IJR Methods & Assumptions

I-5 / SR524
I-5 / 196th St (SR524) Interchange Braided Ramp
MP 181.55 to MP 183.36

1. Stakeholder Acceptance

The undersigned parties, including all members of the team from WSDOT, FHWA and the Local Agencies, concur with the Interchange Justification Report Methods and Assumptions for the I-5 / 196th St (SR524) Interchange Braided Ramp project as presented in this document.

☐ **Concurrence - NW Region, Project Engineer**

By: _____ Date: _____, 2010

☐ **Concurrence - NW Region, Traffic**

By: _____ Date: _____, 2010

☐ **Concurrence – HQ, Traffic**

By: _____ Date: _____, 2010

☐ **Concurrence – HQ, Access & Hearings**

By: _____ Date: _____, 2010

☐ **Concurrence – HQ, WSDOT Assistant State Design Engineer**

By: _____ Date: _____, 2010

☐ **Concurrence – FHWA, Area Engineer**

By: _____ Date: _____, 2010

☐ **Concurrence – FHWA, Safety and Design Engineer**

By: _____ Date: _____, 2010

☐ **Concurrence – CITY of LYNNWOOD, Public Works Director**

By: _____ Date: _____, 2010

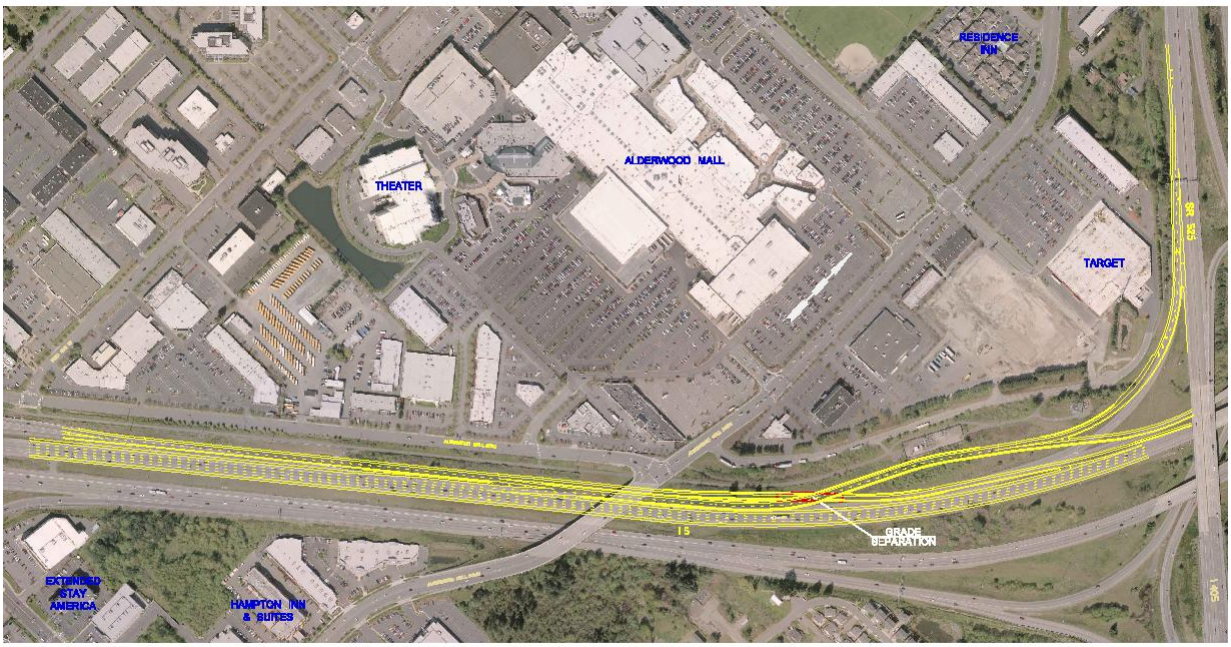
(1) Participation on the Stakeholders Committee and/or signing of this document does not constitute approval of the I-5 / 196th St (SR524) Interchange Braided Ramp Interchange Justification Report.

(2) All members of the Stakeholder Committee will accept this document as a guide and reference as the study progresses through the various stages of project development. If there are any agreed upon changes to the assumptions in this document a revision will be created, endorsed and signed by all the stakeholders.

2. Introduction and Project Description

Currently, the ramp from southbound State Route 525 (SR 525) to southbound Interstate 5 (I-5) and the ramp from northbound Interstate 405 (I-405) to southbound I-5 merge prior to entering southbound I-5. This single entrance ramp forms an auxiliary lane that terminates at the southbound exit to 196th Street (SR 524). The auxiliary lane configuration coupled with the large volume of ramp and mainline traffic creates an adverse weaving condition. This area is within a high accident location. The current use of ramp metering on the two connecting ramps from I-405 to SB I-5 (or Lynnwood exit) and from SR525 to SB I-5 (or Lynnwood) will continue to be the practice after this project is completed. HOV Bypass lanes will be activated on the adjacent shoulders of these two connector ramps during peak hour flows only (not for the entire 24 hour day period). For the ramp from I-405 the Bypass lane will be on the left shoulder. For the ramp from SR525 the bypass lane will be on the right shoulder. This allows for the two GP lanes to be adjacent to one another to allow for metered coordination of movements of those two GP lanes.

This project will improve mainline operations, will improve safety and mobility by eliminating the weave on southbound I-5 between I-405/SR 525 and 196th Street SW and this project will not remove any existing access. Thus this project will provide an obvious benefit to the Public.



3. Analysis Years/Periods

Operational analysis was performed for existing conditions (2005), opening year (2012), and design year (2032) for design periods including AM and PM peak periods.

4. Project and Study Areas

Although the project only eliminates the weave on southbound I-5 between I-405/SR 525 and 196th Street SW, the study area was extended to include the I-5/128th Street SW interchange on the north, the I-5/220th Street SW interchange on the south, SR99 on the west, and North/Dawson Road on the east.

