EXHIBIT B:
Northwest District Plan Remand
Transportation Model Technical Report

May 27, 2010

Prepared by:
Portland Bureau of Transportation and
Bureau of Planning and Sustainability

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A digital copy of this report can be found at:
www.portlandoregon.gov/pbs/nwremand

Table of Contents

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Executive Summary

In coordination with the Bureau of Planning and Sustainability (BPS), the Transportation Planning Division of the Bureau of Transportation (PBOT) has prepared an updated transportation analysis for the Northwest District Plan (NWDP) to determine whether the zoning changes adopted in the Plan significantly affect one or more transportation facilities in the NWDP area.

In particular, this analysis is intended to address the Land Use Board of Appeals (LUBA) determination that the City provided insufficient data for two transportation impact findings related to the land use changes in the NWDP. LUBA asked the City to provide answers to two questions:

(1) Will the NWDP cause traffic that changes the functional classification of NW Vaughn Street as a "Neighborhood Collector?"

and

(2) Will the performance standards at the intersection of NW 23rd Ave. and NW Vaughn St. and the Interstate 405 (I-405) ramp remain at acceptable levels of service?

As part of the analysis, PBOT modeled future growth in the area, which produced projections of 1,050 new households and 3,370 new jobs in the district. This analysis assessed the impacts of growth on the transportation infrastructure in the NWDP area and concluded that:

(1) NW Vaughn St., which is currently classified as a "Neighborhood Collector," will continue to function as it does today; and

(2) With planned future mitigation, the I-405 ramp and the intersection of NW 23rd Ave. and NW Vaughn St. will have performance standards above the minimum acceptable level.

I. Background

In the fall of 2003, the Portland City Council adopted the Northwest District Plan (NWDP). The NWDP was appealed to the Land Use Board of Appeals (LUBA) for multiple reasons. Although LUBA upheld most of the NWDP, it remanded the plan on two issues relating to the State's Transportation Planning Rule. LUBA concluding that:

A. *"[f]or each type of traffic classification, the majority of motor vehicle trips on a street should conform to its classification description … (and) remand is necessary for the city to address whether [the NWDP] "significantly affects" NW Vaughn St. for purposes of OAR 660-012-0060(2)(c)…";* and

B. *"There may be evidence … in the record that would allow a reasonable person to conclude that [the NWDP] will not "reduce the performance standards" of the NW Vaughn St/NW 23rd Ave. intersection and the Interstate 405 on-ramp of the facility "below the minimum acceptable level identified in the TSP" within the meaning of OAR 660-012-0060(2)(d), but the city has not cited us to it.."*

Therefore, Portland Bureau of Transportation (PBOT) and Bureau of Planning and Sustainability (BPS) produced this updated analysis to look at two particular transportation impacts of the NWDP: 1) whether the land uses allowed by the NWDP would allow NW Vaughn St. to continue to function as a neighborhood collector; and 2) whether the NWDP will significantly reduce the performance standards of the NW Vaughn St/NW 23rd Ave. intersection and the Interstate 405 (I-405) on-ramp.

II. Methodology and Descriptions

The Northwest District Plan (NWDP) transportation analysis was based on data that was developed through use of Metro's model for forecasting development (the "Metro Model") and the Portland Bureau of Transportation's model for forecasting traffic related to the Central City Transportation Management Plan (CCTMP2007).

The study looked at the NWDP area as defined in combining sub areas of the Metro Model (see Plot 1 for sub-model boundary map). The 2005 traffic counts, the most recent available, were used as the base year for current conditions. Development was then forecast through the year 2030.

ODOT has accepted the traffic analysis findings; including the methodology and assumptions used for estimating a "reasonable worst case" of households and employment, both before and after (i.e. without and with the NWDP).

The following provides more detailed explanation of the methodology and defines some of the critical terms used in the analysis.

Description of Base Transportation Model.

In order to analyze the transportation impacts of the NWDP, PBOT established sub-area transportation models that can assess transportation impacts at two different scales –

1. Transportation demand for the area on the macro level using the Visumsoftware package; and,
2. Detailed operations on critical intersections and links using the Synchro/SimTraffic software package.

The aims of the modeling process are to:

- Forecast future traffic growth and travel patterns
- Examine Transportation Planning Rule compliance for impacted Oregon Department of Transportation (ODOT) facilities (i.e. I-405)
- Analyze network traffic conditions and traffic impacts in the study area

The NWDP Visum sub model is a refined version of the Visum model used for the North Pearl District Plan (NPDP). Both sub-models were derived from the Metro Model. The Metro Model is derived from Metro's previously-validated 2005 Regional Transportation Plan (RTP) and 2030 Milwaukie Light-rail (LRT) No-Build models.

While the city model kept most of the modeling assumptions that were utilized for the Metro Model, the following assumptions were altered to refine the model for the focus area:

a. The city model added finer detail Transportation Analysis Zones (TAZ).
b. The city model added more detailed local networks with calibrated link and turn characteristics.
c. For a project sub area, the intersection turn capacities are coded according to its peak hour signal timing plan.
d. The city model codes Downtown networks with capacity constraints. Metro's regional model codes Downtown streets with un-limited capacity.

The NWDP sub-model boundary is shown in Plot 1. The area bounded by blue lines is the NWDP sub- area, a total of 11 TAZs.

Description of "Neighborhood Collector" street classification

The Transportation Element of the City's Comprehensive Plan describes a neighborhood collector in the following way:

> Neighborhood Collectors are intended to serve as distributors of traffic from Major City Traffic Streets or District Collectors to Local Service Streets and to serve trips that both start and end within areas bounded by Major City Traffic Streets and District Collectors.
>
> - Land Use/Development. Neighborhood Collectors should connect neighborhoods to nearby centers, corridors, station communities, main streets, and other nearby destinations. New land uses and major expansions of land uses that attract a significant

volume of traffic from outside the neighborhood should be discouraged from locating on Neighborhood Collectors.

- Connections. Neighborhood Collectors should connect to Major City Traffic Streets, District Collectors, and other Neighborhood Collectors, as well as to Local Service Streets.
- Function. The design of Neighborhood Collectors may vary over their length as the land use character changes from primarily commercial to primarily residential. Some Neighborhood Collectors may have a regional function, either alone or in concert with other nearby parallel collectors. All Neighborhood Collectors should be designed to operate as neighborhood streets rather than as regional arterials.

Essentially, Neighborhood Collector Streets should be primarily used for trips in the neighborhood and not for traffic that is trying to move through an area.

Explanation of Level-of-Service (LOS) ratings

Level-of-Service (LOS) is a concept used in transportation planning to describe the operating conditions on a roadway and at intersections. LOS describes operating conditions on a scale from "A" to "F", with A describing a free flowing condition and F describing bumper-to-bumper conditions. If LOS is F, demand has exceeded roadway capacity, which forces excess demand onto parallel routes and extends the peak period. The LOS scale is determined by a mixture of quantitative measures, such as speed, travel time, density of vehicles and delay as well as qualitative observations, such as freedom to maneuver.

Below is a chart that describes the various LOS operating conditions for intersections.

Table 1: Intersection LOS Definitions* LOS	Description
LOS A	Free flow with no delays. Users are virtually unaffected by others in the traffic stream.
LOS B	Traffic flows smoothly with few delays.
LOS C	Stable flow but the operation of individual users becomes affected by other vehicles. Modest delays.
LOS D	Delay becomes more noticeable.
LOS E	Traffic volumes are at or close to capacity, resulting in significant delays and average speeds which are no more than about one-third the uncongested speed.
LOS F	Traffic demand exceeds available capacity with very slow speeds, long delays and standing queues at signalized intersections.

The Transportation System Plan (TSP) contains the adopted policies regarding the City's transportation system. Table 11.1, Performance Measures for Regionally Significant Streets – Deficiency Thresholds and Operating Standards, establishes LOS E as the acceptable LOS for the NW 23rd/Vaughn interchange with I-405.

III. Key Findings

The transportation analysis resulted in nine key findings, as follows:

1. Growth Related to the NWDP. Land use changes adopted with the NWDP will contribute to the addition of approximately 1,050 new households and 3,370 new jobs in the district by the 2030. Metro's regional model assumes that the NWDP area will have slower household and population growth when compared to City and regional averages.

	2005		2030 Base		2005-2030 growth	
	HH	EMP	HH	EMP	HH	EMP
NWDP	4,970	18,040	6,020	21,410	21%	19%
City	234,700	442,700	299,500	603,100	28%	36%
Region	766,800	1032,000	1,134,100	1,691,900	48%	64%

2. Estimate of Pedestrian Trips. Walking as a percent of daily traffic will increase in the NWDP area from approximately 7% in 2005 to 8% by 2030. This is slightly higher than city averages but less than what otherwise might be reasonably expected to occur in the future.

   For example, walk mode splits in the neighboring North Pearl District Plan area are predicted at 13% in 2005 and 20% in 2030. This conservative estimate increases the amount of trips forecast for automobile traffic and could be due to the impact that the industrial area north of Vaughn has on individual transportation choices.

3. Estimate of Transit Trips. The NWDP area's transit mode split will grow, but remain modest through 2030. As a percentage of daily trip traffic, transit trips are predicted to increase from 6% in 2005 to 10% in 2030.

4. Estimate of Auto Trips. Approximately 80% of all future trips in the study area will be made by automobile. This represents a decrease of nearly 6% over 2005, but this mode split remains relatively high for an area with a substantial infrastructure for transit, bikes and pedestrians. This could be due to study area including the industrial sites north of Vaughn.

5. Estimate of Bike Trips. While the model doesn't produce an estimate of the percentage of future trips that will be made by bicycle, one can deduce that these trips will increase from 1% in 2005 to 2% in 2030.

6. Identification of Access Routes to the District. The I-405 ramps east of NW 23rd Ave will remain a major route by which traffic accesses the district. During the evening (PM) peak hours in 2005, approximately 28 percent of district traffic used these ramps accounting for nearly 81 percent of total ramp traffic. The next major access routes for district traffic are the streets connecting to the south. The north/south streets from NW 16th Ave to NW 23rd Ave transported about 20 percent of total district traffic during the same PM peak hours in 2005. The relative role of all these routes is projected to remain the same in 2030.

7. The Role of NW Vaughn for Neighborhood Traffic. In 2030, with the zone changes, NW Vaughn St will continue to function as it does today. Approximately 85% of the traffic on NW Vaughn St — west of NW 23rd Ave. — starts or ends in the area bounded by Major City streets and District Collectors (NW 16th, W. Burnside, NW Yeon). This area boundary represents the policy description of appropriate service area for a Neighborhood Collector.

   The zone changes proposed will have no significant effect on the performance of NW Vaughn St. in regards to its street classification. In 2030, the percentage of trips starting and ending in the area bounded by Major City streets and District Collectors (NW 16th, W. Burnside, NW Yeon) remains the same as today. As described in the TSP, "Neighborhood Collector may have a regional function, either alone or in concert with other nearby parallel collectors." NW Vaughn St, in part, currently provides a regional access function, which is consistent with the City's policy for Neighborhood Collectors located near freeway entrances. Experience elsewhere has demonstrated that mixed use zoning and subsequent development actually increases local trips and displaces non-local trips. Therefore, NW Vaughn St. meets the City's policies for the role of Neighborhood Collectors today and the zone changes will not impact this function.

8. Estimate of the Impact of North Pearl Zoning Changes. Development forecast for the North Pearl will not result in a significant traffic increase on the streets or freeway ramps in NWDP area. The analysis of the NWDP traffic impacts reviewed possible traffic impacts from the major land use and transportation recommendations in the recently completed North Pearl District Rezoning project and found the number of trips projected to and from the NWDP area to be insignificant.

9. Estimate of Future Congestion. By 2030, congestion during the PM peak in the NWDP area will increase, although not dramatically. The percent of traffic that would encounter congestion increases from 3 percent to 17 percent in terms of vehicle miles, and the total length of congested streets will increase from .6 miles to 2.2. miles. The most noticeable area of congestion is projected on NW Yeon Ave. west of NW Nicolai St. The majority of traffic on these street segments are through-trips connecting to US-30/I-405. The northbound traffic on NW 23rd Ave, south of NW Thurman St, is projected to reach its link capacity at the macro planning level analysis. Because of this, additional micro level analysis was conducted which then showed the intersection performing at an acceptable level of service. The table below summarizes the PM peak 2-hour traffic conditions of the district streets, with the average PM peak 2-hour volumes increasing from 570 to 740.

NWDP Study Area Transportation Model Summary (thick links in Plot 2)	2005	2030
Average link volumes	570	740
Total vehicle miles	23,400	30,900
Total VHT[1] (h)	1050	1480
Congested streets		
# of links	5	14
Miles	0.6	2.2
Vehicle-miles	780	5250

% of total v-m	3.3%	17.0%

[1] VHT: Vehicle Hour Traveled = Volumes x Travel Time

10. 2030 Performance of the I-405 interchanges.

a. The 2030 performance of the I-405 ramp at the NW Glisan and NW Everett intersections will meet City and ODOT mobility standards. PM peak-hour traffic operational analyses were performed to assess the traffic conditions in 2030 using the 2030 PM2 base model for the intersections with ODOT's freeway facilities. The Synchro model results indicate that all I-405 ramp intersections at NW Glisan/NW Everett Sts will be operated at the level of service (LOS) D or better with a maximum volume to capacity (V/C) ratio of 0.76 occurring during the weekday PM peak hour in year 2030.

b. 2030 performance of the intersections at I-405 / NW Vaughn / NW 23rd and U.S.30 / NW Nicolai / NW Yeon will change from LOS D to LOS F and mitigation of the impacts at NW Vaughn and NW 23rd should be required.

