King County
Department of
Natural Resources and Parks
Solid Waste Division

TRAFFIC IMPACT ANALYSIS
FACTORIA RECYCLING AND TRANSFER STATION REPLACEMENT PROJECT

Final
January 2012

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FACTORIA RECYCLING AND TRANSFER STATION
REPLACEMENT PROJECT

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Acronyms and Abbreviations

AWSC	All Way Stop Controlled
BKR	Bellevue-Kirkland-Redmond
CH	commercially-hauled
CHRLF	Cedar Hills Regional Landfill
CIP	Capital Investment Program
Factoria RTS	Factoria Recycling and Transfer Station Replacement Project
GFA	Gross Floor Area
HCM	*Highway Capacity Manual*
HHW	household hazardous waste
HOV	high-occupancy vehicle
ITE	Institute of Transportation Engineers
LOS	Level of Service
LUC	land use code
MMA	Mobility Management Areas
OWSC	One Way Stop Controlled
PSE	Puget Sound Energy
PSRC	Puget Sound Regional Council
SEPA	State Environmental Policy Act
SH	self-hauled
TIA	transportation impact analysis
V/C	volume to capacity

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Executive Summary

This report documents the transportation impact analysis (TIA) performed for the proposed Factoria Recycling and Transfer Station (RTS) Replacement Project located in King County and the City of Bellevue, Washington. As required by City of Bellevue codes and state environmental law (State Environmental Policy Act [SEPA]), it describes the analysis of potential impacts on the transportation infrastructure associated with expansion of the existing Factoria RTS, and recommends mitigation, if necessary, for those impacts. This study reviews the anticipated traffic characteristics of the proposed project and provides an assessment of operating conditions of the transportation infrastructure serving the project site, both with and without the proposed expansion.

The Factoria RTS one of the eight existing King County transfer stations where waste is collected and transferred into large tractor-trailers. Commercial haulers as well as business and residential self-haul customers use the transfer station. The Factoria RTS was constructed in the 1960s and is nearing the end of its useful life. It is anticipated that the regional landfill that receives waste from the Factoria RST will continue to accept waste until approximately 2019. After that time, it is expected that waste will be exported to an out-of-county or out-of-state landfill.

Currently, the site is accessed from the SE 32nd Street/Richards Road intersection by all customers and the facility transfer haulers. In the future, facility transfer haulers will use the SE 30th Street/Richards Road intersection for ingress to and egress from the facility, while all customers will continue to use the SE 32nd Street/Richards Road intersection for ingress to and egress from the facility. Thus, the updated Factoria RTS layout will separate the facility transfer hauler trips from the commercial and self-hauler trips. The site will be improved to accommodate the growing demands of local and regional population growth. At the same time, operational improvements will be provided for enhanced compaction of solid waste to reduce the number of facility transfer haulers trips to and from the site. The number of facility transfer hauler trips will initially be reduced after the compaction improvements are completed; however, as the tonnage of waste processed increases in the future, the number of transfer hauler trips will slightly increase.

Level of Service (LOS) analyses were conducted at four study intersections during the PM peak hour for various conditions. The primary results of the analysis are as follows:

- All the study intersections operate at LOS D or better in 2010.
- In 2014 without-project conditions, all study intersections will operate at LOS C or better.
- In 2014 with-project conditions, all study intersections will operate at LOS C or better.
- In 2014 with-project conditions, a net of 12 new trips from the proposed Factoria RTS will not warrant a concurrency test.
- During construction prior to 2014, all signalized intersections will operate at LOS C or better.
- In 2014, it is estimated that the tonnage of solid waste disposal will increase from the current 500 to 550 tons per day to approximately 600 tons per day.

- In 2042, it is estimated that the tonnage of solid waste disposal will increase to approximately 900 tons per day.
- In 2042 without-project conditions, the Richards Road/SE 32nd Street intersection will operate at LOS E with a 1.15 volume to capacity (V/C) ratio, and the Richards Road/SE Eastgate Way intersection will operate at LOS D with a 1.34 V/C ratio.
- For the 2042 with-project conditions, the intersections of Richards Road/SE 32nd Street and Richards Road/SE Eastgate Way will experience an increase of 0.02 in the V/C ratios. All signalized intersections were calculated to operate at the same LOS as the without-project conditions.