Figure 1: Limits of Study Area

5. Travel Forecast

Traffic demand forecasts for years 2012 and 2032 were developed for AM and PM peak hours by Perteet as part of a Final technical Report dated August 28, 2008. The modeling work for this Braided Ramp began in Year 2006 and utilized much of the data prepared in the Lynnwood City Center Access Study (see Appendix “F”) including Technical Memorandum Number 1 (completed December 2005) which documents the traffic demand modeling approach used to generate future year

traffic for the CITY of Lynnwood Access Study. The CITY Study was also prepared by Perteet and was completed in September 2007.

The PM peak forecasts were based on the PM peak hour VISUM traffic forecasting model developed for the Lynnwood City Center Access Study. The PM peak hour Lynnwood Transportation Model validation document is provided as part of Appendix A. The PM peak model was validated as part of the City Center Access Study. Since an AM model was not available from the City Center Access Study, the PM peak hour model was converted to an AM peak hour model. The conversion of both the Existing Year (2005) and Design Year (2032) models from PM peak hour to AM peak hour was documented previously in two technical reports.

- 2005 AM Model Development Technical Report
- 2032 AM Model Development Technical Report Final

The August 28th, 2008 Final technical Report for Traffic Operations by Perteet (including the '05 and '32 AM model Development Technical Reports cited above) is provided in Appendix "A".

Baseline Projects at time of Access Study model development (Dec. 2005):

The Design Year (2032) Model for this Braided Ramp Project includes several planned network improvements identified in the Lynnwood City Center Access Study (in Technical memorandum Number 1 as identified above) as baseline projects which include;

- Interchange Improvements on I-5 at 128th Street SW (SR 96)
- Widen 196th Street SW (SR 524) from 37th Ave W to 48th Ave W
- Widen 200th Street SW from SR 99 to 48th Ave W
- Widen 35th/36th Ave W from Maple Road to 148th Street SW
- Maple Road Extension from 36th Ave W to Alderwood Mall Parkway
- 44th Ave W improvements from 194th Street SW to I-5

All of the above mentioned projects are presently listed in the City of Lynnwood's 2010-2015 Transportation Improvement Plan with the exception of the Interchange improvements on I-5 at 128th Street SW (SR96) project, which is located outside of the City limits.

Projects added to City Baseline since development of Access Study model:

The Design Year (2032) Model leaves out eight (8) projects that are currently on the CITY TIP. After the completion of the Design Year 2032 model, the CITY of Lynnwood developed a long list of concepts and held a design charrette to select which projects should be added to their TIP. The conclusion of that effort is shown on page 7 of the Executive Summary of the City Access Study (see Appendix F). These Projects are;

1. SB I-5 Braided Ramps (current TPA project)
2. Poplar Way bridge over I-5
3. New arterial across the old Lynnwood High School site
4. Widen 200th from 48th to 44th
5. Completion of the I-5/44th Interchange to include full north access
6. Extension of 194th across the north side of convention center property
7. NB braid (similar to SB I-5 braid)
8. 40th under-crossing of I-5

The first four projects, and project number 6, are all currently listed in the CITY 6 year TIP. The last four projects (except project #6) are listed in the 20 year CITY list. The first three projects listed have current funding. The Braided Ramp Project is this subject Project for which this M&A document is being written (sits within the CITY limits thus is included in their TIP list) and is fully funded.

The second project is for the Poplar Way overcrossing which has funding for design and Right-of-way. This was added to the CITY TIP in Year 2006. Anticipated year of opening is Year 2013. An independent review of the Poplar Way Extension project performance and modeling was conducted by WSDOT in July 2007 (See Appendix E). The purpose of the analysis was to review and assess the merits of this extension in terms of its benefits to Interstate 5 in the project area. The results of the independent review were the Poplar Way extension would have a benefit to access into the City of Lynnwood while not increasing delay on the freeway system.

The third project is a new arterial to be built across the old Lynnwood High School site. It is to be privately funded by a developer and is currently under design; however construction is being delayed due to the economic downturn. This project was added to the CITY TIP in Year 2006 and is anticipated to open in Year 2012.

The fourth project is not currently funded and was added to the CITY TIP in Year 2005.

The sixth project is not currently funded and was added to the CITY TIP in Year 2009.

The fifth, seventh and eighth projects are not currently funded and are not included in the CITY TIP but are identified in the City's long range 20-year list of projects located in the City of Lynnwood Comprehensive Plan Transportation element.

These eight projects were identified after Technical memorandum Number 1 of the CITY Access Study was completed in December 2005 and after the start of the modeling for this project. The WSDOT believes inclusion of these eight additional projects into the modeling for this Braided Ramp project is not necessary because the effects of these projects are anticipated to generate a slight positive benefit for the freeway, thus meaning our present model produces a more conservative result for use in analyzing the Braided Ramp Project.

Results of Travel forecast:

The City of Lynnwood Study did not have land use forecasts for the year 2012. Hence, Year of Opening (2012) AM and PM peak hour traffic volumes were developed by assuming a straight-line growth between Existing Year (2005) and Design Year (2032) traffic volumes.

In Existing Year (2005), Year of Opening (2012) and the Design Year (2032), during the AM peak hour, southbound I-5 experiences the highest demand volume on the mainline, and during the PM peak hour, northbound I-5 experiences the highest demand volume on the mainline. HOV volumes assumed in the VISSIM models was based on current HOV percentages obtained from Year 2005 count data. During the AM peak hour, HOV volumes were assumed to be 5% of the total northbound volume and 18% of the total southbound volume. During the PM peak hour, Northbound and southbound I-5, HOV volumes were assumed to be 20% of the total mainline volume. Figure 6-2 shows historical HOV daily traffic count data in the same stretch of freeway this Braided Ramp project is to be built. The assumption that the percentages discussed above (based on Year 2005) are valid today because as figure 6-2 demonstrates traffic demand over the last 5 years has changed very little.