The model examined the operational conditions of these intersections for both AM and PM peak hours. The analysis shows that the two ramp intersections currently operate at LOS D or better with a maximum V/C of 0.97 during weekday peak hours. Both of these interchanges are projected to deteriorate to LOS F with V/C readings of 1.06 in the 2030 PM peak hour. Acceptable Level of Service for this type of intersection is D or E, therefore the intersection drops below the acceptable level of service per the City standards since it drops from D to F.

ODOT has reviewed this analysis and concluded that although intersection operations will be below City of Portland mobility standards there is no significant impact on the planned function and performance of the state facility, I-405 and the ramps associated with I-405. No mitigation of the impact on the state facility is required.

However, PBOT has concluded that the impacts on the performance of the NW Vaughn St. and NW 23rd Ave. intersection requires mitigation. The City proposes actions to mitigate the impacts to ensure that the LOS E standard for this intersection is maintained.

As provided in OAR 660-0012-0060(2)(a) and (3)(d) the City finds that the impact of the NWDP land uses will be consistent with the performance standard of LOS E for the intersection through mitigation measures that future development will provide. Specifically, as development occurs and traffic conditions at the intersection deteriorate, it will be necessary to make changes to the intersection and I-405 off- ramp that will improve the operation of the intersection. These mitigation measures, which involve restriping of the intersection, are already identified in the City's transportation system plan. This mitigation will be required as part of future development applications that cause the intersection to deteriorate. See Exhibit B for a detailed description, drawings and cost estimates for the proposed improvements.

III. Conclusion

In summary, the traffic analysis finds that the questions posed by LUBA in the remand of the NWDP are answered affirmatively and the impacts of the NWDP do not change the functional classification of NW Vaughn and do not cause the intersection of NW 23rd and I-405 to fall below performance standards as follows:

NW Vaughn Will Remain a Neighborhood Collector.

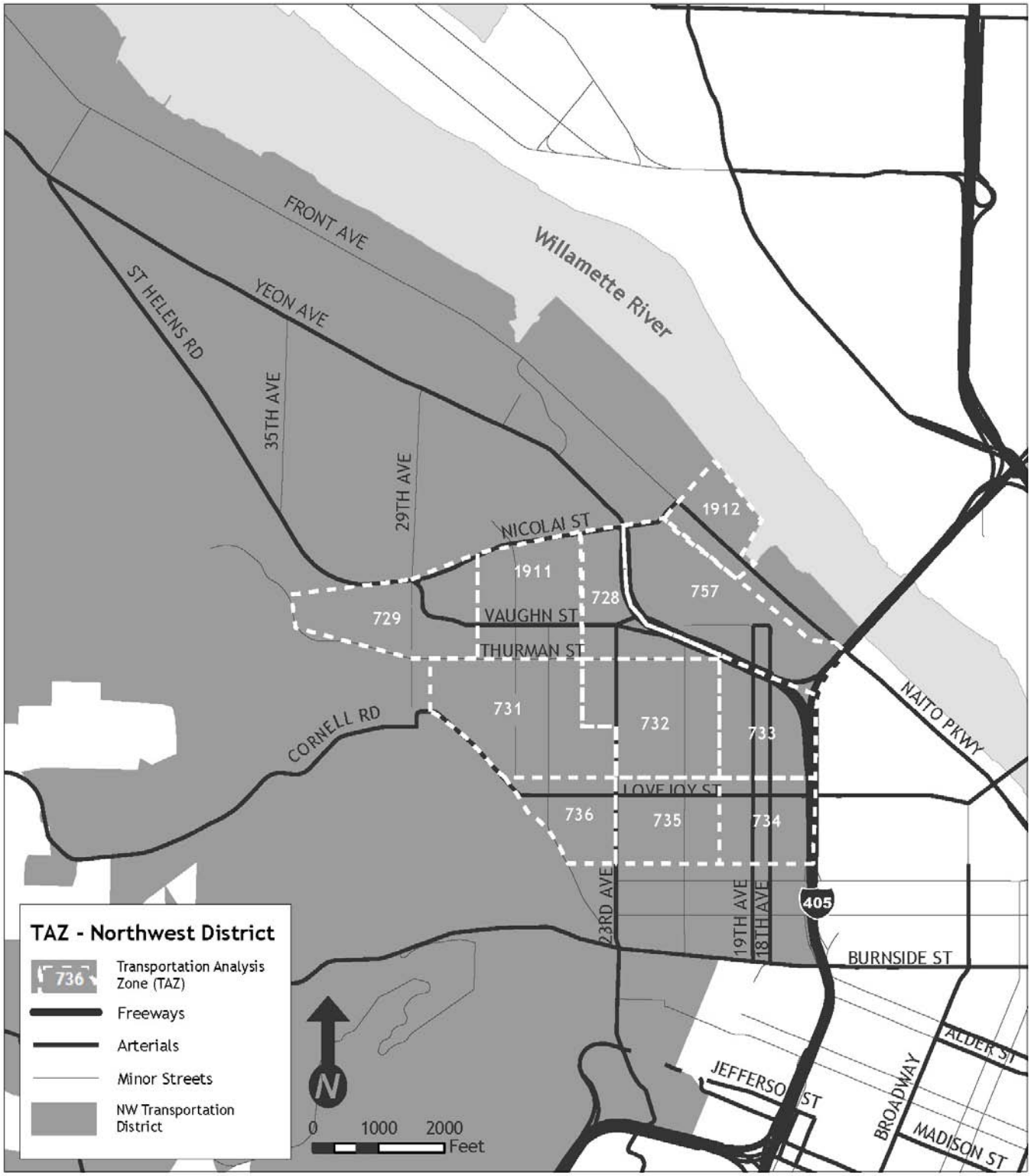
The first purpose of this transportation analysis was to determine whether NW Vaughn St would continue to operate as defined in its classification as a Neighborhood Collector after the implementation of the NWDP. This analysis shows that the zone changes proposed with the NWDP will have no significant effect on the performance of NW Vaughn St, in regards to its street classification.

The I-405 Ramp and the NW Vaughn and NW 23rd Intersection Will Not Fall Below Acceptable Performance Standards.

The second purpose was to determine whether the NWDP will reduce the performance standards of the NW Vaughn St and NW 23rd Ave. intersection and the Interstate 405 (I-405) ramp below the minimum acceptable level. Despite anticipated job and housing growth in the NWDP neighborhood area by 2030, ODOT has concluded that there is no significant impact on the planned function and performance of the I-405 (state) facility. PBOT has concluded that operation conditions will be below City of Portland mobility standards for the city's intersection at some point in the future, and has proposed changes to the interchange to improve the operation and performance of these facilities in the future which will bring the performance standard into acceptable levels and compliance with OAR 660-0012-0060(2).

Appendix A
Plots

Plot 1. Sub Model Boundary and Northwest TAZs



District Street Links

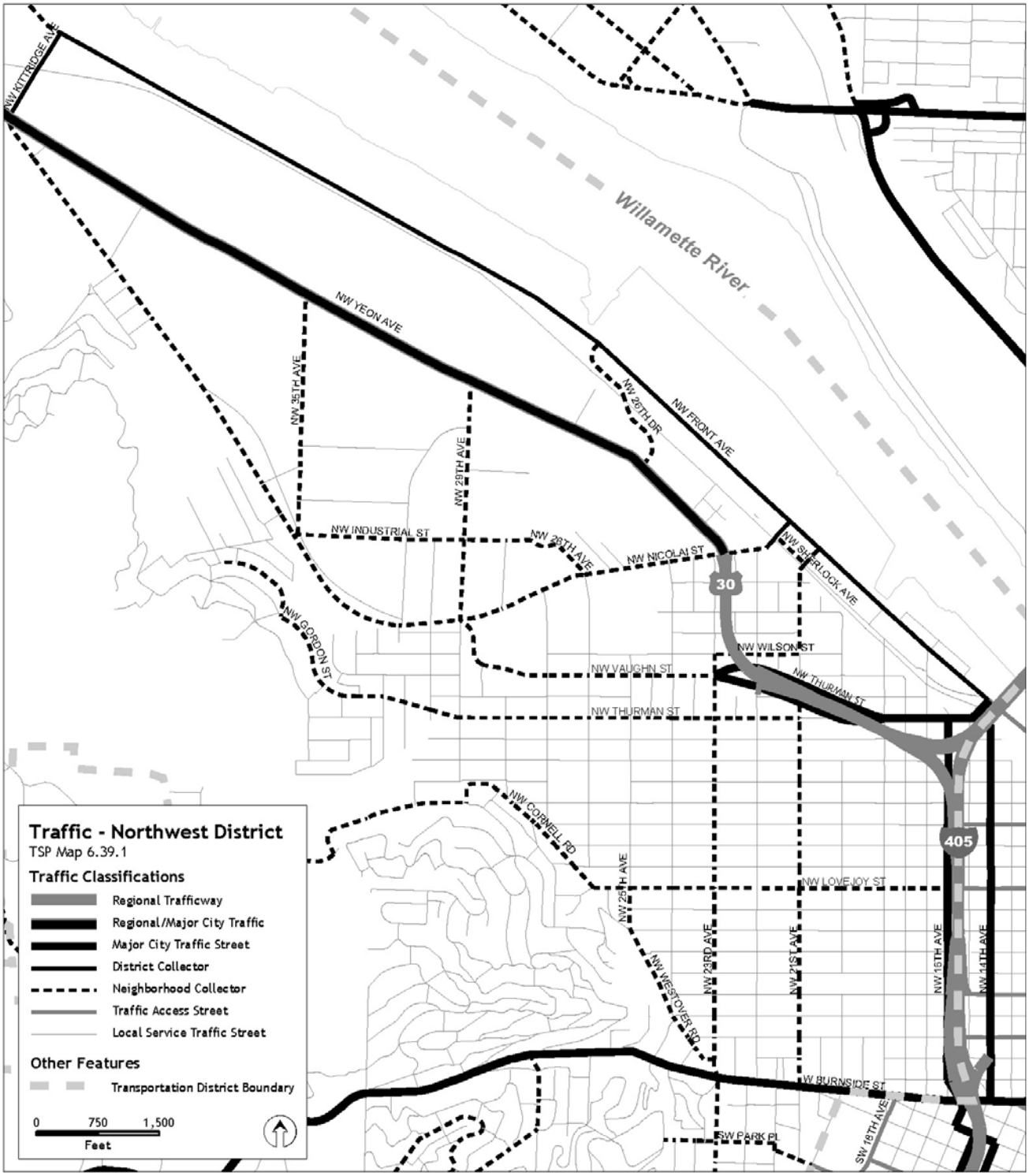
The blue links in Plot 2 are marked as the district links for project analysis.

Plot 2. Northwest Sub Model Networks

Network of the District

Plot 3 shows street classifications within the district and vicinity, as identified in the City of Portland TSP.

Plot 3. Street Classifications



Major Transportation Model Assumptions

Although no major transportation projects are planned within the NWDP project sub area by 2030, two are located in the vicinity of the NWDP sub area and were built into the 2030 demand model:

a. The street car loop project in the North Pearl District area immediately to the east, and
b. The Burnside/Couch couplet project immediately to the south.

Base Model Calibration

The 2005 PM2 sub model has been calibrated using 2005 PM 2-hour traffic counts[1]. A total of 189 counts are used in the calibration process.

Using the NPDP sub model, a further calibration was performed for the NWDP sub model. The main calibration measures include: a) dividing four big TAZs (#729, #755- #757) into eight; and b.) modifying some TAZs' connectors accordingly.

Through the calibration, a correlation of 0.96 was reached between the counts and the assigned traffic volumes (see the assignment analysis regression chart, Plot 4). Plot 5 shows assigned volumes and traffic counts in the core area of the NWDP project. The green links are the links with assignment errors within +-15 percent, while the blue and orange links represent the under or over assignment links, respectively. Assignment errors are measured by the formula of: assigned PM2 link volumes / pm2 traffic link counts.

[1] Some counts are 2007 counts.

