked pedestrian crosswalks along W Nickerson Street. The first one is located just north of the 15th Avenue W interchange, the second near 13th Avenue W, and the third near W Dravus Street. All of these cross four vehicle travel lanes. The Seattle Department of Transportation guidelines for crosswalks are outline in *Directors Rule 04-01*.[1] These guidelines discourage the use of unsignalized pedestrian crossings of four-lane roadways without a median for almost all traffic volume and speed conditions. The Director's Rule also lists potential treatments to improve pedestrian crosswalks. These include (but are not limited to):

- Providing raised medians on multi-lane roads;
- Installing traffic signals (or pedestrian signals) where warranted or where serious pedestrian crossing problems exist;
- Reducing the effective street crossing distance for pedestrians by providing curb extensions or raised pedestrian islands or reducing four-lane undivided road sections to two through lanes with left-turn pockets with sidewalks;
- Providing adequate nighttime lighting for pedestrians;
- Redesigning intersections and driveways with refuge islands and tighter turn radii;
- Using innovative signs, signals and markings.

Potential treatments for the three crosswalk locations were developed based on field observations. These are described in the following sections.

4.1. Crosswalk North of 15th Avenue W Interchange

There is a crosswalk located just north of the 15th Avenue W/W Nickerson Street/W Emerson Street interchange that is unsignalized. It is located on a direct path to the sidewalk and stairs on the Ballard Bridge. Although this crosswalk could be moved to the nearby all-way-stop controlled intersection, it is likely that pedestrians would still cross at this location because it is the shortest path to the Ballard Bridge. To retain this crosswalk, the following improvements, shown on Figure 13 below, are suggested:

- Reduce the northbound traffic to one lane through the crosswalk. To do this, it may be necessary to relocate the right turn lane that arrives from W Emerson Street. This lane now joins the through lane coming from 15th Avenue W just south of the crosswalk. There is a "broken-back" grade change between these two lanes, meaning that the outside lane (coming from W Emerson Street) is sloped towards the outside curb, and the inside lane (coming from 15th Avenue W) is sloped to the center median. It would be very difficult to move the merge location without regrading the slope of this interchange. In addition, it is undesirable to have two lanes merge so close to a crosswalk since the driver will need to look behind to see an approaching vehicle and may miss seeing a pedestrian ahead. For this reason, it is recommended that the right turn lane be relocated to be closer to the intersection. Operations at the