In 2042, all the study intersections will remain at the same LOS without and with the proposed Factoria RTS improvements. The V/C ratios remained constant for the 2014 analysis and increased by a maximum of 0.02 for the 2042 analysis. As a result of the minor changes, no mitigation is necessary for this development.

1.0 Introduction

This report documents the transportation impact analysis (TIA) performed for the Factoria Recycling and Transfer Station (RTS) Replacement Project located in King County and the City of Bellevue (City), Washington. As required by City of Bellevue codes and state environmental law (State Environmental Policy Act [SEPA]), it describes the analysis of potential impacts on the transportation infrastructure associated with expansion of the existing Factoria RTS, and recommends mitigation, if necessary, for those impacts. This study reviews the anticipated traffic characteristics of the proposed project and provides an assessment of operating conditions on the transportation infrastructure serving the project site both with and without the proposed expansion.

1.1 Project Location and Description

The Factoria RTS is one of the eight existing County transfer stations where waste is collected, transferred into large tractor-trailers, and subsequently hauled to the Cedar Hills Regional Landfill (CHRLF) in Maple Valley, Washington. Commercial haulers as well as business and residential self-haul customers use the transfer station. The Factoria RTS was constructed in the 1960s and is nearing the end of its useful life.

The County intends to maintain operation of the existing transfer station during construction of its replacement on adjacent property. The updated Factoria RTS will include the following features:

- New enclosed solid waste transfer and processing area
- New employee/administration facility
- Replace scalehouse with weigh station plaza
- New fueling facility
- New maintenance shop
- Replace household hazardous waste (HHW) collection area
- New recycling facility
- New vactor truck decant area

Construction of the new facilities is planned to occur in four phases to limit disruption to site operations.

The existing transfer station is situated on an approximately 8.7-acre parcel that is constrained by steep topography, wetlands, streams, and a large utility corridor easement occupied by Olympic Pipeline high-pressure liquid petroleum lines and Puget Sound Energy (PSE) overhead power lines. The transfer station operation and HHW collection are contained within one large canopy on the site. SE 32nd Street terminates at the existing transfer station entrance, where a small scalehouse is located to weigh vehicles entering and exiting the site. To maintain existing operations, the County purchased adjacent property northwest of the site that contains two warehouse buildings and will process a boundary line adjustment to increase the total size of the project site to approximately 15.2 acres. **Figure 1-1** shows the site vicinity.

Waste collected within King County is hauled to the transfer stations and drop boxes, transferred into large facility transfer haulers, and then hauled to the CHRLF, as mentioned above. It is anticipated that the regional landfill will continue to accept waste until approximately 2019. After that time, it is expected that waste will be exported to an out-of-county or out-of-state landfill.

The transfer station is open between 6:30 AM and 4:00 PM Monday through Friday, and between 8:30 AM and 5:30 PM on weekends. The site is open to commercial haulers, residential self-haulers, and business self-haul customers. Currently, the site is accessed from the SE 32nd Street/Richards Road intersection by all customers and facility transfer haulers. In the future, facility transfer haulers will use the SE 30th Street/Richards Road intersection for ingress to and egress from the facility, while customers will continue to use the SE 32nd Street/Richards Road intersection for ingress to and egress from the facility. Thus, the updated Factoria RTS layout will separate the facility transfer hauler trips from the commercial and self-hauler trips.

The facility transfer haulers drive approximately 10 minutes to enter I-405 from Factoria Boulevard SE. Several different haul routes were studied and the results were summarized in a technical memorandum (see **Appendix D**). The study indicated that the transfer haulers are currently using the most efficient haul route between the site and the interstate.

The site will be improved to accommodate the growing demands from local and regional population growth. At the same time, operational enhancements will be provided for enhanced compaction of solid waste to reduce the number of facility transfer hauler trips to and from the site. The number of facility transfer hauler trips will initially be reduced after the compaction improvements are completed; however, as the tonnage of waste processed increases in the future, the number of transfer hauler trips will slightly increase.