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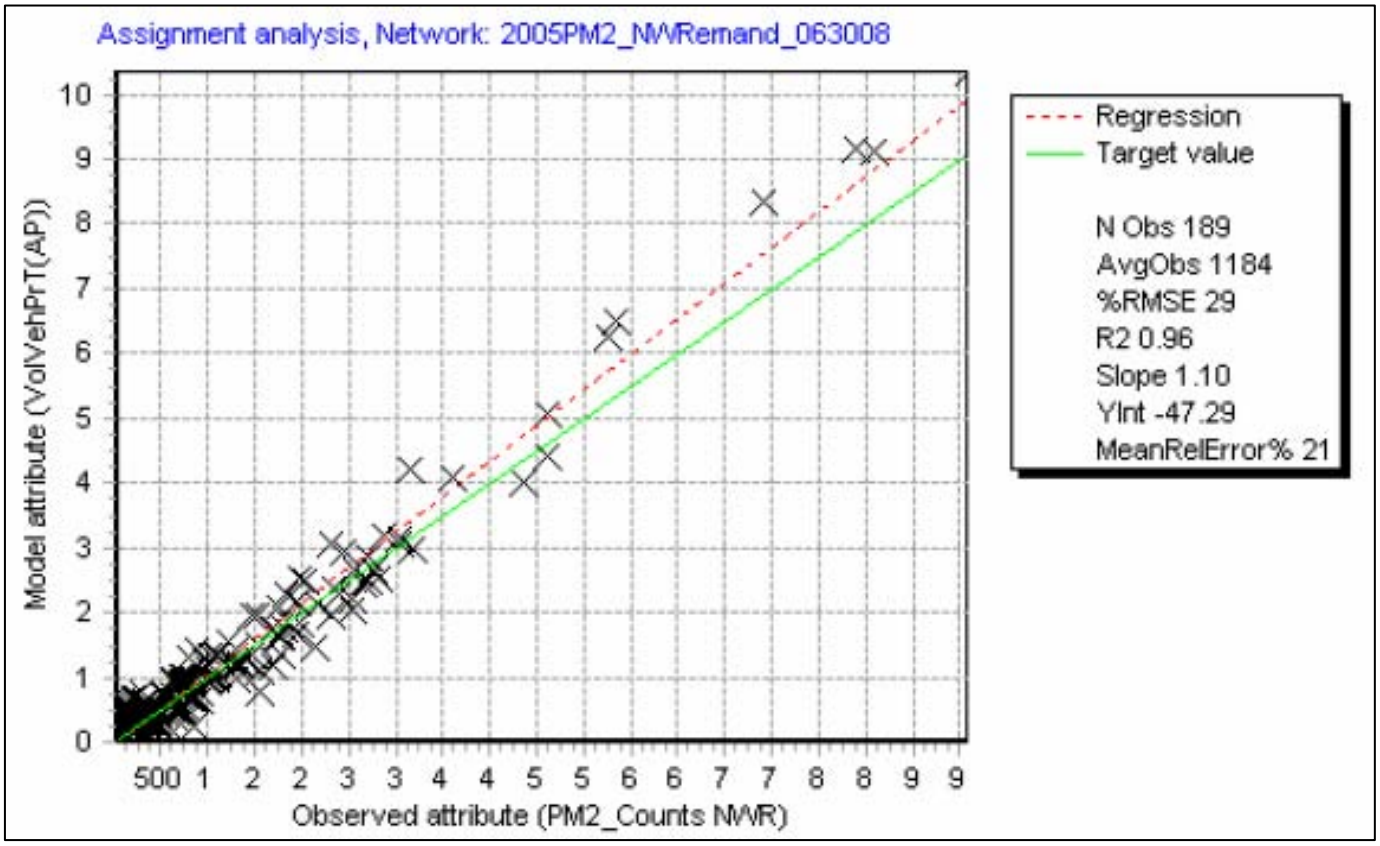
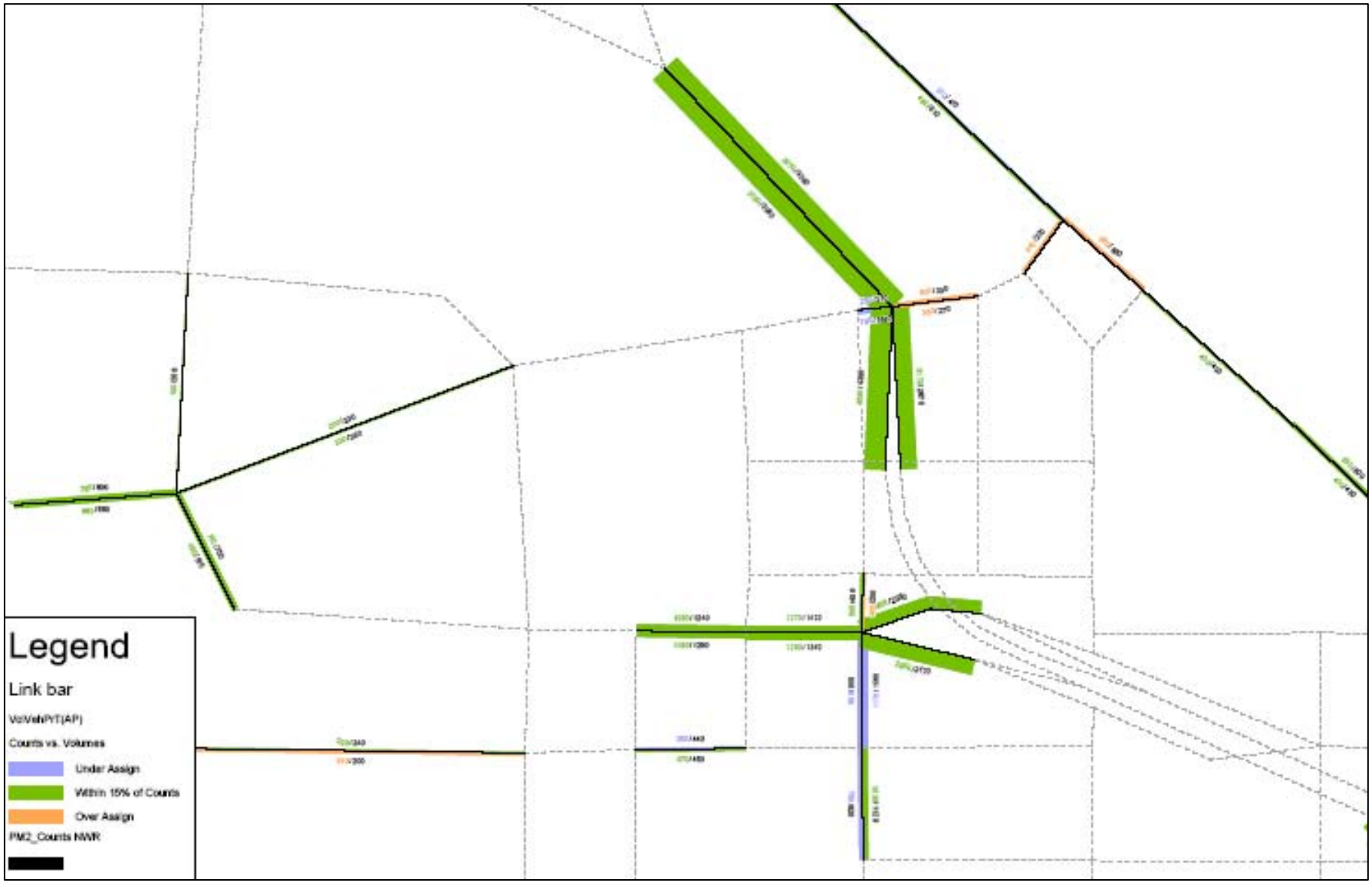
Plot 4. Assignment Analysis Regression Chart



Plot 5. Traffic Counts and Assigned Volumes



Appendix B
Transportation Demand Forecasting

Base Model Projections

The following tables show the land use and resulting trip demands derived from the 2005/2030 NWDP base models:

Land use – Although household and employment growth in NWDP area is projected to occur at a slower rate when compared with the city and other areas within the region, the area will still experience significant growth in both categories (i.e., 1050 additional households and an increase of 3370 new jobs). These land use assumptions were based on the adopted NWDP zoning and comprehensive plan changes. One possible resul1t of these changes could be the constraint of any additional growth that might have otherwise occured in the study area through 2030.

Table 1. Land Use Assumptions in the model

	2005		2030		2005-2030 growth	
	HH	EMP	HH	EMP	HH	EMP
NWDP	4,970	18,040	6,020	21,410	21%	19%
City	234,700	442,700	299,500	603,100	28%	36%
Region	766,800	1032,000	1,134,100	1,691,900	48%	64%

District Daily Trip Demands and Mode Split – The NWDP area's existing auto mode split percentage is relatively high now and is predicted to remain so in the future. This is especially true when compared against the neighboring NPDP district. In addition, the most noticeable differences in non-motorized traffic modes between the two areas are the relatively low readings in the walk mode split, even though they are still a little higher than City averages. The NWDP walk mode split, as a percent of daily traffic, is predicted to increase from approximately 7 percent to 8 percent by 2030. The walk mode splits in the NPDP are predicted at 13 percent in 2005 and 20 percent in 2030. The NWDP walk figure represents a number slightly higher than City averages but less than what otherwise might be expected to reasonably occur in the future. Again, this would indicate that the model represents a reasonable worst case scenario in terms of studying future traffic volumes.

Table 2. District Daily Traffic

	auto		transit		bike		walk		Total
	trips	%	trips	%	trips	%	trips	%	trips
2005	180,300	86.0	11,500	5.5	2,100	1.0	15,800	7.5	209,700
2030	223,900	80.4	27,200	9.8	3,200	1.2	24,100	8.7	278,300
Growth%	24.2		136.9		51.0		52.2		32.7

Table 3. District PM Peak 2-hour Traffic

	Auto		Transit		Bike[1]		Walk[1]		Total
	trips	%	trips	%	trips	%	trips	%	trips
2005	15,240	74.6	1,540	7.6	420	2.1	3,160	15.5	20,360
2030	18,180	66.5	3,700	13.5	640	2.3	4,820	17.6	27,340
Growth%	19.3		140.3		52.4		52.5		34.3

[1] Bike and Walk trips are estimated at 20 percent of daily trips.

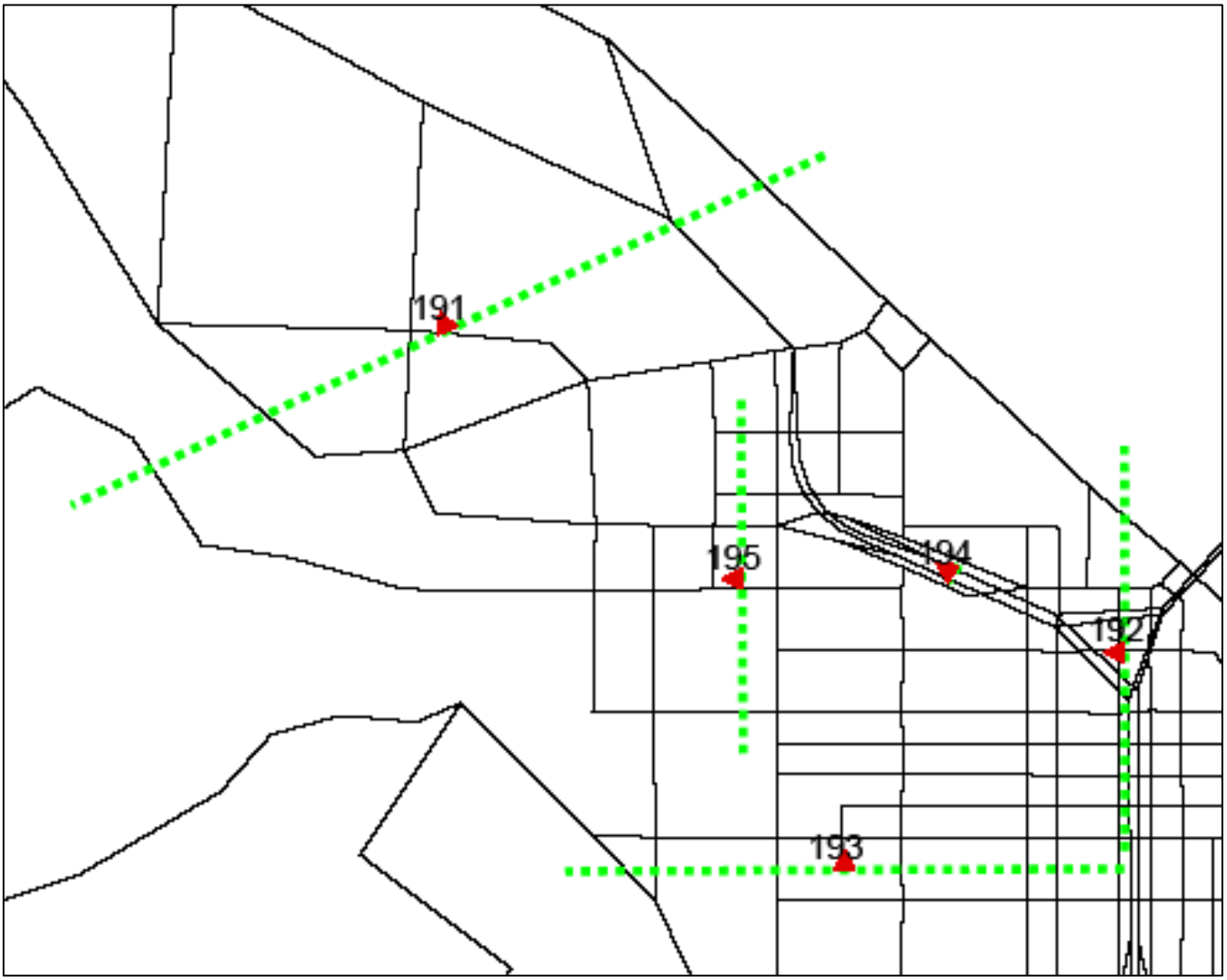
Network Screen-line Traffic Growth (PM peak 2-hours) – The first four screen-lines gate NWDP area streets (See Plot 6). The table below shows that the traffic running through the gate screen-lines will grow at a much faster pace than the growth rate of 19.3 percent of the district auto demands. This implies that through auto traffic will gain shares in the future on those streets. By comparison, the fifth screen-line is located inside the district, and the traffic growth rate on it is more consistent with NWDP traffic growth.