As a result, the Final Technical Report from Perteet (August 28, 2008) produced Existing Year (2005), Year of Opening (2012) and Design Year (2032) total traffic volumes, (HOV volume included), in the vicinity of the I-5/196th Street SW and I-5/I-405 interchanges as shown below in figures 5-1 thru 5-3:

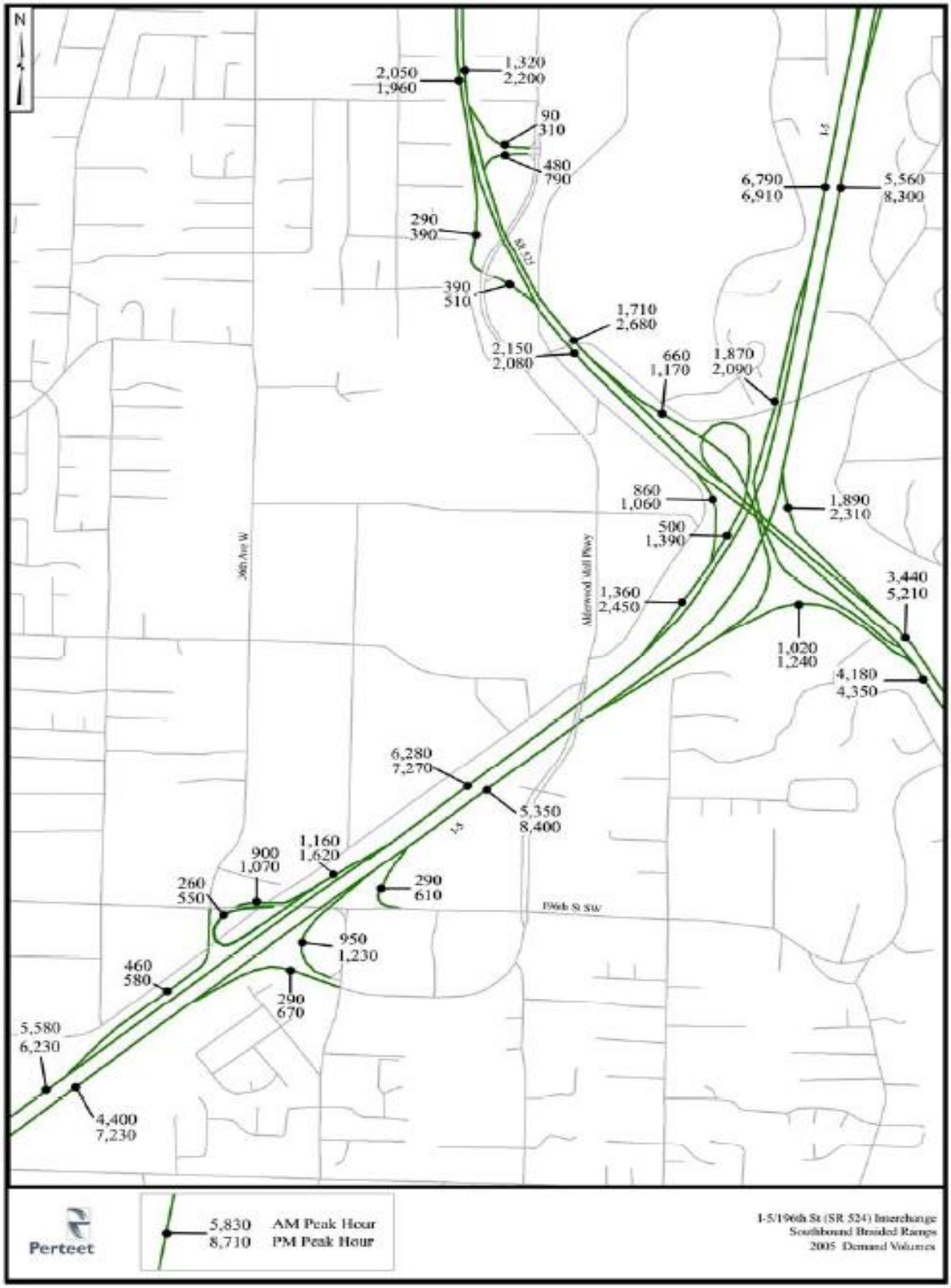