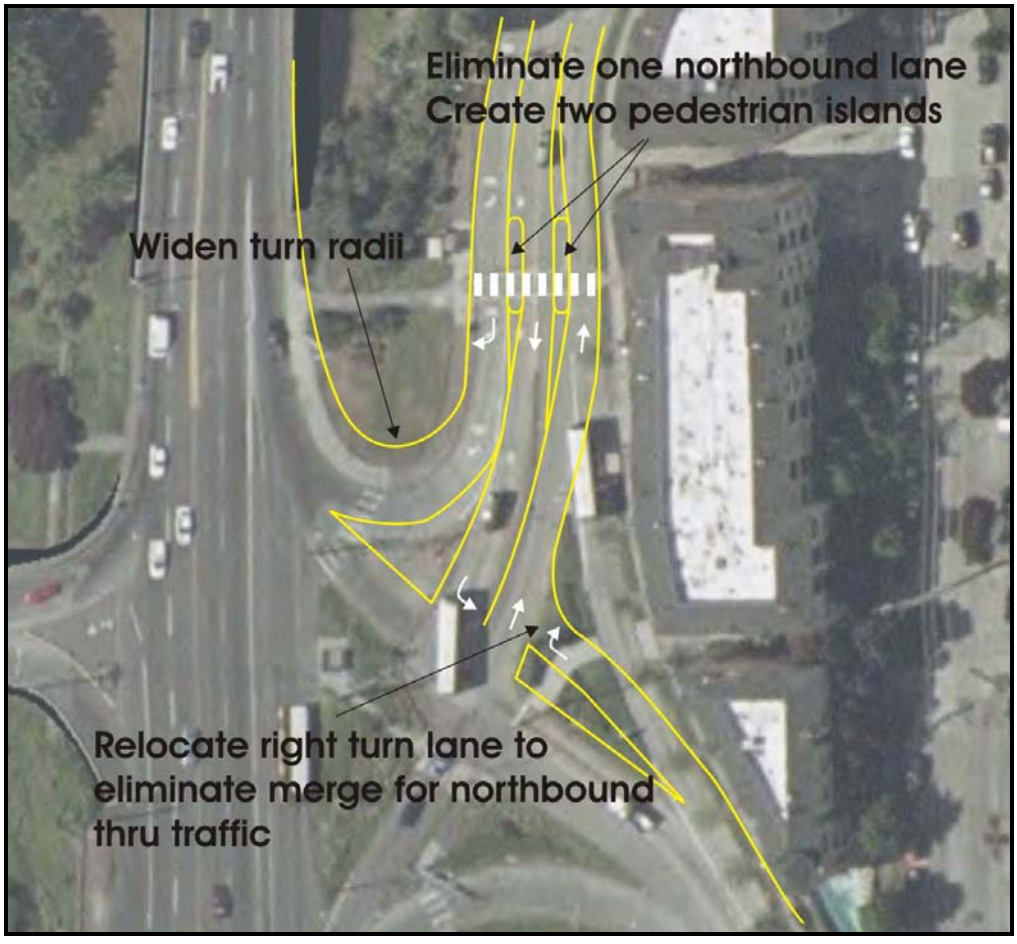
[1] Seattle Department of Transportation, Director's Rule 04-01. *Installation Criteria & Procedures for Responding to Requests for Safety Improvements regarding: Marked Pedestrian Crosswalks; General Traffic Control Signals; Pedestrian Traffic Signals; Pedestrian Traffic Signals for the Disabled or Senior Citizens; and Pedestrian Traffic Signals to Accommodate School Crossings.* Effective December 31, 2004.

adjacent intersection would not be adversely affected by this change since the right-turn movement from W Emerson Street to W Nickerson Street can be made simultaneous to both the southbound left turn movement and northwest-bound through movement (towards the Ballard Bridge).

- Provide two pedestrian islands, one between each traffic lane. This would provide a refuge for pedestrians to cross the full width of the multi-lane arterial. Also, if a standing queue extends through the crosswalk due to an opening of the Ballard Bridge, the pedestrian island on the outside of this queue lane will provide a refuge for pedestrians before they cross a lane of moving traffic.

- Widen the turn radii onto the Ballard Bridge. Vehicles, particularly large trucks, currently can ride up onto the sidewalk when making a turn from southbound W Nickerson Street to northbound 15th Avenue W. The radius at this location should be widened and the sidewalk relocated.

Figure 13. Suggested Improvements for the Crosswalk
Near the 15th Avenue W Interchange



Source: Heffron Transportation, Inc. August 2007. Schematic only: not to scale.

4.2. Crosswalk near 13th Avenue W

This crosswalk serves a King County Metro transit stop that is located in the median area on W Nickerson Street between the southwest-bound lane that connects under 15th Avenue W and the mainline of W Nickerson Street that connects to the interchange on the east side of 15th Avenue W. The crossing of the mainline street is the most challenging because the pedestrian must find a gap in both directions of vehicle traffic simultaneously. The waiting area for the transit stop is also very narrow, and cannot accommodate wheelchairs. Suggested improvements, which are schematically illustrated in Figure 14 below, include:

- Restripe W Nickerson Street to extend a raised center median through the crossing area on the W Nickerson Street mainline. Because the section to the east of the crosswalk is recommended to be three-lanes, this median would not affect the capacity of the corridor. The median should break at the crosswalk to make it handicap accessible.

- Make single through lanes at least 14-feet wide to accommodate large trucks. Narrower lanes (11 to 12-feet wide) can be used where there are two lanes in the same direction.