Table 4. PM Peak 2-Hour Screen-Line Traffic

	Line 1		Line 2		Line 3		Line 4		Line 5	
	WB	EB	EB	WB	SB	NB	EB	WB	WB	EB
2005	4350	4820	2500	4110	4850	2290	6620	5150	2190	2060
2030	5950	7180	4550	5400	6020	3010	8610	6970	2560	2640
Growth	37%	49%	82%	32%	24%	32%	30%	35%	17%	28%

Line 1 – Northwest of NW Nicolai St. from NW Front Ave. to NW Thurman Ave.
Line 2 – East of NW 16th Ave from NW Front to NW Johnson, no freeway
Line 3 – North of NW Glisan from NW 16th Ave to NW Westover
Line 4 – Freeway I-405 west of Freemont bridge interchange
Line 5 – west of NW 23rd Ave. from NW York St. to NW Pettygrove St.

Plot 6. Screen Lines



Daily traffic Origin-Destination patterns – The top five districts with the highest origin-destination traffic relations are listed in Table 5. There is no change between 2005 and 2030 in terms of the ranks of these traffic relations. The average trip distance for trips from, to or through the NWDP Remand area is 7.3 miles in 2005 PM peak 2-hours.

Table 5. PM Peak 2-hour Trip Distribution Pattern

	2005		2030	
Area	Trips	%	Trips	%
Beaverton/Hillsboro	1940	12.9	2590	14.4
NWDP Area	1440	9.6	1510	8.4
CBD	1370	9.1	1510	8.4
SW Portland	1280	8.5	1500	8.4
NE Portland	1170	7.8	1310	7.3
Total*		47.8		46.9

*Total includes remainder of trips distributed to other districts.

Main Access Routes -- During weekday PM peak 2-hours, the I-405 ramps at NW Vaughn St and NW 23rd Ave serve as major access routes to the NWDP area. This represents 28 percent of the total vehicle demands coming in and out of the district. Other than the freeway, local traffic is scattered among the streets connecting to the south, east and west and Screen-line 3 captures the most local traffic among the 3 boundary screen-lines. Local traffic here refers to traffic with at least one trip end within the district.

Table 6. PM 2-hour traffic on the top six main access routes

		District related volumes	% of the total district trips	% of the total link volumes
2005	I-405 E/ NW 23rd	4330	28%	81%
	NW 18th-19th n/ Glisan	1510	10%	90%
	NW 23rd n/ Glisan	1040	7%	73%
	NW Cornell w/ Love Joy	930	6%	41%
	NW Naito Pkwy e/ 14th	880	6%	46%
2030	I-405 E/ NW 23rd	4750	26%	76%
	NW 18th-19t th n/ Glisan	1840	10%	86%
	NW 23rd n/ Glisan	1140	6%	66%
	NW 16th n/ Glisan	1080	6%	60%
	NW Naito Pkwy e/ 14th	1010	5%	35%

Comprehensive Plan Changes North of Vaughn St - Planning and PBOT prepared a sensitivity analysis of the Comprehensive Plan changes adopted in the area North of Vaughn St. Planning conducted a business owner survey and land use analysis that led to the preparation of a development estimate for all properties in the Mixed Employment (ME) designated area. The analysis shows that the area could expect a total increase of 191 additional jobs. Some or all of those jobs are

already captured by the 2030 base model (See Table 7) and the only TAZs effected by the Comprehensive Plan changes are TAZ #728 and #1911. These 191 jobs also represent an insignificant increase when compared to the 2030 base employment figures for the study area (i.e., 21,410 total employment). As a result, PBOT has concluded that any increase in travel demand associated with this amount of additional employment would not significantly change the travel behaviors of or impacts in the NWDP area beyond those already predicted in the 2030 base model. Therefore, a separate model and analysis for the area North of Vaughn St was deemed unnecessary and the model uses the same trip generation rates from the 2030 base model to project the additional vehicle trips from the NWDP, and also maintains the same mode split figures for each TAZ.

Trip Generation – In order to derive the PM peak 2-hour trip generation rates from the base models, a generic trip generation formula is first used to separate the residential and employment components of the traffic, and then the trip generation rates are obtained by dividing the commercial traffic with the total employment of the TAZ. On average, 0.5 vehicle trips are added into the PM2 demands by every new employee in the model.

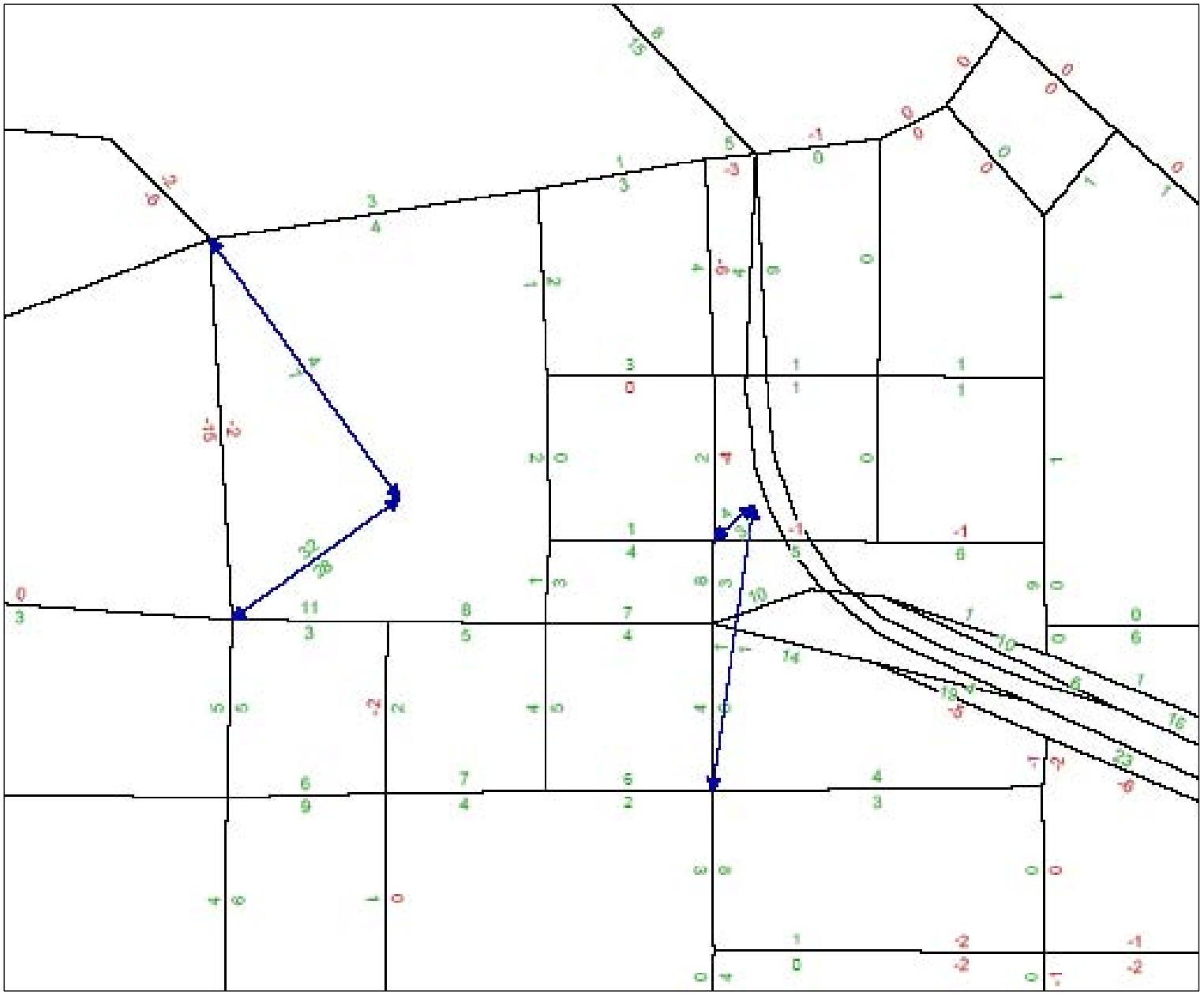
Table 7. NWDP & North of Vaughn projected PM2 total vehicle demand

	2005	2030 Base NWDP	2030 NWDP, plus N of Vaughn
Household	4720	5760	5760
Employment	17110	20400	20590
Total Travel Demand*	15200	19020	19100

*Total Travel Demand is a function derived of Household and Employment figures for the study area.

Plot 7 shows the differences between the rezoning scenario and the base model. It can be seen that there is no significant difference between the two assignments. The biggest change happens on I-405 east of the division point to US-30 with a total of 39 vehicles for 2 hours (23 eastbound and 16 westbound). With this amount of traffic change, no further traffic analysis, specifically for the Comprehensive Plan changes North of Vaughn St, is needed.

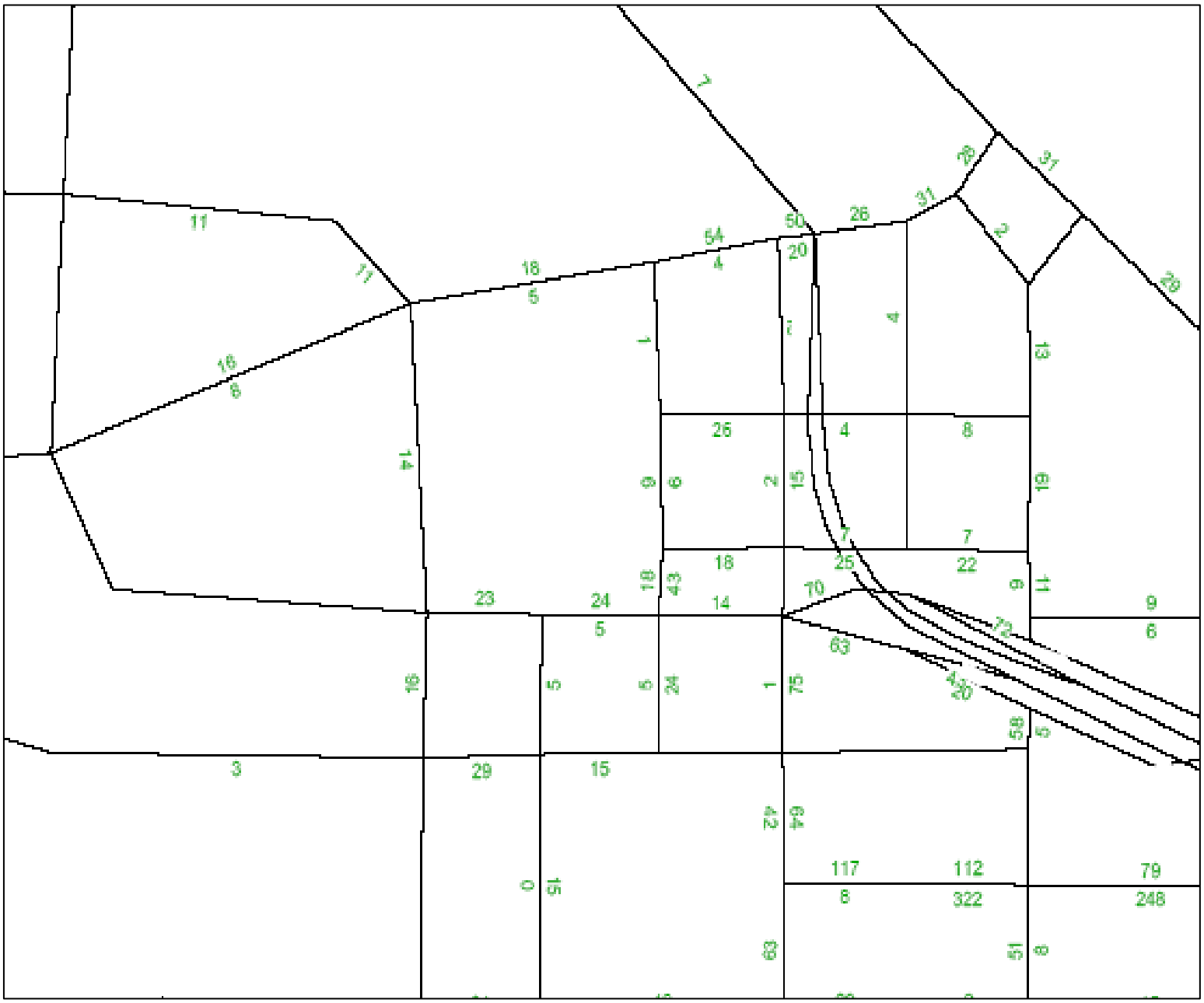
Plot 7. 2030 PM2 Volume Difference between Base and Rezoning Models



North Pearl District Plan Analysis - the NPDP's potential traffic impacts were also examined. PBOT set-up an alternative scenario which introduced recommendations from the NPDP into the base model. Those added elements included: a) an additional 2050 households in the North Pearl District in the planning year of 2030 (i.e., land use alternative 3); b) the NW Lovejoy / NW Overton couplet street network between 9th and 16th Aves; and c) a range of Transportation Demand Management (TDM) measures proposed in the plan.