Figure 5-1: Existing Year (2005) AM and PM Peak Hour Traffic Volumes

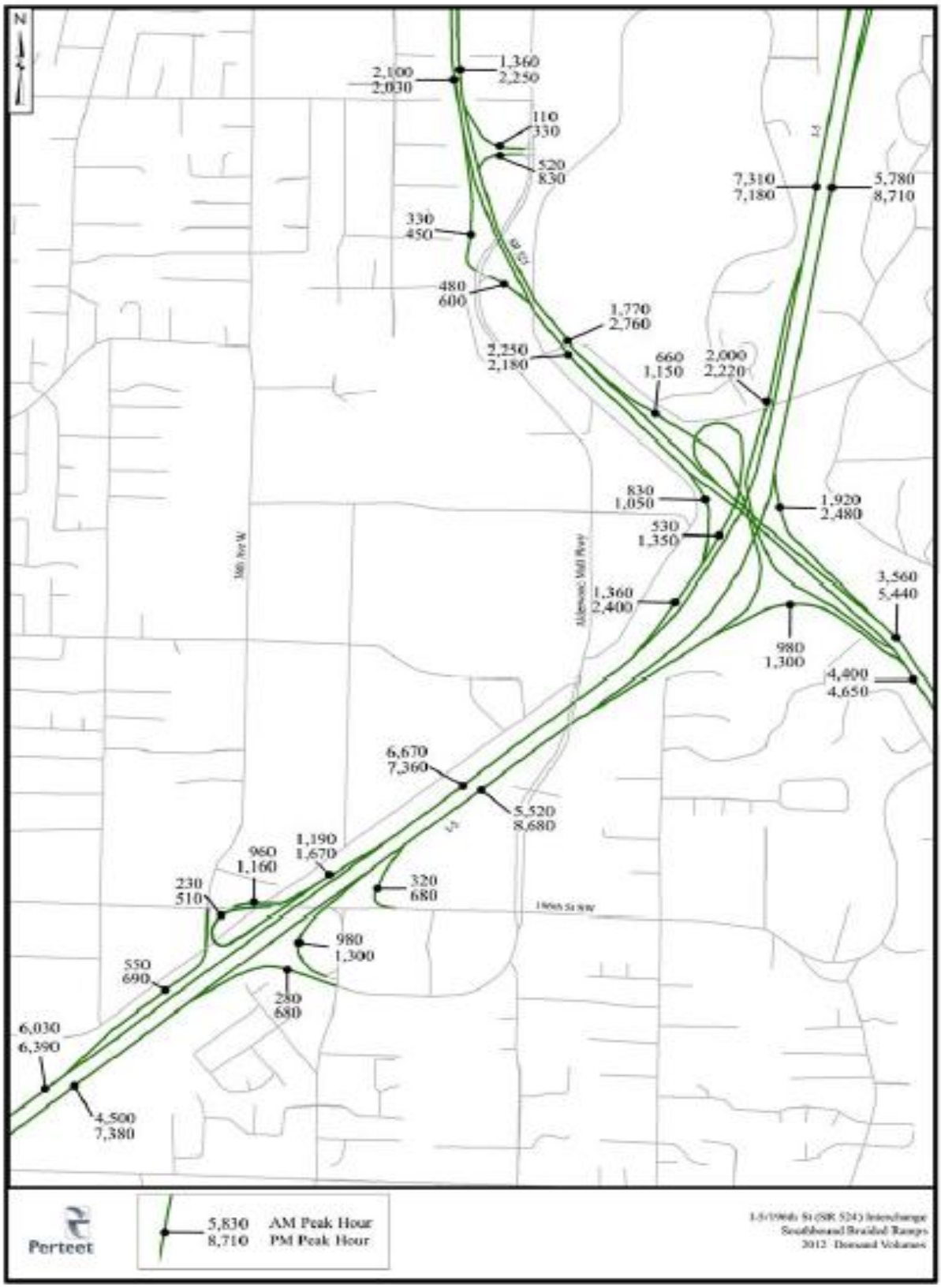


Figure 5-2- Year of Opening (2012) AM and PM Peak Hour Traffic Volumes

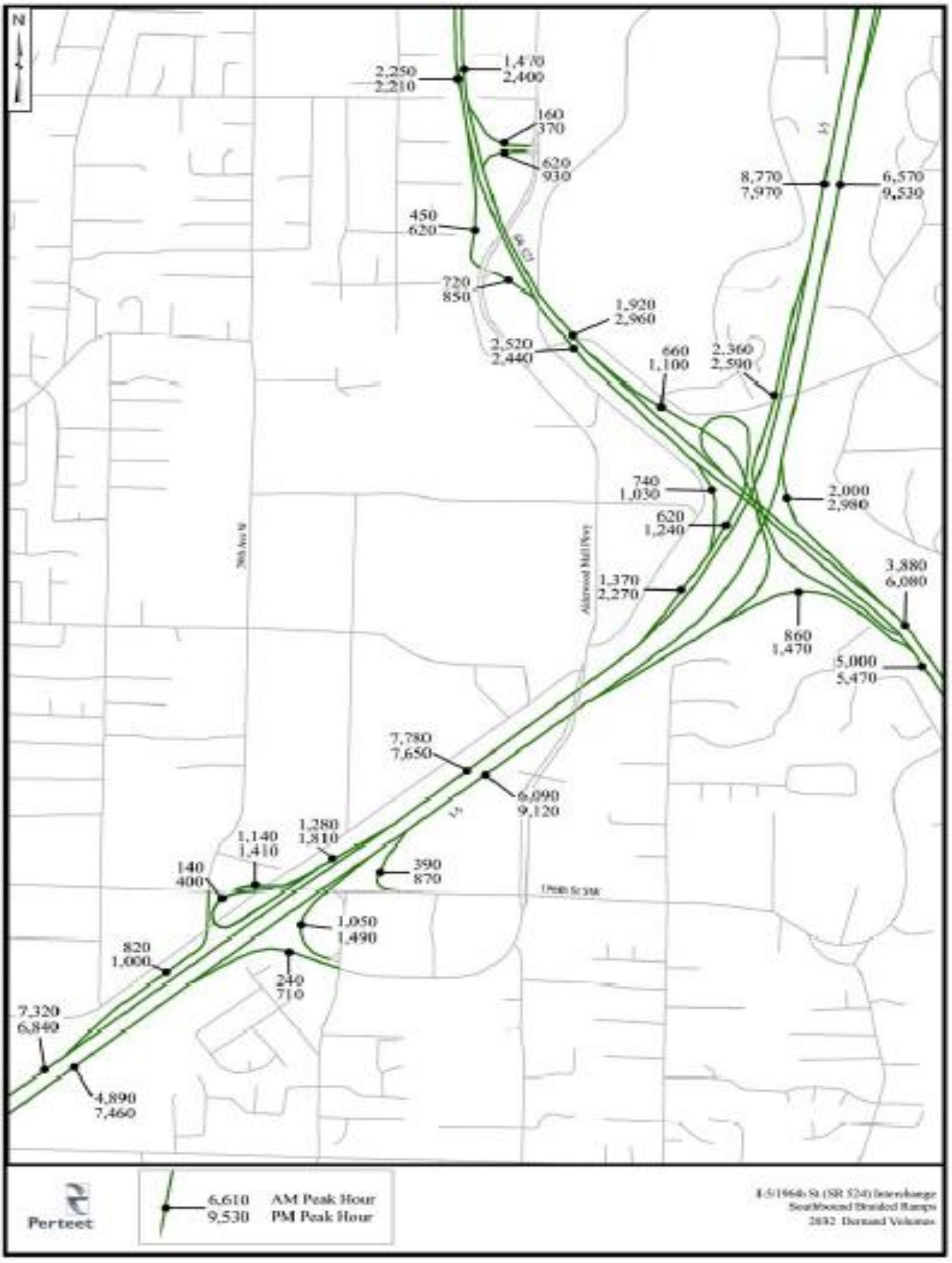


Figure 5-3 - Design Year (2032) AM and PM Peak Hour Traffic Volume

Table 1:
Southbound I-5 Mainline and Ramps Traffic Volume Summary (vehicles per hour)