Figure 1-1. Site Vicinity

1.2 Study Approach

Most agencies require analysis of the weekday PM peak hour because it is typically the time period when the local street system is experiencing the highest volumes and the worst operations. Although the peak traffic associated with King County transfer stations does not occur during the weekday PM peak hour, the total volume on the local street system will likely be higher during the weekday PM peak hour than during an hour when demand is highest for a transfer station (typically on a weekend). For this reason, traffic impact was analyzed for the weekday PM peak hour at each of the study intersections.

The study area for the project encompasses the major intersections providing access to the site. These signalized intersections were analyzed using the traffic operation analysis tool Synchro. The four intersections included in this analysis are as follows:

- Richards Road/SE 30th Street
- Richards Road/SE 32nd Street
- Richards Road/SE Eastgate Way
- Richards Road/SE 36th Street

The following sections document the existing, future without-project (baseline), and future with-project conditions in the study area. Project impacts are identified by comparing with-project conditions against without-project conditions. The impacts that will occur due to traffic pattern changes during the construction phase are also identified and analyzed.

2.0 Existing Conditions

This section describes the condition of the existing traffic network throughout the study area. This will serve as the foundation from which future traffic conditions are forecasted and evaluated. The following paragraphs describe the roadway network vicinity, existing traffic volumes, and operations.

2.1 Roadway Network

The project is directly served from Richards Road by SE 32nd Street. New access will be provided by SE 30th Street from Richards Road. Other roadways that will be used by traffic to and from the proposed project include I-90, SE 36th Street, Factoria Boulevard SE, and SE Eastgate Way. It is anticipated that these roadways will accommodate a majority of the Factoria RTS users and, in doing so, could experience potential project impacts.

I-90 is an east–west interstate freeway facility providing regional access to the area. It has four lanes (three general-purpose lanes and one high-occupancy vehicle [HOV] lane in both directions). Richards Road is classified as a major arterial street, providing access to I-90. It bridges the northeast side of the I-90/I-405 interchange with the southeast side. It is a five-lane facility near the project site, providing left-turn lanes at each of the study intersections. Factoria Boulevard SE is classified as a minor arterial street, providing connections between major arterials and residential and commercial activities. SE 36th Street and SE Eastgate Way are collector arterial streets providing traffic circulation and distribution of vehicles from the arterial or freeway system to local roads. SE 32nd Street and SE 30th Street are local streets that serve short-distance vehicular trips from adjacent industrial areas. **Figure 2-1** illustrates the existing roadway network, including traffic control and channelization in the study area.

2.2 Traffic Volumes

Existing PM peak hour traffic counts were obtained from the City of Bellevue 2009 traffic databank. Most of the counts were conducted in 2008. Count data are presented in **Appendix A**. Although the study area is already built out and historical data since 2007 show no growth in the PM peak hour volumes, to be conservative, year 2008 traffic volumes were increased straight-line at an annual growth rate of 2% to estimate year 2010 traffic volumes. Based on the 4:00 to 6:00 PM count data, the PM peak hour was determined to occur between 4:30 and 5:30 PM. The traffic volumes between intersections were balanced using a common traffic analysis balancing procedure called the bi-proportional method. **Figure 2-2** illustrates the existing 2010 PM peak-hour turning movement traffic volumes.

Transfer station customer traffic volumes are primarily comprised of two types of trips: self-hauled (SH) and commercially-hauled (CH). Self-hauled trips are comprised of residents or small businesses delivering their recycling and waste. Commercially-collected trips are those from larger waste hauling companies. **Figure 2-3** summarizes the 2008 vehicle volumes accessing the transfer station throughout a typical weekday. The year 2008 was selected for several reasons. The years 2007 and 2008 had higher-than-current-average waste volumes collected; therefore, analysis of these years provides a more conservative traffic analysis. The year 2008 also coincided with the base year of the traffic demand model that is described in more detail in later sections of the report.

As **Figure 2-3** illustrates, traffic associated with King County transfer stations is not the highest during the weekday PM peak hour, when traffic volumes are the highest. The transfer station experiences higher volumes between 1:00 and 2:00 PM due to increased self-haul residential trips. There are no fixed hourly runs for the long-haul facility trucks from the transfer station. However, for calculation purposes, it was assumed that there are four long-haul facility truck runs per hour with two inbound runs and two outbound runs.