Plot 8 shows the PM 2-hour Volume difference between the 2030 base model and the one with the additional NPDP changes. The plot shows a limited traffic increase resulting in approximately 20+ more vehicles on NW Vaughn St and 70+ more vehicles on the I-405 westbound off-ramp during the PM peak 2-hour period. Therefore, PBOT concludes that the North Pearl District Rezoning Plan will not significantly affect the NWDP traffic conditions at this level of planning analysis.

Plot 8. Volume Difference between NWDP and NPDP Incorporated Models



PM Peak 2-hour Traffic Conditions - A two-level analysis of the PM peak 2-hour traffic conditions was conducted:

1. The planning level of analysis focused on the traffic conditions at a link level using outputs from the Visum demand model software package
2. The operations level of analysis was performed at the intersection level using the Synchro modeling software package.

Planning Analysis

District PM Peak 2-hour Total Traffic - NWDP area vehicle demands are predicted to increase 20 percent by 2030. This is in the same range of traffic growth projected at the inner screen-line west of NW 23rd Ave running through NW York St and NW Pettygrove St. Compared with the other four screen-lines, traffic growth inside the NWDP area appears slower than traffic growth on the streets surrounding the district.

Table 8. PM2 total vehicle demand growth

	2005	2030	growth %
District Demands	15,400	18,400	20%
4-Screen-line Traffic total[1]	31,700	44,200	39%
Average Area Link Volumes[2]	570	740	30%

[1]The first four screen-lines, defined as before

Congestion - From the 2005 PM2 assignment (See Plot 9), there are 780 vol-miles (number of vehicles times distance traveled) on NWDP area links with a v/c ratio higher or equal 1, which equals approximately 3 percent of total vol-miles for the district links, all of them located in the southwest boundary of the district network. It is projected that this number would increase to 5,250 vol-miles, or approximately 17 percent of the total district vol-miles in 2030. More noticeable, the projected congested links show up inside the district area. The V/C readings on NW Yeon Ave west of NW Nicolai St, the only Major City Traffic (TSP Classification) street in the district, will reach 1.15. The northbound link on NW 23rd Ave south of NW Thurman St is also projected to become congested at link level in 2030. Even though the link capacity is only a generic coding for traffic assignment in the demand model, the conditions of V/C >1 are a clear indication that the traffic congestion could be a problem in the future base model.

Plot 9. 2005 PM 2-hour Assign Volumes

Table 9. PM2 traffic conditions on district streets

	2005	2030 base
Average Link Volumes	570	740
Total Veh-Miles	23,400	30,900
Total VHT[1] (h)	1050	1480
Congested streets		
# of links	5	14
miles	0.6	2.2
Veh-miles	780	5250
% of total v-m	3.3%	17.0%
Max V/C	1.43	1.58
Average V/C	1.22	1.26
VHD[2] (h)	48	260
% of total vhd	4.6%	17.5%

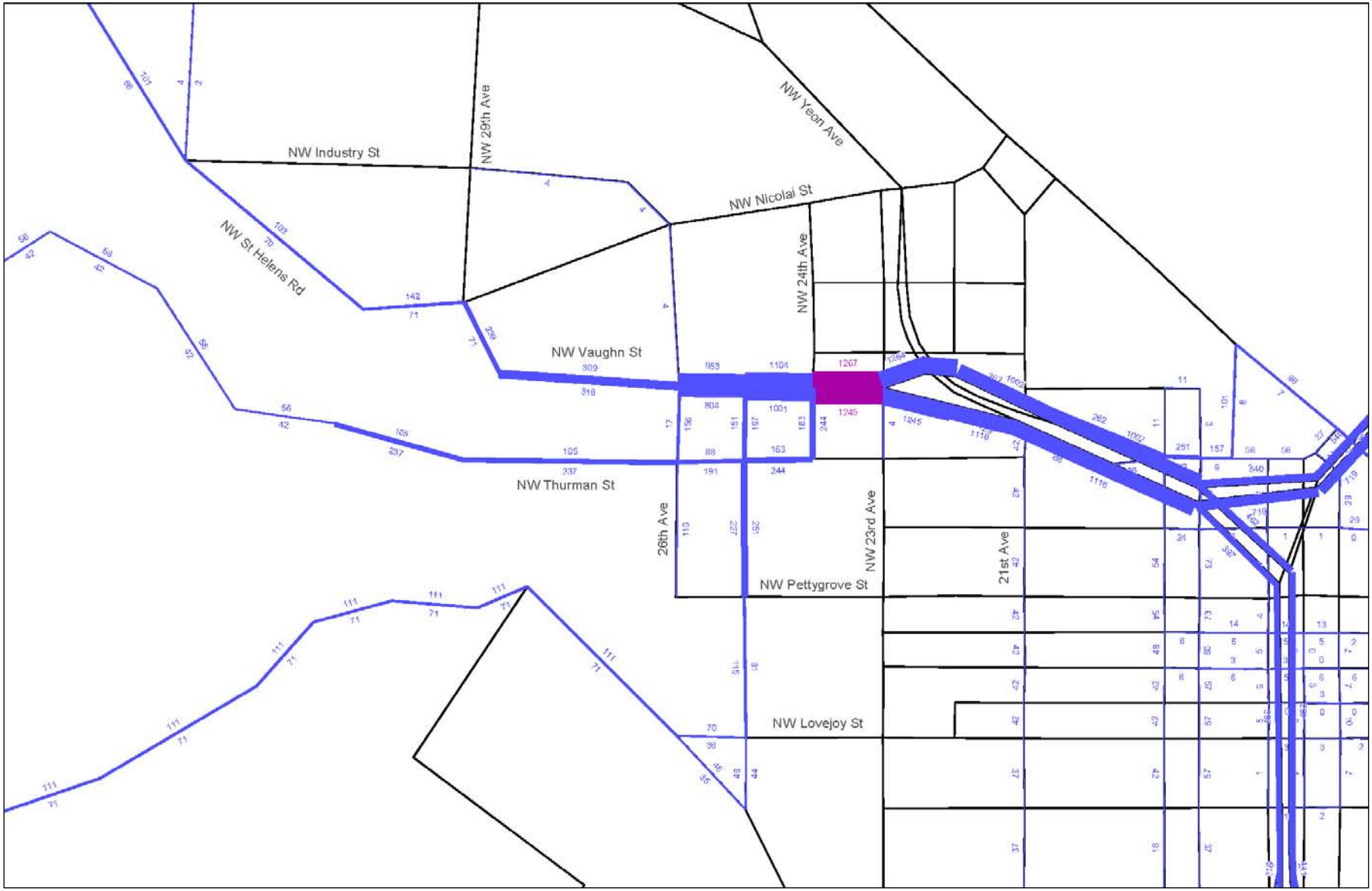
[1] VHT: Vehicle Hour Traveled = Volumes x Travel Time

[2] VHD: Vehicle Hour Delayed = Volumes x (Congestion Delay Time)

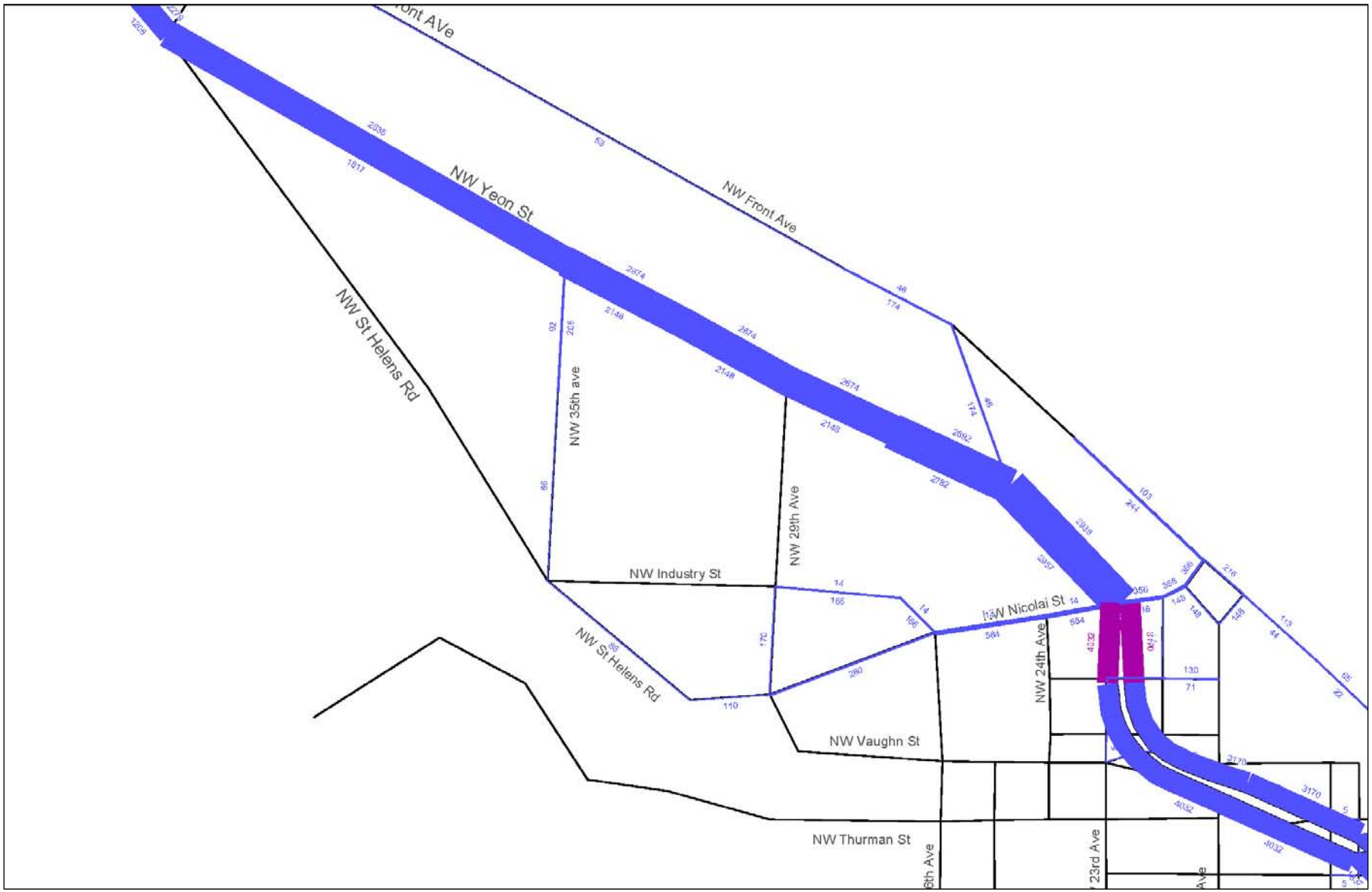
NW Vaughn St - The 2005 model indicates that NW Vaughn St has two main functions in the network. First, it functions as a Neighborhood Collector to distribute NWDP area traffic. Approximately 85 percent to 90 percent of the traffic on NW Vaughn St, west of NW 23rd Ave, originates or is destined primarily along NW Vaughn St (the area shown by the TAZs shown on Plot 1)or is distributed in the study area east of NW 29th Ave (See Plot 10). This means that only 10 to 15 percent of the total traffic in the NW Vaughn St corridor could be considered 'through' traffic (i.e., having neither an originations or destination in the corridor). NW Vaughn St is predicted to function roughly the same in 2030 model and the street function will remain consistent with its current TSP classification, Neighborhood Collector. Second, NW Vaughn St functions as the primary access route for connecting with I-405, which provides approximately 28 percent of the district's weekday PM peak 2-hour traffic demands. On the link west of NW 23rd Ave., approximately 80 percent of eastbound and 90 percent of westbound traffic are from and to the I-405 freeway, respectively. Therefore Vaughn has two functions in the street system – as a neighborhood collector and as the main access street to I-405.

By comparison, US-30 ramps in the area function in an almost entirely different role for the network (See Plot 11). The vast majority of traffic on US-30 ramps are through traffic with little relation with the district.