Mainline Volumes						
Freeway Segment	2005 AM	2005 PM	2012 AM	2012 PM	2032 AM	2032 PM
n/o I-405 Off	6,790	6,910	7,310	7,180	8,770	7,970
I-405 Off to I-405/SR 525 On	4,920	4,820	5,310	4,960	6,410	5,380
I-405/SR 525 On to 196th St SW Off	6,280	7,270	6,670	7,360	7,770	7,650
196th St SW Off to 196th St SW On	5,120	5,650	5,480	5,700	6,490	5,840
s/o 196th St SW On	5,580	6,230	6,030	6,390	7,310	6,840
Ramp Volumes						
Ramp Segment	2005 AM	2005 PM	2012 AM	2012 PM	2032 AM	2032 PM
off to I-405	1,870	2,090	2,000	2,220	2,360	2,590
on from I-405/SR 525	1,360	2,450	1,360	2,400	1,370	2,270
on from I-405	500	1,390	530	1,350	620	1,240
on from SR 525	860	1,060	830	1,050	740	1,030
off to 196th St SW	1,160	1,620	1,190	1,670	1,280	1,810
off to WB 196th St SW	900	1,070	960	1,160	1,140	1,410
off to EB 196th St SW	260	550	230	510	150	400
on from 196th St SW	460	580	550	690	820	1,000

6. Traffic Operations Analysis

Existing Conditions Traffic Analysis Approach

Traffic counts from 2004 and 2005 were used. Use of count data from 2005 is still validated due to negligible increase in traffic as observed in the years since 2005. Figure 6-2 (see below) shows historical traffic data for Southbound I-5 within the same stretch of freeway where the new braided ramps will be located. As the figure illustrates, there has been little change in traffic volume over the last 5 years, thus use of the Year 2005 traffic volumes (at the time this model was under development) is justified.

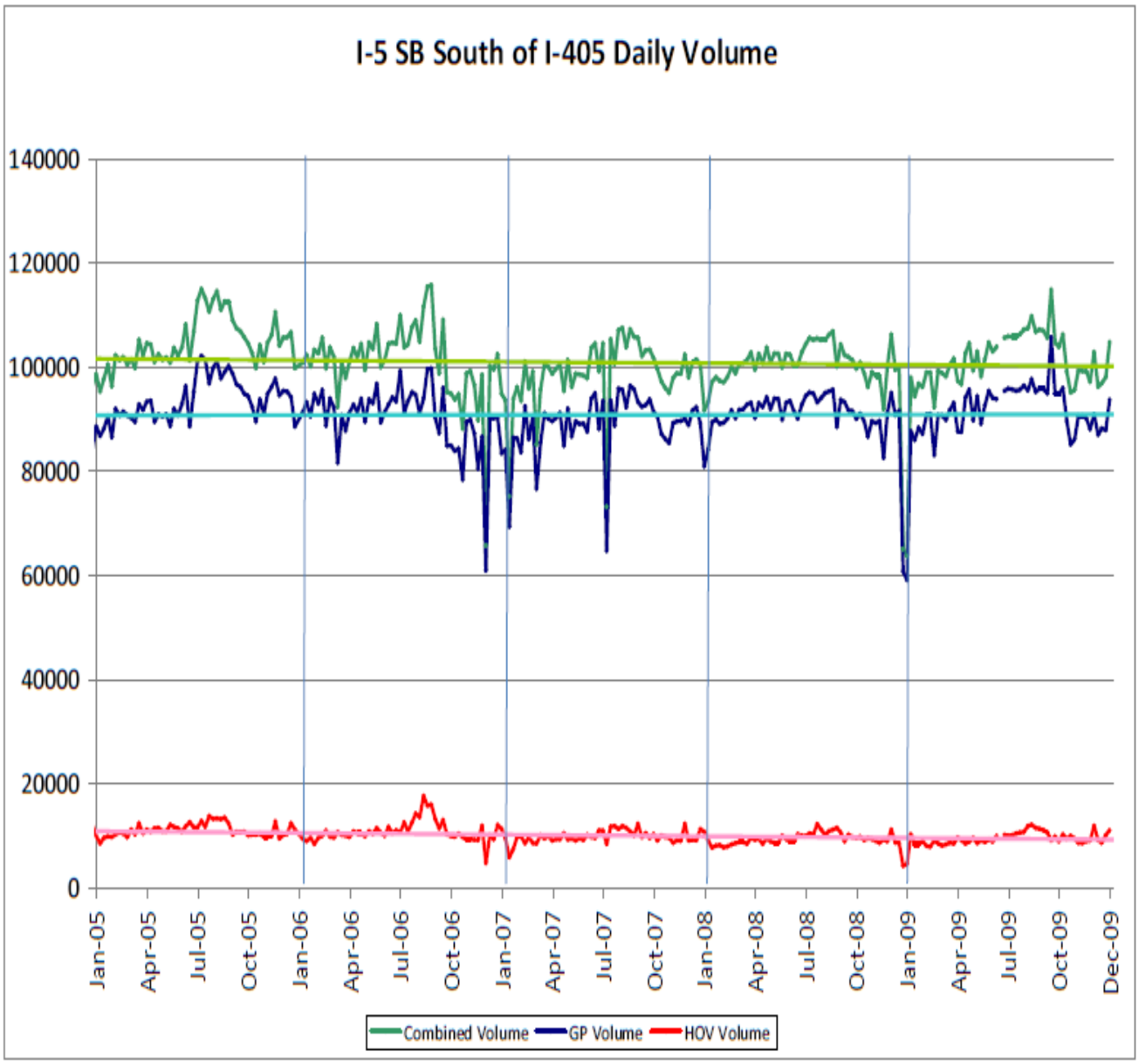


Figure 6-2

VISSIM was used for freeway operations including mainline and freeway merge analysis to produce volume/density and volume/speed results.

SYNCHRO was used for City streets and freeway ramp terminals to produce Highway Capacity Manual 2000 (HCM) Level of Service (LOS). It was also used for signal timing in a VISSIM microsimulation of the local street network.