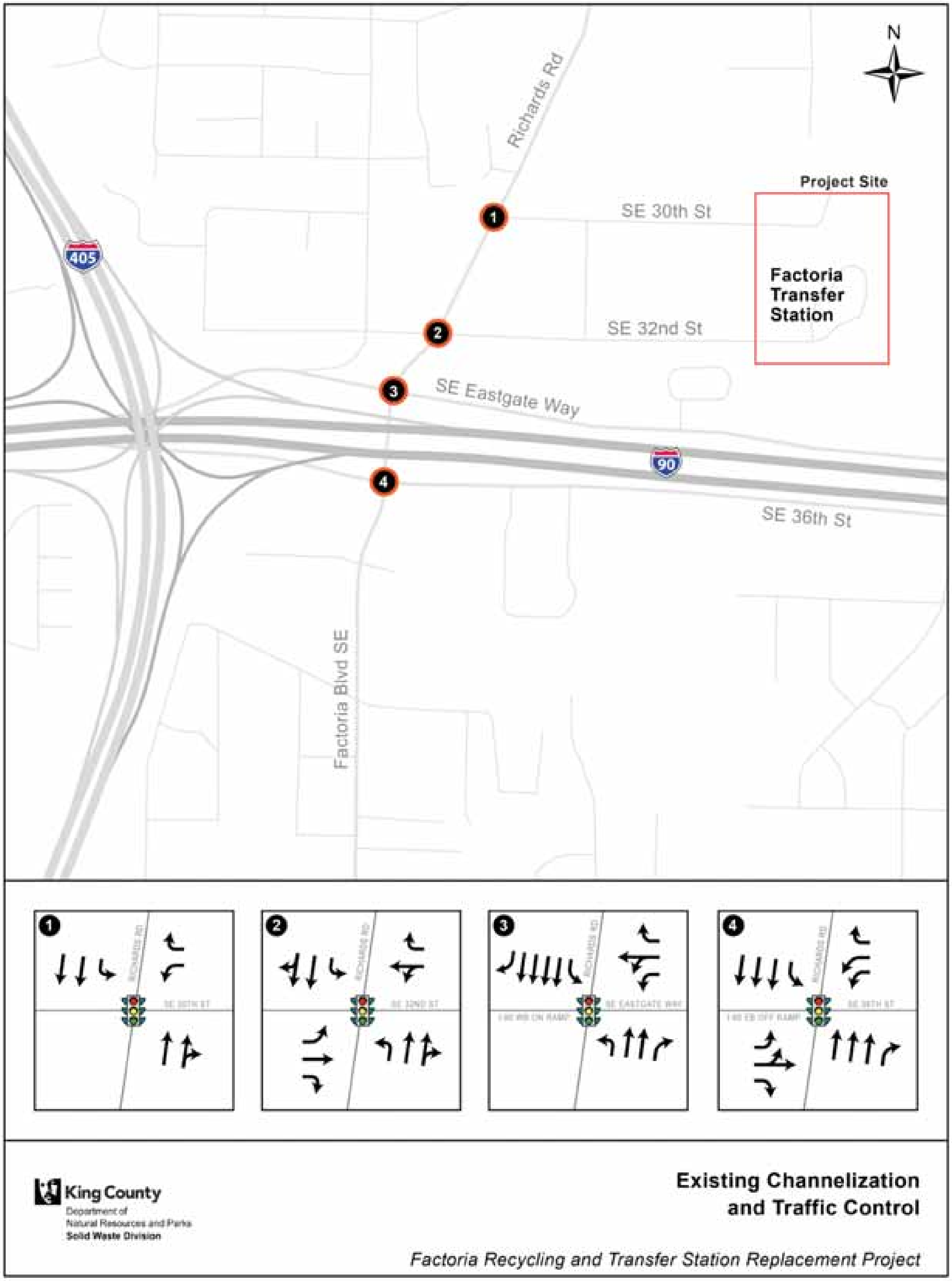

Figure 2-1. Existing Channelization and Traffic Control

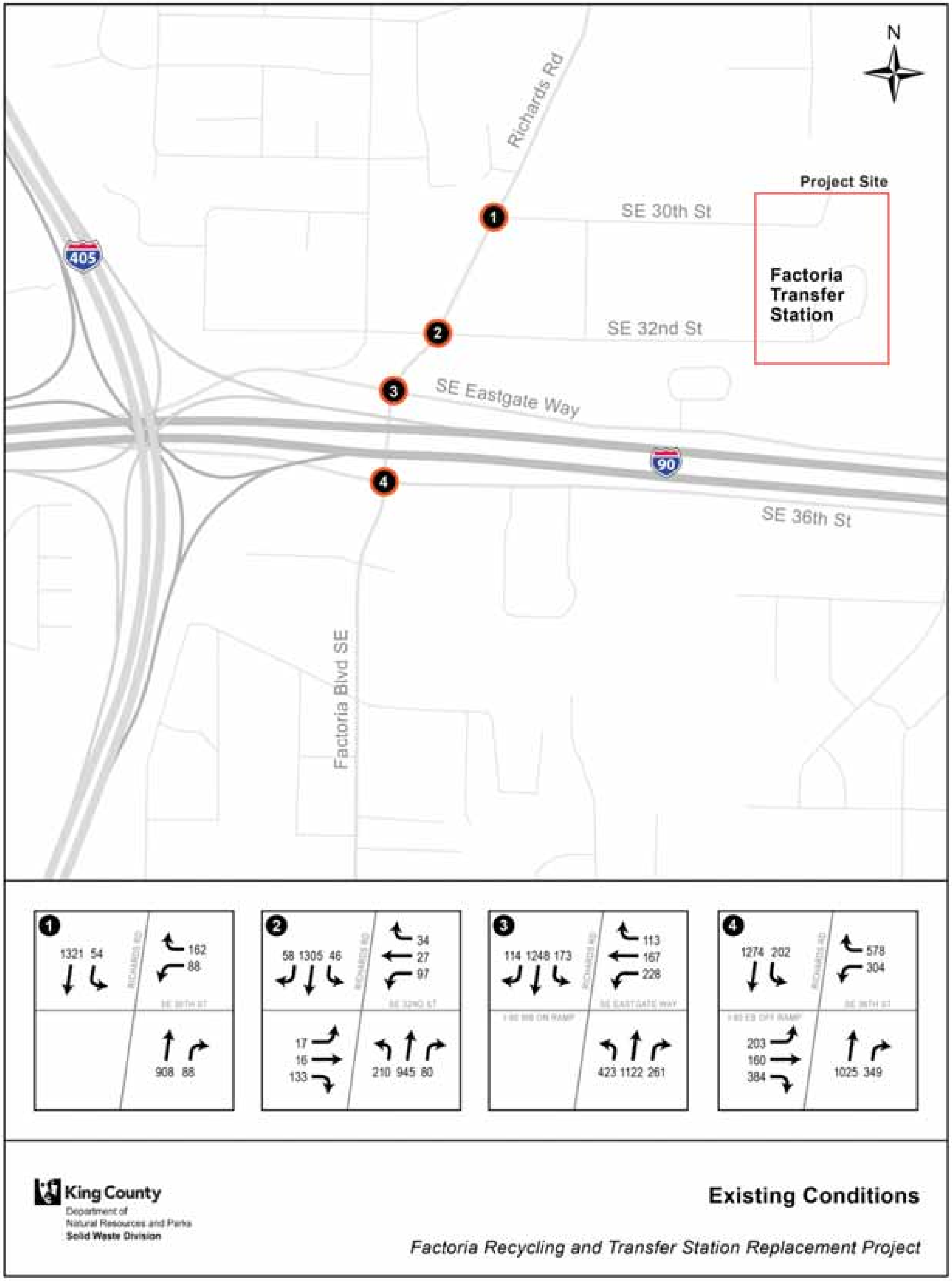

Figure 2-2. Existing PM Peak Hour Turning Movement Counts

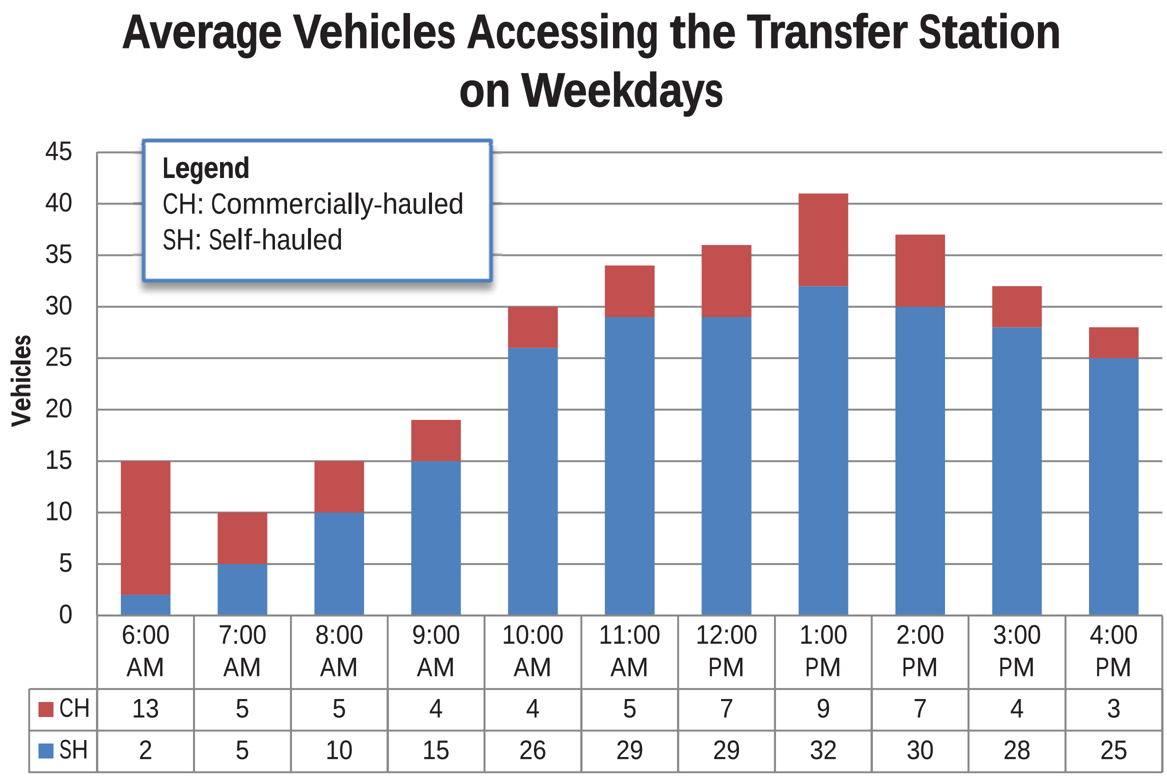

Figure 2-3. 2008 Vehicle Arrival Pattern

2.3 Traffic Operations

This section of the report summarizes existing traffic operations at the study intersections. Level of service (LOS) refers to the degree of congestion at an intersection, measured in average control delay. LOS A represents free-flow conditions (motorists experience little or no delay and traffic levels are well below roadway capacity), LOS F represents forced-flow conditions (motorists experience very long delays and traffic levels exceed roadway capacity), and LOS B to E represent decreasingly desirable conditions. A more detailed discussion of the LOS concept is presented in **Appendix B.**