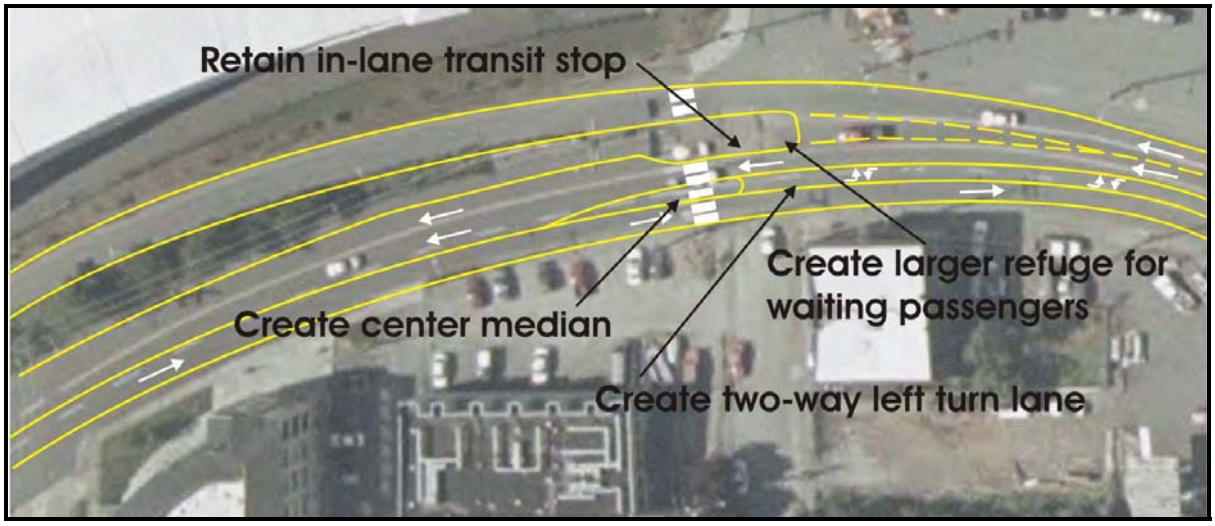
- Transition from one southwest-bound lane through the crosswalk to two lanes after the crosswalk. The second lane would be a queue-storage lane for vehicles turning onto the Ballard Bridge.

- Retain the in-lane transit stop at its current location. The extended curb and center median will prevent vehicles from passing the bus when it is stopped.

- Widen the median between the southwest lanes of W Nickerson Street where the transit stop is located to make it handicap accessible. Create ramps at each crosswalk.

- Retain access for the businesses located on the north side of W Nickerson Street by creating a two-way left turn lane. Additional analysis may need to be performed to determine if vehicles should be allowed to turn left through the gore area between the southwest-bound lanes.

Figure 14. Suggested Improvements for the Crosswalk near 13th Avenue W



Source: Heffron Transportation, Inc. August 2007. Schematic only: not to scale.

4.3. Crosswalk near W Dravus Street

An unsignalized crosswalk is located just east of W Dravus Street that crosses four vehicle travel lanes. There is a King County Metro bus stop in the south lane (eastbound) just to the east of this crosswalk. The possibility of moving this crosswalk further east to make it more evenly spaced between signalized crossings was reviewed. However, it is recommended that the transition from the existing four to three lanes occur just to the east of Warren Avenue to provide adequate vehicle merge and queuing space for intersections further east (e.g., the intersection at the Fremont Bridge). Therefore, moving this crosswalk to the east would put it into the transition area for the vehicle merge, an undesirable location. Also, the Metro transit stop is located on the south side of Nickerson Street between W Dravus Street and Warren Avenue N. Locating the crosswalk west of (behind) the transit stop is a safer crossing location so that pedestrians to no cross in front of the bus into a lane of moving traffic.

It is recommended that the crosswalk remain at its current location east of W Dravus Street where it would cross three lanes of vehicle traffic. The following improvements are illustrated on Figure 15 below:

- Transition from four lanes to three lanes just east of Warren Avenue N. A center two-way left-turn-lane should be provided through the intersection to improve the left turn movements. This lane can also serve left turns to and from the office park on the north side of W Nickerson Street.

- Create a pedestrian island at the crosswalk.

- Retain a wide eastbound lane (or create a bus pull-out lane) so that buses do not block the single traffic lane when stopping to load/unload passengers.

Figure 15. Suggested Improvements for the
Crosswalk near Queen Anne Avenue N

Source: Heffron Transportation, Inc. August 2007. Schematic only: not to scale.