Plot 10. Volume Traces of the PM Peak 2-hour Vaughn Traffic

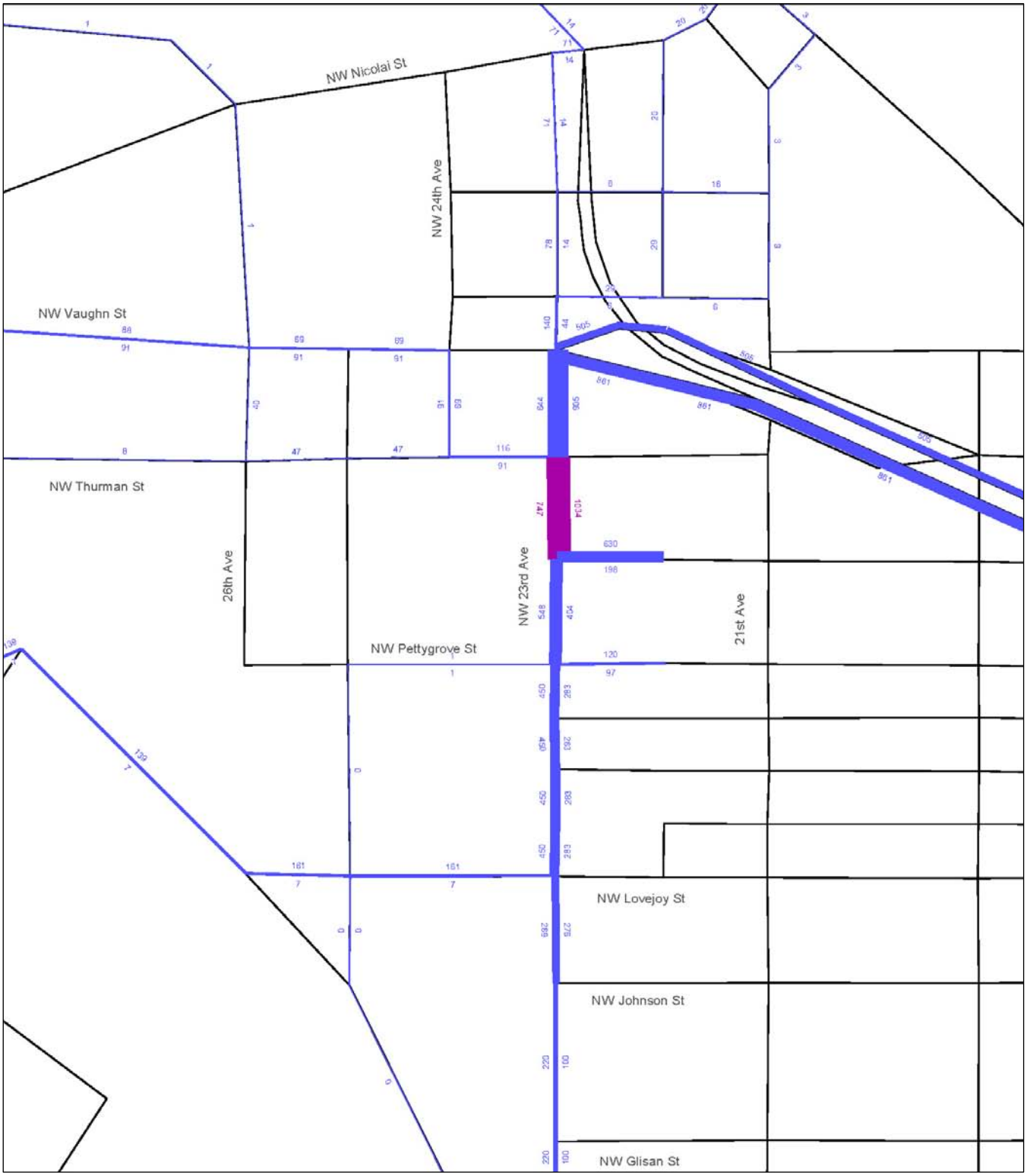


Plot 11. Volume Traces of the PM Peak 2-hour US-30 Traffic



NW 23rd Ave - NW 23rd Ave is another important Neighborhood Collector for traffic circulation in the NWDP area. The select link analysis (See Plot 12) indicates that about 40 percent of the traffic on NW 23rd Ave reaches south as far as to NW Lovejoy St. The 2030 PM2 base model projects that the V/C readings on the northbound link of NW 23rd Ave south of NW Thurman St will reach 1.01. The capacity coded for the street link is 600 vehicles per hour. With active commercial and heavy auto parkings along both sides of NW 23rd Ave, the narrow 2-lane street could operate at a more congested level than the demand model indicated.

Plot 12. PM Peak 2-hour Traffic Volume Traces for NW 23rd Ave



Traffic Operation Analysis

All traffic operations analyses at the intersection level are based on current signal timing plans.

Transportation Planning Rule compliance for ODOT facilities - The TPR requires that PBOT and Planning provide evidence of no significant impact to ODOT facilities resulting from the NWDP. An operational analysis of intersection capacity on the 2030 base scenario is presented here to provide background information for this assessment.

Table 10 shows district traffic usage of the freeway ramps in the NWDP vicinity. I-405 ramps at NW Vaughn St, at NW Everett St, and US-30 ramps at NW Nicolai St are the main freeway ramps used by NWDP area traffic. More specifically, the traffic conditions on the I-405 ramps at NW Vaughn and NW Everett Sts are significantly effected by the traffic coming and leaving the district. While the district's traffic on US-30 SB ramp reach 340 during PM peak 2-hours, the traffic condition is more impacted by the through traffic here since the district traffic is only 8.4 percent of the total traffic on the link.

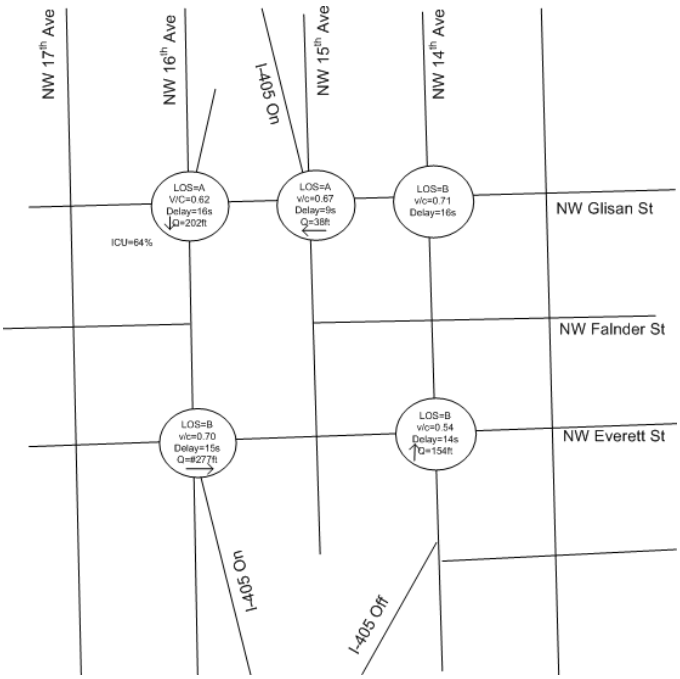
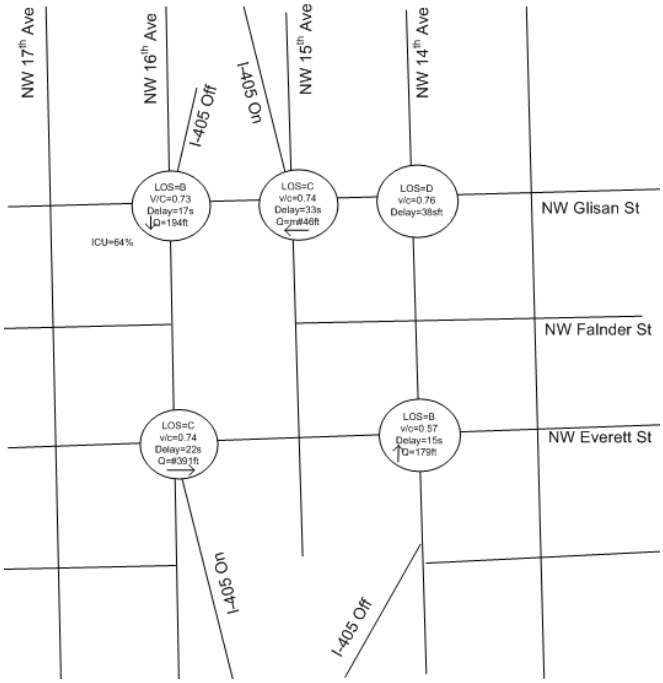
Table 10. 2005 PM Peak 2-Hour Freeway Ramp Usages of NWDP Remand Area traffic

	2005 PM2 conditions			Projected 2030 PM2 district Vol.
	District traffic	Total link volumes	%	
I-405 WB Exit @ Vaughn	1830	2400	76.3	1910
I-405 EB Entry @ Vaughn	2500	2950	84.7	2840
I-405 NB Exit @ Everett	710	2060	34.5	610
I-405 SB Entry @ Everett	680	2120	32.1	940
US30 NB Exit @Nicolai	90	3170	2.8	260
US30 SB Entry @ Nicolai	340	4030	8.4	220
I-405 NB Entry @ Glisan	70	920	7.6	70
I_405 SB Exit @ Glisan	100	705	14.2	120
I-405 SN Exit @ Couch	100	1340	7.5	120

Plots below show the results from the Synchro model for the freeway ramps mentioned above. All analyses are based on current signal timing plans on these streets. The 2005 model is based on traffic turning movement counts and the 2030 volume inputs are derived from the sum of the count and the volume delta between 2030 and 2005 demand models.

I-405 ramps: NW Glisan and NW Everett Sts - The analysis (See Plot 13) shows that all ramp intersections will be operate at the LOS (Level of Service) D or better and the maximum V/C is 0.76 during weekday PM peak hour in 2030. This performance meets City and ODOT mobility standards for these facilities.

Plot 13. Traffic Operation Analysis for Southern NW District Freeway Interchanges

2007 PM	2030 PM
	

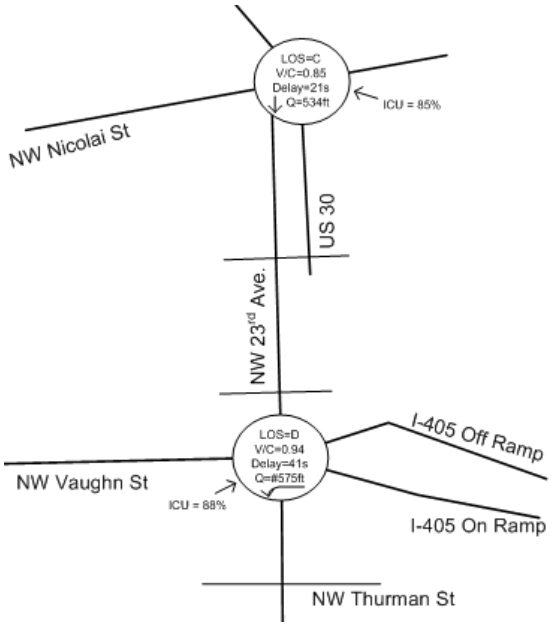
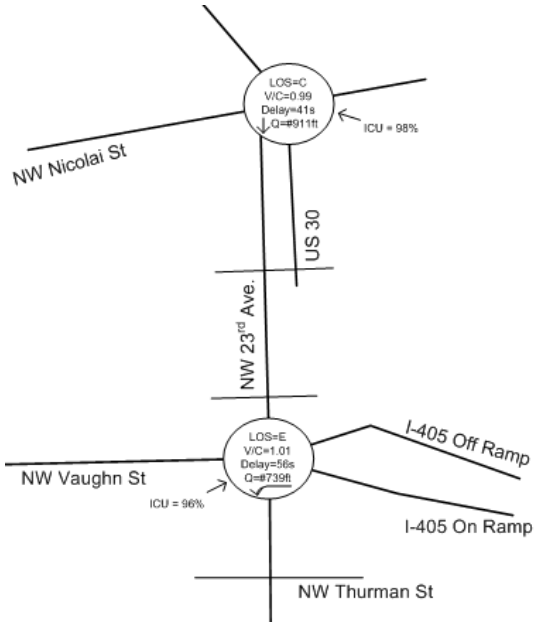
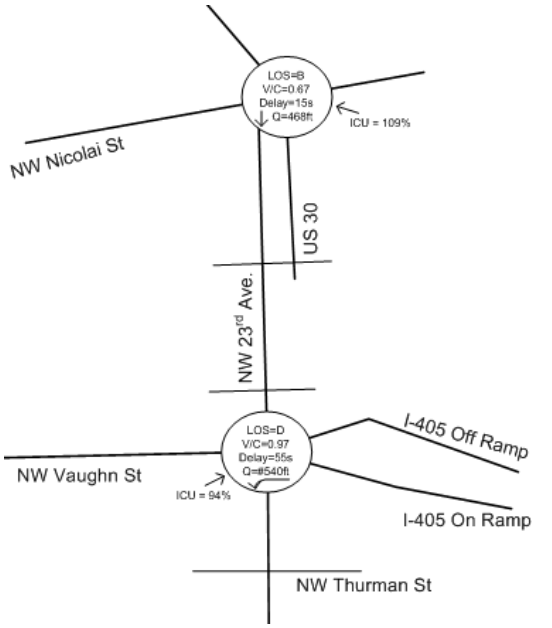
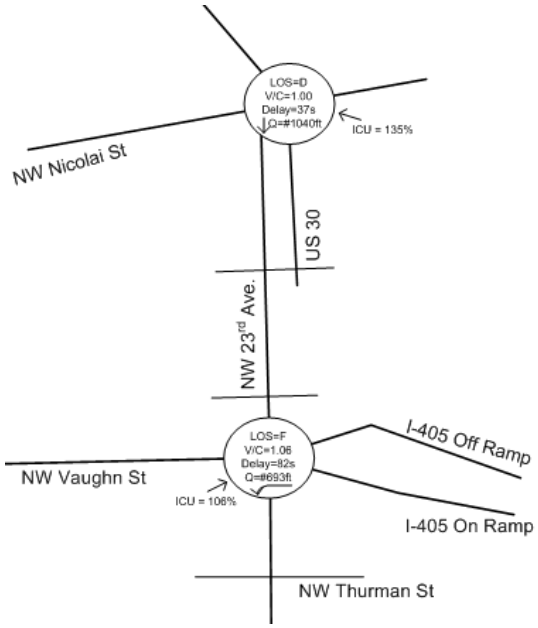
LOS = HCM Level Of Service
V/C = HCM Volume to Capacity ratio
Delay = Signal Average Control Delay
Q = 95th Queue length in feet
ICU= Intersection Cap Utilization

It is worth noting that the above 2030 PM LOS and V/C data are achieved with a slightly modified signal timing plan for the intersection of NW Glisan St at NW 15th Ave. The only modification to the timing plan is to change the offset time. With the current signal timing plan and the projected future traffic demands, the westbound traffic queue would be longer than the available storage length at the intersection. The modification effectively reduces the westbound queue at the intersection and results in significant improvements on the operation conditions of all intersections along NW Glisan St.