- A Base Free Flow Speed of 60 mph was used in the analysis, which is the posted speed limit for this segment of interstate.
- Peak Hour Factors (PHF) of 0.95 and 0.98 were used along the mainline and on the local roadway network, respectively for 2005 operating conditions.

Design Year Traffic Operations Analysis approach

The Year 2030 traffic volumes were generated by the City of Lynnwood VISUM traffic demand model, checked with the 2030 Puget Sound Regional Council (PSRC) screen line traffic data, extrapolated to 2032 at the growth rates agreed to in technical memorandum #1. Two different analysis tools were used to predict the operations of the proposed interchange: SYNCHRO, and VISSIM.

VISSIM was used for freeway operations including mainline and freeway merge analysis to produce volume/density and volume/speed results.

SYNCHRO was used for City streets and freeway ramp terminals to produce Highway Capacity Manual 2000 (HC) Level of service (LOS). It was also used for signal timing in a VISSIM micro-simulation of the local street network.

- A Base Free Flow Speed of 60 mph was used in the analysis, which is the posted speed limit for this segment of interstate.
- Peak Hour Factors (PHF) of 0.95 and 0.98 were used along the mainline and on the local roadway network, respectively for 2030 operating conditions.

Local Intersections

Level of service analysis (LOS) were performed at 15 intersections. Existing Year (2005), Year of Opening (2012) and Design Year (2032) LOS for both the AM and PM peak hour will be determined for these intersections using Synchro (Build 614).

Existing signal timings for the 15 study intersections were obtained from Snohomish County, WSDOT and the City of Lynnwood. For each of the future year scenarios, signal timings will be optimized, but no changes will be made to the existing channelization with one exception. In the Design Year 2032, it is assumed the 128th Street SW/I-5 interchange will be a SPUI.

Freeway

The freeway operations were analyzed for the Southbound direction only since there are no improvements proposed for the Northbound direction. As discussed in Technical memorandum #6 in the CITY Access Study (see appendix F), the freeway operations were analyzed using two approaches. The first approach used a VISSIM model with freeway ramps connected to the signals at the ramp

terminus. The analysis in the first approach indicates that in the Design Year (2032), arterial congestion will severely impact freeway operations which caused the micro-simulation model to "freeze". The second approach disconnected the arterial system so demand volumes entered the freeway at the ramps. This approach allowed the team to identify potential freeway operational issues not related to the local arterial system.

The following summarizes the two approaches.

Approach 1 – Freeway and Arterial System Operations

A high level of congestion on the arterials associated with the freeway interchanges causes many of the interchange ramps to queue onto the freeway mainline. When this happens within VISSIM it tends to disproportionately impact freeway operations on the mainline. One example is that congestion from 196th Street SW impacts the southbound off ramp and backs onto the freeway during the PM peak hour. Southbound traffic exiting to 196th Street SW queues onto the shoulder or right side lanes through to the I-405 interchange. This limits the ability of traffic to access I-5 from I-405. Similar conditions occur at the 164th Street SW southbound off ramp and the 44th Avenue W northbound off ramp.

Figure 6-1 (copy of Exhibit 3 in the Tech Memo #6) depicts congestion areas in the I-5 interchange areas that results from congestion on the arterial system.

Mainline densities and speeds through the study area were collected using VISSIM; however due to the high level of congestion from the arterials, the values were not calculable. For instance, in the southbound direction, a third of the demand for the Design Year (2032) was unable to reach 220th Street SW. This traffic was "stuck" in queues to the north. The VISSIM model essentially freezes after 10 minutes with travel times jumping from 8 minutes to over 25 minutes. When traffic demand increases at such a great rate, peak spreading occurs (people choose to travel earlier in the afternoon or later in the evening). The forecast analysis assumed some peak spreading; however the VISSIM micro-simulation model indicates further peak spreading would occur given current capacity constraints.