A PM peak hour LOS analysis was conducted at the four study intersections for the year 2010 existing conditions. The traffic analysis software program Synchro (Version 7, Build 763, Rev 73) was used to analyze the intersections. The LOS information was obtained from Synchro utilizing the *Highway Capacity Manual* (HCM) methodology. Synchro is a macroscopic traffic operations analysis program that uses the methodology outlined in the 2000 HCM. The HCM is a publication of the Transportation Research Board.

The existing signal timing plans were obtained from the City of Bellevue Synchro model. The model contains lane widths and saturation flow rate data input by the City. Truck percentage and peak hour factor data were updated from the most recent count data. The results of the LOS analysis for the study intersections are shown in **Table 2-1**. The detailed LOS worksheets are included in **Appendix C** of this report.

King County LOS standard for an urban area is LOS E. The City of Bellevue LOS standard is LOS D for the Richards Valley area and LOS E for the Factoria area. Intersections of Richards Road/SE 30th Street and Richards Road/SE 32nd Street are within the Richards Valley area. Intersections of Richards Road/SE Eastgate Way and Richards Road/SE 36th Street are within the Factoria area. As **Table 2-1** shows, all the study intersections operate at LOS D or better. The intersection at Richards Road/SE Eastgate Way has a volume to capacity (V/C) ratio greater than 1, which indicates that it is over capacity under existing conditions.