5. ADDITIONAL IMPROVEMENT NEEDS

5.1. Traffic Signal at 6th Avenue W

The traffic analysis for the proposed West Ewing Street Development (six sites located north of W Nickerson Street and west of 6th Avenue W) determined that a traffic signal might be needed in the future with those developments.

The level of service analysis in the *Transportation Impact Analysis for the West Ewing Street Developments*, (Heffron Transportation, Inc., August 2007) determined that the intersection at W Nickerson Street/6th Avenue W would operate at a very poor LOS F condition unless a traffic signal is installed. Before a new traffic signal can be installed, it must meet one or more "warrants." The proposed traffic volumes on 6th Avenue W were evaluated against standard signal warrants published in the *Manual on Uniform Traffic Control Devices (MUTCD).* The manual states, "A traffic control signal should not be installed unless one or more of the factors described in this section are met." The eight (8) warrants for traffic signal installation are listed below:

- Warrant 1 – Eight-Hour Vehicular Volume (minimum volumes over eight hours)
- Warrant 2 – Four-Hour Vehicular Volume (minimum volumes over four hours)
- Warrant 3 – Peak Hour (minimum volume over one hour period)
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing (adequacy of gaps near school crossing location)
- Warrant 6 – Coordinated Signal System (platooning for one-way or two-way streets)
- Warrant 7 – Crash Experience (number and type of accidents)
- Warrant 8 – Roadway Network (for organized traffic flow networks)

For this intersection, volume Warrants 1 (Eight Hour), 2 (Four Hour), and 3 (Peak Hour) are most relevant. The other warrants do not apply.

Year 2012 traffic volumes with full build out of all West Ewing Street Development buildings were assumed to test the traffic signal warrants. In addition, the warrants were tested for only the left turn movement from 6th Avenue W to W Nickerson Street. This is the movement that would benefit most from a signal. This analysis determined that Warrants 1B, 2, and 3 would be met when about 40% of the combined Ilahie development projects are constructed. The analysis is shown in Appendix B.

In addition, the City of Seattle has developed a supplemental rule for pedestrian signal warrants to address conditions where the crossing volume does not reach the thresholds prescribed by the MUTCD, yet the through street volumes are so high that there are very limited available gaps for pedestrians to safely cross a street. (*Director's Rule 2004-01*, Seattle Transportation Department, SMC 11.16.340(N); 3.12.020) The first case is based on curves published on a graph. There are four criteria for the second case:

1. 500 vehicles per hour on the main street for 8 hours
2. Less than 30 adequate gaps in ½ hour
3. At least 300 feet between new signal location to an existing signal
4. Serves a pedestrian transportation facility

These criteria would also likely be met for the potential signal location at 6th Avenue W. W Nickerson Street has volumes that exceed 500 vehicles per hour for 17 hours per day. It is located more than 900 feet from the existing signal at 3rd Avenue W, and 6th Avenue W could become an access point to the future Ship Canal Trail that will be located north of W Nickerson Street. Although no information related to gaps is available, the volumes are high enough that there are not likely enough gaps through which a pedestrian could cross the street.

5.2. Signal Timing Changes

The existing signals along W Nickerson Street, particularly those at the south end of the Fremont Bridge, operate with very long cycle lengths (currently more than 180 seconds). The traffic operations analysis (described below in Section 6) determined that the signals may operate at better levels of service with lower cycle lengths (around 120 seconds). In addition, the intersection at W Nickerson Street/W Florentia Street/3rd Avenue N has six legs. Although some turning movements are now prohibited, some additional turn prohibitions may also be needed in the future to improve overall operations for the major movements at this intersection.

With the change in lane configuration, the existing pedestrian signals (located near W Cremona Street and 11th Avenue W) and the signal at 3rd Avenue W should be retimed. The time needed to serve pedestrian crossings of W Nickerson Street would be less with the three-lane configuration than with the four-lane configuration because the crossing distance is shorter.