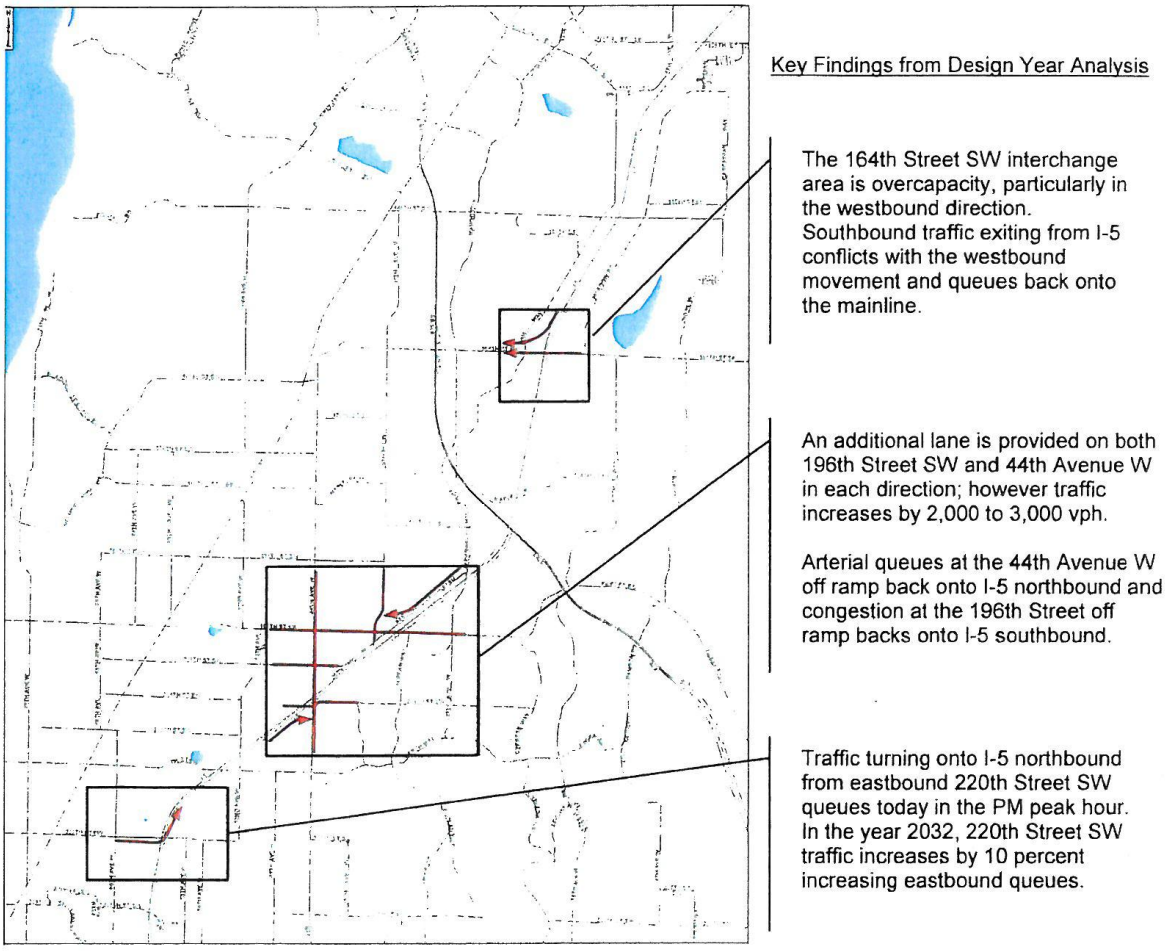


Figure 6-1 – Design Year Congestion Areas

Approach 2 – Freeway System Operations

The following summarizes the second approach conducted to determine freeway operations through the merge and weave sections. The ramps were disconnected from the arterial system in the VISSIM model to determine separately how the freeway would operate with forecasted volumes. This approach is similar to the Highway Capacity Methodology in that it analyzes freeway operations with traffic demand and does not include downstream impacts. This analysis identifies problem areas not discovered in the first approach.

In addition to the ramps being disconnected, other adjustments were made to the Year of Opening (2012) and Design Year (2032) AM peak hour VISSIM models, which are described below.

As part of the calibration process for the Existing Year (2005) AM peak hour model, constraints were introduced on southbound I-5 south of the 220th Street SW interchange to represent the queuing on the mainline south of the study area which currently exists today. This queue subsequently built itself into the study area, with the back of the queue typically reaching a point between the I-405 and 196th Street SW interchanges. In both the Year of Opening (2012) and the Design Year (2032) AM peak hour, the volumes on the SB I-5 mainline were higher than the Existing Year (2005) volumes, causing the same queue to build well beyond the I-405/I-5 interchange during the AM peak hour.

Like the assumption made with the local intersections, it is assumed that in the baseline conditions, the freeway network does not change by the Design Year 2032, with the exception of the SPUI at the 128th Street SW/I-5 interchange. However, the introduction of the SPUI did not have a significant impact on the operations of the system because the ramps in the model were disconnected from the mainline.

Another assumption involves ramp metering on the system. Currently, during the AM peak hour, ramp meters operate at every on ramp to southbound I-5, and during the PM peak hour ramp meters operate on the 220th Street SW, Alderwood Mall Pkwy, 196th Street SW, and 164th Street SW on ramps to northbound I-5. During the PM peak hour, the northbound I-405 to northbound I-5 ramp is not metered. In the Year of Opening (2012) and Design Year (2032) the ramp meters will be left alone with the same meters operating in the future and existing scenarios for the AM and PM peak hours.

WSDOT conducted an origin-destination study for several locations throughout the corridor and the results were included in the existing and future year VISSIM models. Of particular importance is the weave on southbound I-5 between the I-405/SR 525 on ramp and the 196th Street SW off ramp. During the PM peak hour an average of 10% of the traffic from SR 525 and 25% of the traffic from I-405 merges onto I-5 and then exits immediately at 196th Street SW. These proportions were held constant for the Year of Opening (2012) and Design Year (2032)

VISSIM models. The 10% and 25% percentages referenced above are based on an origin-destination study conducted in 2007. These percentages are expected to remain the same through the design year as the land use in this section of Lynnwood will remain largely commercial/retail and continue to draw the same percentages from each ramp.

In Existing Year (2005) during the AM peak hour, southbound I-5 mainline experiences significant congestion between the 196th Street SW off ramp and the southern end of the study area, south of the 220th Street SW on ramp. It is important to note that the cause of this congestion exists outside of the study area. Somewhere south of the 220th Street SW on ramp, a queue forms that eventually backs up to the 196th Street SW interchange. In order to accurately reflect the above mentioned conditions, a constraint was introduced at the southern end of the study area as part of the calibration of the Existing Year (2005) AM peak hour VISSIM model.

As mentioned previously, the Lynnwood access study focused on the PM peak hour freeway analysis for a one (1) hour peak duration. The Perteet study of 2008 (results of which are in Appendix A) used the results of the CITY Access study as the basis and included an AM peak analysis that was not present in the CITY Study. The Perteet 2008 study converted the PM Peak results over to an AM Peak model analysis. The result of the AM and PM peak analysis indicated, that in the design year of 2032, the braided ramp volumes from I-405 and SR525 and the ramp volumes to 196th Street are significantly higher during the PM peak hour.