I-405 ramps: NW Vaughn and US-30 ramp at NW Nicolai St - AM peak hour traffic conditions were also analyzed for these two intersections / interchanges. This analysis was conducted in order to address concerns that traffic operations at the AM peak could be worse then the PM peak at these intersections. The AM 2-hour demand is a simple modeling exercise conducted by transposing the PM 2-hour vehicle demands on AM operating conditions. No further calibration is necessary to evaluate the AM 2-hour assignments. The analysis for existing conditions is based on current traffic turning movement counts, and the future condition is based on the sums of the counts and the projected traffic growths. This approach is the same as that used for the PM analysis. The two signals at the intersections are full actuated and uncoordinated signals.

The analysis shows that the two ramp intersections are currently operated at the LOS D or better with the maximum V/C of 0.97 during weekday peak hours, and their operation condition is projected to deteriorate to LOS F with a V/C readings of 1.06 in 2030 PM peak hour (See plots below). Although the projected operational conditions will be below both PBOT and ODOT mobility standards of LOS E or better and V/C<=0.99, respectively, for these facilities, ODOT has determined that there is no significant impact on the planned function and performance of the State facility, I-405. PBOT does however recommend re-striping the off-ramp to facilitate additional turning movements that will relieve the queueing pressure at the intersection and bring the facility to within city mobility standards for these facilities. Please see Exhibit B to this report for a description, drawing and cost estimate of this improvement.

Plot 14. Traffic Operation Analysis for Northern NW District Freeway Interchange

	2007	2030
AM		
PM		

The operating conditions at the intersection of US-30 at NW Nicolai St in future peak hours are projected to be within PBOT's and ODOT's mobility standard excepting the V/C reading (1.0). It is worth noting that the traffic at this intersection will be mostly through traffic. Since the model projects the longest queue will be at the north leg (southbound approach) on NW Yeon St, it is determined that the queuing would not cause any problems for freeway traffic operations.

The potential increased traffic volumes for the facilities and intersections described above are all projected based on the 2030 model and includes the re-zonings and comprehensive plan changes contained within the NWDP Ordinance. Based on this analysis, PBOT does not expect that the NWDP would significantly further downgrade the operational conditions to these two intersections. This expectation assumes certain signal timing improvements as described in Exhibit B to this report.

Conclusion

The purpose of this transportation analysis is to determine whether the land uses allowed by the NWDP Ordinance would change the predominant type of traffic on NW Vaughn St in a manner inconsistent with its functional classification as a neighborhood collector; and to determine whether the NWDP Ordinance will reduce the performance standards of the NW Vaughn St/NW 23rd Ave intersection and the Interstate 405 (I-405) off-ramp below the minimum acceptable level identified in the City of Portland's Transportation System Plan.

First, PBOT's analysis of the existing conditions shows that approximately 85 percent to 90 percent of the traffic on NW Vaughn St, west of NW 23rd Ave, originates in the area along NW Vaughn St east of NW 29th Ave. NW Vaughn St is predicted to function roughly the same in 2030 and the street function will remain consistent with its current TSP classification, Neighborhood Collector. Therefore, the NWDP Ordinance will not change the predominant traffic type in a manner inconsistent with NW Vaughn St's functional classification.

Second, ODOT has determined that there is no significant impact on the planned function and performance of the State facility, I-405, and therefore Transportation Planning Rule OAR 660-012-0060, section -060 does not apply. ODOT does not have a position on potential significant affects to the planned capacity or function of City transportation facilities.

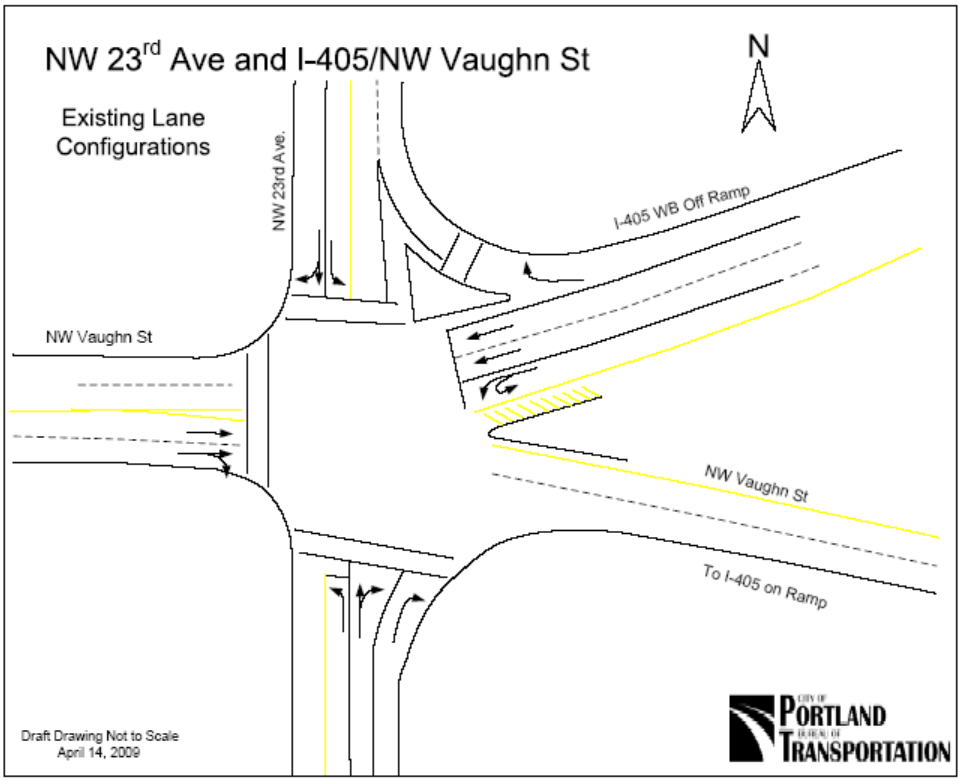
PBOT's analysis demonstrates that the NWDP Ordinance may result in traffic conditions that reduce performance of the NW 23rd Ave intersection below the minimum acceptable City levels for this type of facility. Therefore, as development occurs, mitigation is required to improve the operation of the intersection. With implementation of the remediation efforts described in Exhibit B to this report, the intersection will meet city operating standards for this type of facility.

Appendix C
Proposed improvements to the I-405 interchange at NW Vaughn Street and NW 23rd Avenue

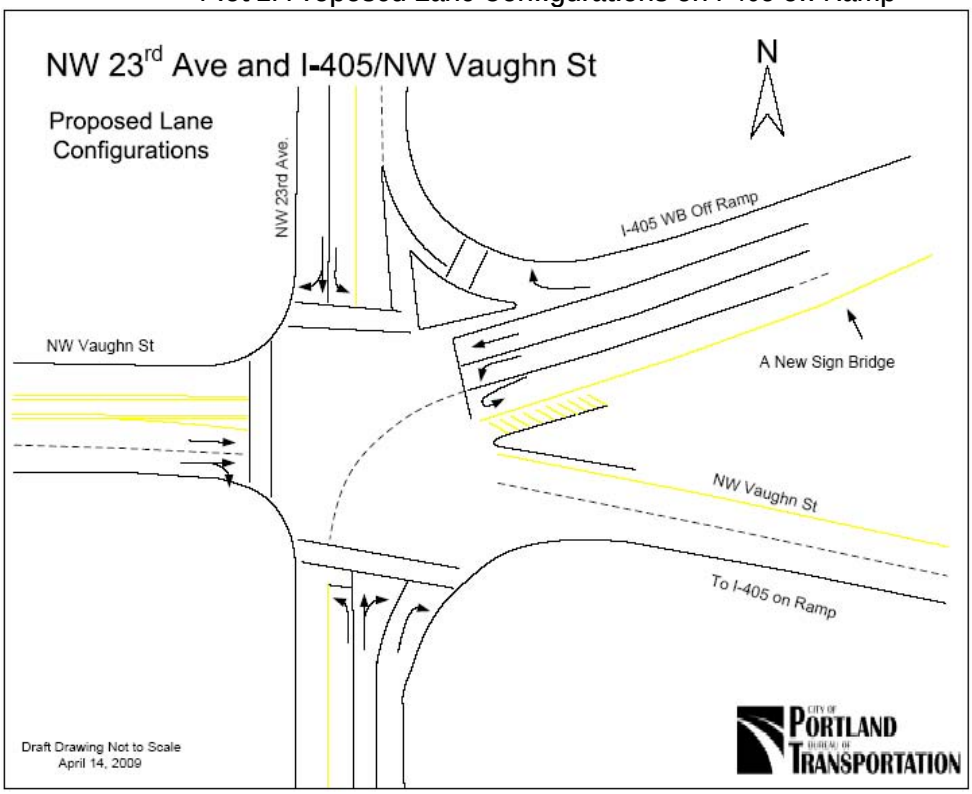
The Northwest District Plan (NWDP) transportation analysis has identified that future traffic operation conditions at the interchange of I-405 ramps/ NW Vaughn St and NW 23rd Ave will deteriorate below the city's acceptable mobility standard for this facility (i.e., whether the intersection is operating at less than LOS E). Further analysis indicates that this intersection's operational condition could be improved with a modest re-configuration of the I-405 off ramp and re-striping on NW Vaughn St.

Currently, the I-405 off ramp consists of one left-turn lane, two through-lanes and one channelized right-turn lane (See Plot 1). The preliminary analysis found that the ramp could be re-configured to include one u-turn lane, one left-turn lane and one through-lane while maintaining the channelized right-turn lane (See Plot 2). This reconfiguration would allow the intersection to operate at LOS E or better with a maximum of V/C at 0.97, meeting PBOT's mobility standards for the facility as well as maintaining the current level of service.

Plot 1. Existing Lane Configurations on I-405 off Ramp



Plot 2. Proposed Lane Configurations on I-405 off Ramp



Again, the re-configuration consists of changing one through lane into a left-turn lane and changing the currently combined left-/U-turn lane into a U-turn only lane. Consequently, other improvements associated with the lane re-configurations are required, which include but may not be limited to the following:

- New lane-use skip stripes
- Increased/decreased length of deceleration lanes
- Re-striping the westbound receiving lane on NW Vaughn St from two lanes to one lane
- New signal timing plan
- New signal heads
- New signal detectors
- New freeway overhead sign bridge (guide sign for bridge drivers) to indicate new lane-use
- Modification of the existing freeway overhead sign bridge to reflect lane-use changes
- New pavement markings
- Pedestrian improvements

Based on initial engineering estimates of the concept plan (i.e., without detailed engineering design parameters), today's cost of the above described improvements would be approximately $199,000. The cost estimate covers construction, design, management, overhead and includes significant contingency.

Without a detailed traffic engineering study, it is impossible to set the precise parameters of the improvements such as the lengths of the lanes or the number of detectors. As such, the above drawing and cost estimate is provided only to illustrate the main mitigation concepts and the order of

magnitude costs associated with them. It is important to note that since ODOT has jurisdiction over the freeway I-405 Ramps, all proposed changes will require ODOT's review and approval. It is also worth noting that these improvements will be implemented as future real property development occurs. Should these developments and/or traffic impacts fail to materialize, these improvements may not be necessary or constructed.

In summary, the proposed mitigation measures described above will improve traffic operations at the interchange to meet PBOT's mobility standard for these facilities. Transportation System Plan Project (TSP) # 60027 – 23d/AVaughn, NW: Intersection Improvements (page 3-72 of the TSP) incorporates these improvements. Additional project details as outlined inthis Exhibit B will be included as an appendix in the adopting ordinance.

For additional detail regarding the existing and future performance of the facility, see Table 1. PBOT's mobility standard is to operate the intersection at LOS E or better during peak 2-hour periods.