5.3. Reconfiguration of the W Nickerson Street/15th Avenue W interchange

The traffic operations analysis (described below in Section 6) revealed that in the long-term horizon (after 2012 but before 2027), the existing all-way stop-controlled intersection at the W Nickerson Street/15th Avenue W interchange would fail (LOS F). Queues extending from the stop sign (where W Nickerson Street and the ramps intersect) could back into the northbound through lanes of 15th Avenue W. One option to improve the operations would be to reconfigure the intersection and signalize the off-

ramp intersection. The signal could also control pedestrian crossings of the intersection. As shown in the analysis below, a signalized intersection that serves all but the southbound Nickerson Street-to-northbound 15th Avenue W movement could operate at LOS D in the year 2027.

6. OPERATIONS WITH CHANGES

The analysis described previously shows that a change to three lanes could improve side-street level of service, although it may adversely affect operations at signalized intersections. To test how the W Nickerson Street corridor would operate, a level of service analysis for years 2012 and 2027 were performed.

6.1. Year 2012 Operations

The assumptions and results for the year 2012 analyses are presented below.

Assumed configuration for the Year 2012

- Convert the roadway configuration to three lanes from just east of Queen Anne Avenue W to east of 13th Avenue W.
- Retain eastbound and westbound right-turn-only lanes at the intersection of W Nickerson Street/3rd Avenue W.
- Retime the intersection of W Nickerson Street/3rd Avenue W with the lane change.

Assumed additional improvements for the Year 2012

- Install traffic signal at W Nickerson Street/6th Avenue W.
- Retime intersections at W Nickerson Street/W Florentia Street and W Nickerson Street/4th Avenue N.

The year 2012 levels of service for these changes are summarized in Table 5. This shows that with the changes recommended above, all major intersections along the corridor would operate at LOS D or better during both the AM and PM peak hours.

Table 5. Level of Service Summary – Year 2012

	2012 No Action (4-Lane Configuration) [1]		2012 w/ Lane Changes (3-Lane Configuration) [2]		2012 w/ Additional Improvements [3]	
	LOS[4]	Delay[5]	LOS	Delay	LOS	Delay
AM PEAK HOUR						
Signalized Intersections						
W Nickerson Street/3rd Avenue W	C	21.0	C	22.4	No Changes	
W Nickerson Street/4th Avenue N	E	58.4	No Changes		D	36.6
W Nickerson Street/Florentia Street	D	43.4	No Changes		C	33.4
W Nickerson Street/6th Avenue W	Unsignalized		Unsignalized		B	16.4
W Nickerson Street/Ped Signal near 8th	A	7.4	B	11.3	No Changes	
Unsignalized Intersections [6]						
W Nickerson Street/6th Avenue W	F	>200	F	>200	Signal Proposed	
W Nickerson Street/15th Ave W Off-ramp	C	16.1	No Changes		C	15.0
PM PEAK HOUR						
Signalized Intersections						
W Nickerson Street/3rd Avenue W	C	21.8	C	34.0	No Changes	
W Nickerson Street/4th Avenue N	F	91.1	No Changes		D	45.8
W Nickerson Street/Florentia Street	D	52.7	No Changes		D	41.9
W Nickerson Street/6th Avenue W	Unsignalized		Unsignalized		C	23.4
W Nickerson Street/Ped Signal near 8th	A	8.0	B	15.8	No Changes	
Unsignalized Intersections [6]						
W Nickerson Street/Queen Anne Ave N	F	56.9	C	21.0	No Changes	
W Nickerson Street/6th Avenue W	F	>200	F	>200	Signal Proposed	
W Nickerson Street/15th Ave W Off-ramp	D	32.5	No Changes		D	25.8

Source: Heffron Transportation, July 2007. All levels of service reflect the Synchro software and methodology.

1. *Levels of service reflect current lane configuration along W Nickerson Street and existing signal phasing and timing.*
2. *Levels of service reflect changing the lane configuration to three lanes from east of Queen Anne Avenue N and about 13th Avenue W. Signal timing would remain the same except at the intersection of W Nickerson Street/3rd Avenue W.*
3. *Levels of service reflect changes to signal timing at noted intersections and the installation of a new signal at W Nickerson Street/6th Avenue W.*
4. *Level of service.*
5. *Average seconds of delay per vehicle.*
6. *Average seconds of delay per vehicle on the worst movement, generally a turn movement from the minor street.*

***Bolded** values indicate the level of service with all potential changes.*

6.2. Year 2027 Operations

The same operations analysis was performed for year 2027 conditions to determine if additional improvements may be needed to accommodate 15 more years of growth. In addition to the improvements assumed for the year 2012 conditions, the following improvements were assumed:

Assumed additional improvements for the Year 2027 (added to those assumed for 2012)

- Reconfigure the all-way stop controlled intersection at W Nickerson Street/W Emerson Street/15th Avenue W ramps and signalize.