Table 2-1. Existing Conditions PM Peak Hour LOS Summary

Int. No.	Description	Control Type[1]	Delay/ Veh[2]	LOS[3]	V/C Ratio[4]
1	Richards Rd/SE 30th St	Signal	8.8	A	0.55
2	Richards Rd/SE 32nd St	Signal	21.2	C	0.80
3	Richards Rd/SE Eastgate Way	Signal	39.4	D	1.07
4	Richards Rd/SE 36th St	Signal	27.0	C	0.70

Notes:

1. OWSC = One-way stop controlled intersection. AWSC = All-way stop controlled intersection. Signal = Signalized intersection. Unsignalized and signalized intersections were analyzed using Synchro.
2. Control delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the control delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst control delay, which is typically one of the stop controlled side street approaches. The control delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. V/C ratio is a measure that relates prevailing volume to the estimated capacity, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

2.4 Traffic Safety

For larger study areas, a historical review of the frequency of accidents may be completed. A more in-depth accident study was not completed for this analysis because the Factoria RTS improvements will not alter any of the existing intersection channelization at the four study intersections.

3.0 Future Conditions: 2014 Without-Project

The evaluations described in this section establish a baseline for identifying project impacts. The future roadway network, traffic volumes, and traffic operations are defined in this section.

A 2014 baseline (representing a without-project scenario) analysis was developed to identify future traffic conditions. Independent of the proposed transfer station improvements, traffic volumes on the roadway network in the year 2014 without-project conditions represent traffic resulting from background traffic growth. Traffic volumes accessing the site were assumed to remain consistent with existing conditions in order to isolate growth in site-related traffic volumes for the with-project analysis.

3.1 Planned Transportation Improvements

No City of Bellevue short-term (year 2014) transportation improvement projects that would enhance capacity were identified for the study intersections. However, the Washington State Department of Transportation has plans to improve signal timing on Richards Road freeway connections and widen I-405 as part of the South Bellevue I-405 project prior to 2014.

3.2 Forecasted Traffic Volumes

Year 2014 without-project traffic volumes were established based on a forecast from the Bellevue-Kirkland-Redmond (BKR) regional traffic forecasting model processed in EMME, a travel demand modeling software. The model was derived from the City of Bellevue 2008 and 2020 BKR model as well as the 2010 and 2020 Puget Sound Regional Council (PSRC) model. The 2008 BKR model has been updated to include the capacity improvement projects in 2009–2015 Capital Investment Program (CIP) Plan. Land uses for 2014 internal traffic analysis zones are interpolated between 2008 and 2020 BKR model land uses. Trips for the 2014 external traffic analysis zones are interpolated between 2010 and 2020 PSRC model trip productions and trip attractions (see **Appendix E**). Traffic volumes are expected to decrease on some links along Richards Road due to traffic shifts created by capacity improvements along I-405.

Site access traffic volumes are addressed under the with-project conditions section. **Figure 3-1** shows the future 2014 without-project traffic volumes for the weekday PM peak hours. These volumes were used to estimate year 2014 without-project conditions operational analysis.

3.3 Traffic Operations

This section summarizes baseline traffic operations at the study intersections. Future traffic operations in the study area were evaluated based on the year 2014 forecast traffic volumes. Because no short-term planned improvements were identified per City of Bellevue CIP Plan, intersection channelization is consistent with existing conditions. The traffic operations analysis used the same methodologies discussed in the evaluation of existing levels of service. Synchro signal timing plans (green time and offsets) for the intersections were optimized for 2014. Signal cycle lengths remained unchanged from existing timing plans. A peak hour factor of 0.9 was used for the future analysis to account for future variability. **Table 3-1** summarizes the weekday PM without-project LOS results; existing conditions results are provided for comparison. The detailed LOS worksheets are provided in **Appendix C**.

As **Table 3-1** shows, under future without-project conditions, all signalized intersections will operate at LOS C or better. The intersection at Richards Road/SE Eastgate Way will improve from LOS D to LOS C because of improved signal timing as well as the inclusion of I-405 widening projects done by the State that will shift traffic away from Richards Road to I-405.