Table 1. Comparison of Traffic Operation conditions

Scenario	2007PM	2030PM	2030PM with Improvements
Total Volumes (vph)	3020	3370	3370
LOS*	D	F	E
Delay (s/veh)	54.9	81.8	58.3
Volume / Capacity	0.97	1.06	0.97

*Represents peak 1-hour Level of Service (LOS)

Timeline for Mitigation Project Improvements

As part of the analysis for the mitigation project, staff completed a trend line analysis to get a sense of when the Mitigation Project intersection improvements might be needed. The calculation is based on the straight line interpretation of each traffic movement at the intersection between 2007 and 2030 in the NW Remand model. No signal timing settings or lane layouts were modified in this exercise.

Through this exercise it was determined that the intersection would reach a V/C of 1.02 (LOS E) in 2015 and a V/C of 1.11 (LOS F) in 2029, both of which are above the city's level of service standard. Based on this exercise, the City traffic engineering staff recommends that the Mitigation Project improvements be made at the intersection between 2015 and 2020. Because this analysis is based on long range planning models and development assumptions which may not hold true, the Bureau of Planning and Sustainability and the Bureau of Transportation will conduct additional analysis in 2015 to establish the level of service at the intersection and determine when it would be appropriate to add the project to the city's Capital Improvement Program (CIP).

Table 2. Trend Line Analysis

	2007	2015	2020	2025	2028	2029	2030
Total Vol	3035	3155	3230	3310	3355	3370	3385
TCM	1310	1380	1425	1470	1495	1505	1513
MAX V/C	0.99	1.05	1.12	1.18	1.23	1.24	1.25
Int V/C	0.97	1.02	1.05	1.09	1.11	1.11	1.12
Int Delay	56.2	63.4	68.9	75.2	79.4	80.7	82
LOS	E	E	E	E	E	F	F

TCM = Total Critical Movements for the intersection

MAX V/C = biggest Volume/Capacity reading among all turn movements

int V/C = HCM intersection Volume / Capacity ratio

int delay = HCM average intersection control delay

LOS = HCM Level of Service

HCM = Highway Capacity Manual

HCM Signalized Intersection Capacity Analysis 2007PM

I-405 Ramp/Vaughn St @ NW 23rd Ave

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		0.95			1.00	0.95	1.00	1.00	0.95	0.95	1.00	1.00
Frpb, ped/bikes		0.99			1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.99			1.00	1.00	0.85	1.00	0.87	0.85	1.00	0.97
Flt Protected		1.00			0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3482			1770	3539	1583	1770	1536	1504	1770	1788
Flt Permitted		1.00			0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		3482			1770	3539	1583	1770	1536	1504	1770	1788
Volume (vph)	0	690	55	170	265	605	170	145	45	645	160	70
Peak-hour factor, PHF	0.95	0.95	0.95	0.92	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	726	58	185	279	637	179	153	47	679	168	74
RTOR Reduction (vph)	0	5	0	0	0	0	84	0	0	0	0	7
Lane Group Flow (vph)	0	779	0	0	464	637	95	153	386	340	168	83
Confl. Peds. (#/hr)	1		16		16		1	40				
Turn Type				Prot	Prot		Prot	Prot		Prot	Prot	
Protected Phases		2		1	1	6	6	3	8	8	7	4
Permitted Phases												
Actuated Green, G (s)		25.9			29.0	58.9	58.9	20.7	28.8	28.8	11.0	19.1
Effective Green, g (s)		25.9			29.0	58.9	58.9	20.7	28.8	28.8	11.0	19.1
Actuated g/C Ratio		0.23			0.26	0.53	0.53	0.19	0.26	0.26	0.10	0.17
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		815			464	1883	842	331	400	391	176	308
v/s Ratio Prot		c0.22			c0.26	0.18	0.06	0.09	c0.25	0.23	c0.09	0.05
v/s Ratio Perm												
v/c Ratio		0.96			1.00	0.34	0.11	0.46	0.96	0.87	0.95	0.27
Uniform Delay, d1		41.8			40.8	14.8	12.9	40.0	40.5	39.2	49.6	39.7
Progression Factor		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		21.2			41.8	0.1	0.1	1.0	35.6	18.2	54.2	0.5
Delay (s)		63.0			82.6	14.9	13.0	41.1	76.1	57.3	103.8	40.2
Level of Service		E			F	B	B	D	E	E	F	D
Approach Delay (s)		63.0				39.2			62.7			81.6
Approach LOS		E				D			E			F

Intersection Summary			
HCM Average Control Delay	54.9	HCM Level of Service	D
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	110.7	Sum of lost time (s)	16.0
Intersection Capacity Utilization	93.9%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Volume (vph)	15
Peak-hour factor, PHF	0.95
Adj. Flow (vph)	16
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	40
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

HCM Signalized Intersection Capacity Analysis

2030PM w/ Improvement

I-405 Ramp/Vaughn @ NW 23rd Ave

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0		4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		0.95		1.00	1.00	1.00	1.00	1.00	0.95	0.95	1.00	1.00
Frpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.99		1.00	1.00	1.00	0.85	1.00	0.87	0.85	1.00	0.98
Flt Protected		1.00		0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3487		1770	1770	1863	1583	1770	1534	1504	1770	1801
Flt Permitted		1.00		0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		3487		1770	1770	1863	1583	1770	1534	1504	1770	1801
Volume (vph)	0	790	55	185	320	655	170	145	45	705	210	90
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	832	58	195	337	689	179	153	47	742	221	95
RTOR Reduction (vph)	0	4	0	0	0	0	0	0	0	0	0	5
Lane Group Flow (vph)	0	886	0	195	337	689	179	153	418	371	221	106
Confl. Peds. (#/hr)	1		16		16		1	40				
Turn Type				Prot	Prot		custom	Prot		Prot	Prot	
Protected Phases		2		1	1	6	3 4 6!	3	8!	8	7	4
Permitted Phases												
Actuated Green, G (s)		31.9		23.0	23.0	58.9	119.9	14.9	33.0	33.0	16.0	34.1
Effective Green, g (s)		31.9		23.0	23.0	58.9	119.9	14.9	33.0	33.0	16.0	34.1
Actuated g/C Ratio		0.27		0.19	0.19	0.49	1.00	0.12	0.28	0.28	0.13	0.28
Clearance Time (s)		4.0		4.0	4.0	4.0		4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0		3.0	3.0	3.0		3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		928		340	340	915	1583	220	422	414	236	512
v/s Ratio Prot		c0.25		0.11	c0.19	0.37	c0.11	0.09	c0.27	0.25	c0.12	0.06
v/s Ratio Perm												
v/c Ratio		0.95		0.57	0.99	0.75	0.11	0.70	0.99	0.90	0.94	0.21
Uniform Delay, d1		43.3		44.0	48.3	24.6	0.0	50.3	43.3	41.8	51.4	32.6
Progression Factor		1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		19.2		2.3	46.3	3.5	0.0	9.2	41.2	21.2	41.0	0.2
Delay (s)		62.5		46.3	94.6	28.2	0.0	59.5	84.5	63.1	92.5	32.8
Level of Service		E		D	F	C	A	E	F	E	F	C
Approach Delay (s)		62.5				43.1			72.0			72.5
Approach LOS		E				D			E			E

Intersection Summary			
HCM Average Control Delay	58.3	HCM Level of Service	E
HCM Volume to Capacity ratio	0.97		
Actuated Cycle Length (s)	119.9	Sum of lost time (s)	16.0
Intersection Capacity Utilization	88.0%	ICU Level of Service	E
Analysis Period (min)	15		

! Phase conflict between lane groups.

c Critical Lane Group

Movement	SBR
Lane Configurations	
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Volume (vph)	15
Peak-hour factor, PHF	0.95
Adj. Flow (vph)	16
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	40
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

HCM Signalized Intersection Capacity Analysis 2030 PM2

I-405 Ramp/Vaughn St @ NW 23rd Ave

Movement	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Lane Util. Factor		0.95			1.00	0.95	1.00	1.00	0.95	0.95	1.00	1.00
Frpb, ped/bikes		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
Flpb, ped/bikes		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt		0.99			1.00	1.00	0.85	1.00	0.87	0.85	1.00	0.98
Flt Protected		1.00			0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (prot)		3487			1770	3539	1583	1770	1534	1504	1770	1801
Flt Permitted		1.00			0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Satd. Flow (perm)		3487			1770	3539	1583	1770	1534	1504	1770	1801
Volume (vph)	0	790	55	185	320	655	170	145	45	705	210	90
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	0	832	58	195	337	689	179	153	47	742	221	95
RTOR Reduction (vph)	0	5	0	0	0	0	81	0	0	0	0	5
Lane Group Flow (vph)	0	886	0	0	532	689	98	153	418	371	221	106
Confl. Peds. (#/hr)	1		16		16		1	40				
Turn Type				Prot	Prot		Prot	Prot		Prot	Prot	
Protected Phases		2		1	1	6	6	3	8	8	7	4
Permitted Phases												
Actuated Green, G (s)		30.0			32.0	66.0	66.0	14.7	29.0	29.0	13.0	27.3
Effective Green, g (s)		30.0			32.0	66.0	66.0	14.7	29.0	29.0	13.0	27.3
Actuated g/C Ratio		0.25			0.27	0.55	0.55	0.12	0.24	0.24	0.11	0.23
Clearance Time (s)		4.0			4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vehicle Extension (s)		3.0			3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		872			472	1946	871	217	371	363	192	410
v/s Ratio Prot		c0.25			c0.30	0.19	0.06	0.09	c0.27	0.25	c0.12	0.06
v/s Ratio Perm												
v/c Ratio		1.02			1.13	0.35	0.11	0.71	1.13	1.02	1.15	0.26
Uniform Delay, d1		45.0			44.0	15.1	13.0	50.6	45.5	45.5	53.5	38.1
Progression Factor		1.00			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		34.4			81.1	0.1	0.1	10.0	85.7	53.0	111.5	0.3
Delay (s)		79.4			125.1	15.2	13.0	60.5	131.2	98.5	165.0	38.4
Level of Service		E			F	B	B	E	F	F	F	D
Approach Delay (s)		79.4				56.7			106.8			122.7
Approach LOS		E				E			F			F

Intersection Summary			
HCM Average Control Delay	81.8	HCM Level of Service	F
HCM Volume to Capacity ratio	1.06		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	105.7%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	SBR
Lane Configurations	
Ideal Flow (vphpl)	1900
Total Lost time (s)	
Lane Util. Factor	
Frpb, ped/bikes	
Flpb, ped/bikes	
Frt	
Flt Protected	
Satd. Flow (prot)	
Flt Permitted	
Satd. Flow (perm)	
Volume (vph)	15
Peak-hour factor, PHF	0.95
Adj. Flow (vph)	16
RTOR Reduction (vph)	0
Lane Group Flow (vph)	0
Confl. Peds. (#/hr)	40
Turn Type	
Protected Phases	
Permitted Phases	
Actuated Green, G (s)	
Effective Green, g (s)	
Actuated g/C Ratio	
Clearance Time (s)	
Vehicle Extension (s)	
Lane Grp Cap (vph)	
v/s Ratio Prot	
v/s Ratio Perm	
v/c Ratio	
Uniform Delay, d1	
Progression Factor	
Incremental Delay, d2	
Delay (s)	
Level of Service	
Approach Delay (s)	
Approach LOS	
Intersection Summary	

Project Estimate Report: Development Phase

for

Fremont Br – Vaughn St Ramp

4/8/09

Requested by: Ningsheng Zhou **Prepared by:** Jennie Tower & Nelson Chi

Location: Fremont Br – Vaughn St Ramp from NW 21st Pl to NW 23rd Pl

Description: Traffic signal and lane alterations for Fremont Br–Vaughn St ramp at NW 23rd Ave

Current Cross-Section: From south to north: sharp left/soft left – thru – thru – right

Proposed Cross-Section: From south to north: sharp left – soft left – thru – right

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Issues: (*describe issues, or indicate "none identified"*)

- Water – None identified
- BES (storm, sanitary, water-quality facilities) – None identified
- Signals and Street Lighting – Alterations necessary
- Environmental and Zoning (OPDR; Army Corp of Engineers; Division of State Lands) – None identified
- Contaminated Media – None identified
- Right-of-Way Needs – None identified
- Railroads (BNSF; UPRR; PTTR) – None identified
- Parks (landscaping and irrigation) – None identified
- Other Jurisdictions (counties, schools, Port, ODOT, Tri-Met) – Will need ODOT approval

Cost Estimate:

(Estimates greater than $10,000 round numbers to the nearest $1,000; for less than $10,000 round to the nearest $100)

Construction	$ 70,000
Project Management (5%)	$ 3,500
Design Engineering (25%)	$ 17,000
Construction Management (15%)	$ 11,000
Right-of-Way (Cost + 20% Contingency)	-
Overhead (68.46%)	$ 21,000
Estimate Contingency	$ 77,000

Total Project Estimate: $ 199,000

Estimating Assumptions:

(*Written explanation of contingencies, variations from the base unit prices and why*)

- Existing sign bridge will not need to be relocated.
- New sign bridge will need to be installed.

Review & Approval:

Reviewed by Engineer of Record Date

Reviewed and Approved by Engineering Services Division Manager Date

Attachments:

- Detailed estimate spreadsheet
- Site map