The resulting levels of service for the year 2027 are summarized in Table 6. This analysis shows that all but one intersection would continue to operate at LOS D with all of the changes. The poorest-operating intersection would be at W Nickerson Street/W Florentia Street. This intersection has six legs (including those for 3rd Avenue N). In order to further improve the intersection operations in the future, it may be necessary to prohibit some movements from the intersection's minor legs.

Table 6. Level of Service Summary – Year 2027

	2027 No Action (4-Lane Configuration) [1]		2027 w/ Lane Changes (3-Lane Configuration) [2]		2027 w/ Additional Improvements [3]	
	LOS[4]	Delay[5]	LOS	Delay	LOS	Delay
AM PEAK HOUR						
Signalized Intersections						
W Nickerson Street/3rd Avenue W	C	24.2	C	26.2	No Changes	
W Nickerson Street/4th Avenue N	E	62.1	No Changes		D	40.2
W Nickerson Street/Florentia Street	D	44.7	No Changes		C	35.0
W Nickerson Street/6th Avenue W	Unsignalized		Unsignalized		B	18.0
W Nickerson Street/Ped Signal near 8th	A	8.1	B	17.4	No Changes	
Unsignalized Intersections [6]						
W Nickerson Street/6th Avenue W	F	>200	F	>200	Signal Proposed	
W Nickerson Street/15th Ave W Off-ramp	C	22.4	No Changes		Signal Needed	
PM PEAK HOUR						
Signalized Intersections						
W Nickerson Street/3rd Avenue W	C	26.3	D	42.3	No Changes	
W Nickerson Street/4th Avenue N	F	167.9	No Changes		D	53.3
W Nickerson Street/Florentia Street	E	76.1	No Changes		E	65.2
W Nickerson Street/6th Avenue W	Unsignalized		Unsignalized		C	30.9
W Nickerson Street/Ped Signal near 8th	A	8.8	C	31.7	No Changes	
W Nickerson Street/15th Ave W Off-ramp	Unsignalized		Unsignalized		D	52.3
Unsignalized Intersections [6]						
W Nickerson Street/Queen Anne Ave N	F	117.5	D	25.3	No Changes	
W Nickerson Street/6th Avenue W	F	>200	F	>200	Signal Proposed	
W Nickerson Street/15th Ave W Off-ramp	F	67.2	No Changes		Signal Needed	

Source: Heffron Transportation, July 2007. All levels of service reflect the Synchro software and methodology.

1. *Levels of service reflect current lane configuration along W Nickerson Street and existing signal phasing and timing.*
2. *Levels of service reflect changing the lane configuration to three lanes from east of Queen Anne Avenue N and about 13th Avenue W. Signal timing would remain the same except at the intersection of W Nickerson Street/3rd Avenue W.*
3. *Levels of service reflect changes to signal timing at noted intersections and the installation of a new signal at W Nickerson Street/6th Avenue W.*
4. *Level of service.*
5. *Average seconds of delay per vehicle.*
6. *Average seconds of delay per vehicle on the worst movement, generally a turn movement from the minor street.*

Bolded values indicate the level of service with all potential changes.

7. CONSULTANT RECOMMENDATION

The above analysis shows that the W Nickerson Street corridor would benefit by changing the current four-lane configuration to three-lane configuration. Although some intersections along the corridor would experience increased delay as a result, the delays would not exceed the threshold for LOS D, which is an acceptable level of operation. The recommended improvements are separated into "near-term improvements," which should be implemented within the next five years, and "long-term improvements," which will likely be needed in 15 to 20 years.