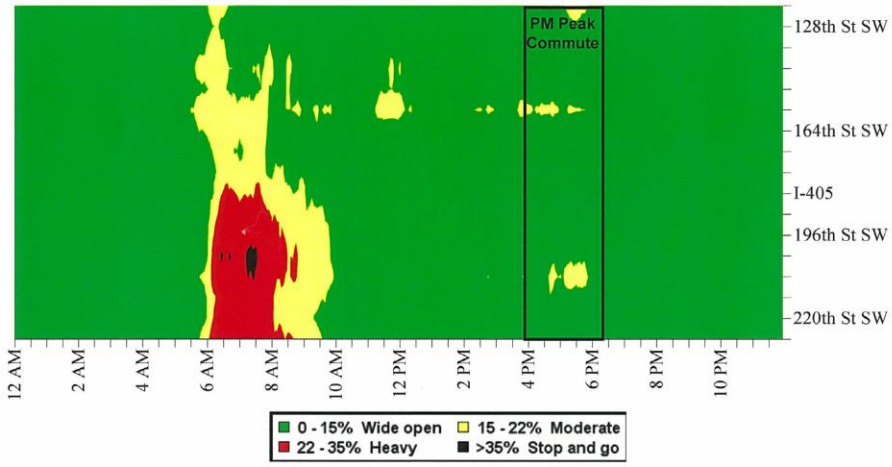
The analysis also shows the AM peak hour model does not allow for accurate operational analysis of the proposed braided ramps. The braided ramps are not the cause of congestion on the southbound I-5 mainline. In order to analyze the true operational capabilities of the braided ramps, traffic on the southbound I-5 mainline should be flowing near free flow speeds. As mentioned above, this is not the case during the AM peak hour. However the afternoon and evening the southbound I-5 mainline is always in a free-flow condition (see Figure 6-1 taken from page 8 of CITY Access Study Tech memo #5 below). Thus the PM peak hour provides an ideal situation in which we analyzed the operations of the braided ramps. The mainline queuing problem during the AM peak hour combined with the result that ramp volumes are higher during the PM peak hour, as documented above, makes the PM peak hour the optimal scenario for analyzing the operations of the braided ramps.

Freeway

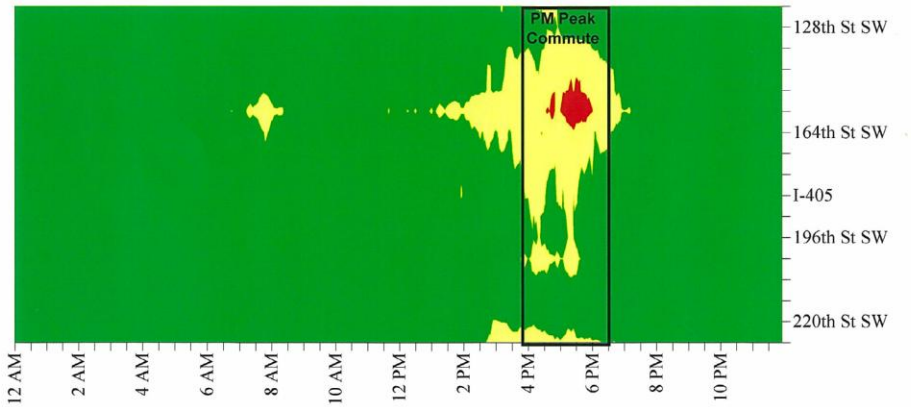
I-5 through the City of Lynnwood experiences congestion in the north direction during the evening commute. This is illustrated in Exhibit 4, a congestion diagram provided by WSDOT.

Exhibit 4. Existing Congestion Diagram

I-5 Southbound
Average Weekday March 2006



I-5 Northbound
Average Weekday March 2006



City of Lynnwood
Lynnwood City Center Access Study
September 2006

Page 8

Perteet

Figure 6-1 – Existing Congestion Diagrams for southbound and northbound I-5, March 2006

7. Safety Issues

Collision data was obtained and compiled for a three year period. The most current available information will be obtained through the Washington State Department of Transportation's Data Office. The available information is for the period January 2006 to December 2008. The report detailed the collision rate in the project study area, contributing factors to collisions, and which locations have been identified as collision analysis corridors and collision analysis locations.

8. Selection of Measures of Effectiveness (MOE)

The metrics that were used to demonstrate how the proposal will accomplish its stated objectives are:

- 95^{th} Percentile and Maximum Queue Lengths
- Average Queue Length
- Travel Time on Network (vehicle-hours)
- Average speed and density
- Duration of Congestion (hours at defined density, speed or flow rate)
- Extent (segment miles congested)
- LOS as defined by HCM, or other approved guidance
- Safety Analysis Results (Accident Potential/Risk Reduction)

9. Deviations/Justifications

The Project Analysis prepared for this project (dated April 24th, 2009) discusses deviations 1 thru 5 and are presented in Appendix "B". There is a sixth deviation that is presented in Appendix "C". The deviations are summarized below;

Deviation Number and title

#1 – Left Shoulder Width for Two-lane Ramp

#2 – Two-Foot Shy Distance to Barriers

#3 – Three Centered Circular Curves

#4 – Use of Ramp Shoulders for HOV Bypass Movements during Ramp Metering Operation Periods

#5 – Horizontal Sight Distance

#6 – Horizontal sight distance

10. Conclusion

In summary this project will improve safety and mobility by eliminating the weave on southbound I-5 between I-405/SR525 and 196th street SW. The essential feature of the project is the braided ramp which provides the grade separation that makes the elimination of the weave possible.

This project is constrained by several factors. These include the desire to restore the existing deviated southbound I-5 mainline to current shoulder and lane width standards, while maintaining the current configuration of Alderwood Mall Parkway Bridge; minimize improvements outside of the existing ROW; minimize impacts to the Interurban Trail; limit the 3-sided box structure length to less than 300 feet; and avoid relocating existing Snohomish County PUD utilities. In order to gain the room necessary to provide this grade separation and maintain proper merge distances with I-5 the access point for the exit from I-5 to SR524/196th St. SW is being moved from MP 182.04 to MP 182.73.

The milepost locations of the nearest southbound access points from and to southbound I-5 in the vicinity of this project are as follows;

MP location	Description of access point
183.64	Junction 164th st SW (existing on ramp)
182.92	Junction SR405/SR525 (existing off ramp connector)
182.73	Junction SR524/196th St SW (**New** off ramp)
182.74	Junction SR524 SP CEDRWY/44th Ave. (existing HOV median access off-ramp)

The existing access point to Junction SR524/196th St. SW (off-ramp) is located at MP 182.04.

11. Appendices

Appendix A – Final Technical Report – Traffic Operations, Perteet August 28, 2008

Appendix B - Project Analysis

Appendix C - Deviation #6

Appendix D - Approved Channelization Plans

Appendix E – WSDOT review of CITY Center Poplar Way Extension model

Appendix F - Lynnwood City Center Access Study

Appendix G – Signing Plans