7.1. Near-Term Improvements

- Convert the roadway configuration to three lanes from just east of Warren Avenue N to west 13th Avenue W.
- Make pedestrian improvements at the three unsignalized crosswalks along the W Nickerson Street corridor located near 15th Avenue W, 13th Avenue W, and Queen Anne Avenue N. Specific improvement suggestions were described in Section 4 (*Pedestrian improvements*).
- Retain eastbound and westbound right-turn-only lanes at the intersection of W Nickerson Street/3rd Avenue W.
- Retime the intersection of W Nickerson Street/3rd Avenue W with the lane change to account for the shorter north-south crossing distance.
- Install traffic signal at W Nickerson Street/6th Avenue W.
- Retime intersections at W Nickerson Street/W Florentia Street and W Nickerson Street/4th Avenue N. This should be done in conjunction with retiming of the entire Fremont Avenue/4th Avenue N corridor.
- Retime the signalized pedestrian crossings that are located near W Cremona Street and 11th Avenue W to account for the shorter crossing distance.
- Install center median near 8th Avenue W and at the 11th Avenue W pedestrian crossing to prevent center turn lane from being used as a passing lane.
- Work with King County Metro to enhance bus stops. This could include extending the length of the bus stops to increase deceleration and acceleration with the three-lane section; consolidating some bus stop locations; and/or relocating bus stops to the far side of a signalized intersection.

7.2. Long-Term Improvements

- Reconfigure the all-way stop controlled intersection at W Nickerson Street/W Emerson Street/15th Avenue W ramps and signalize.
- Consider additional turn prohibitions at the W Nickerson Street/W Florentia Street/3rd Avenue N intersection.

REFERENCES

City of Seattle, *Accident Data*, January 1, 2004 through March 3, 2007

City of Seattle, *Arterial Roadway Map.*

Heffron Transportation, Inc., *Transportation Impact Analysis for the West Ewing Street Developments*, August 2007.

Metro Transit route schedules, from Metro website, June 2007.

Transportation Research Board, *Highway Capacity Manual*, 2000.

APPENDIX A
Level of Service Definitions

Levels of service (LOS) are qualitative descriptions of traffic operating conditions. These levels of service are designated with letters ranging from LOS A, which is indicative of good operating conditions with little or no delay, to LOS F, which is indicative of stop-and-go conditions with frequent and lengthy delays. Levels of service for this analysis were developed using procedures presented in the *Highway Capacity Manual* (Transportation Research Board, 2000).

Level of service for signalized intersections is defined in terms of delay. Delay can be a cause of driver discomfort, frustration, inefficient fuel consumption, and lost travel time. Specifically, level-of-service criteria are stated in terms of the average delay per vehicle in seconds. Delay is a complex measure and is dependent on a number of variables including: the quality of progression, cycle length, green ratio, and a volume-to-capacity ratio for the lane group or approach in question. Table A-1 shows the level of service criteria for signalized intersections from the *Highway Capacity Manual.*

Table A-1. Level of Service for Signalized Intersections

Level of Service	Average Delay Per Vehicle	General Description
A	Less than 10.0 Seconds	Free flow
B	10.1 to 20.0 seconds	Stable flow (slight delays)
C	20.1 to 35.0 seconds	Stable flow (acceptable delays)
D	35.1 to 55.0 seconds	Approaching unstable flow (tolerable delay—occasionally wait through more than one signal cycle before proceeding.
E	55.1 to 80.0 seconds	Unstable flow (approaching intolerable delay)
F	Greater than 80.0 seconds	Forced flow (jammed)

Source: Transportation Research Board, Highway Capacity Manual, 2000.

For unsignalized intersections, level of service is based on the average delay per vehicle for each turning movement. The level of service for a two-way, stop-controlled intersection is determined by the computed or measured control delay and is defined for each minor movement. Delay is related to the availability of gaps in the main street's traffic flow, and the ability of a driver to enter or pass through those gaps. Table A-2 shows the level of service criteria for unsignalized intersections from the *Highway Capacity Manual*.

Table A-2. Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Delay (seconds per vehicle)
A	Less than 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	Greater than 50.0

Source: Transportation Research Board, Highway Capacity Manual, 2000.

APPENDIX B
Traffic Signal Warrant Analysis