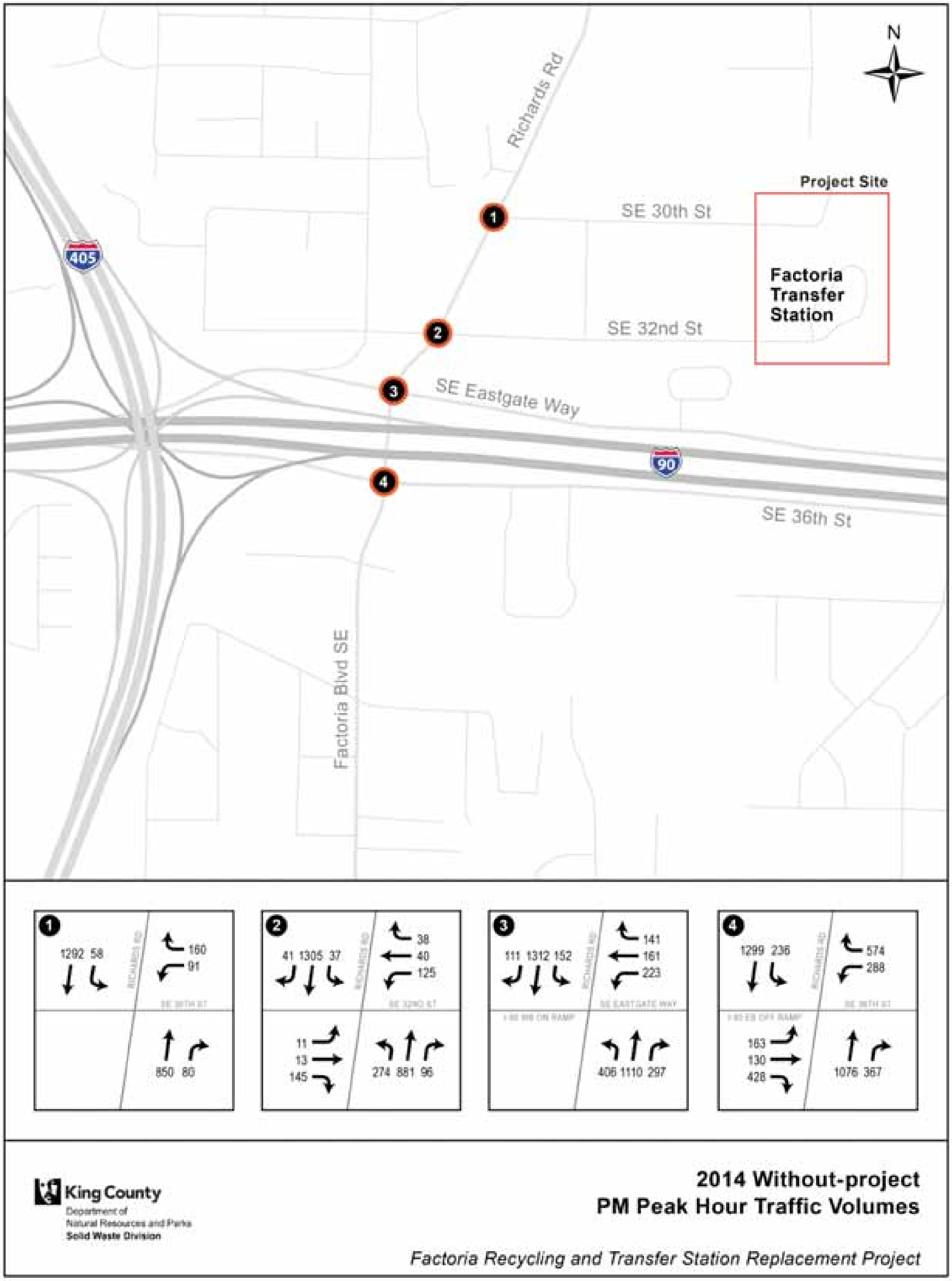

Figure 3-1. 2014 Without-Project PM Peak Hour Traffic Volumes

Table 3-1. 2014 Without-Project Conditions PM Peak Hour LOS Summary

Int. No.	Description	Control Type[1]	Delay/ Veh[2]	LOS[3]	V/C Ratio[4]
2014 Without-Project					
1	Richards Rd/SE 30th St	Signal	7.8	A	0.52
2	Richards Rd/SE 32nd St	Signal	24.6	C	0.85
3	Richards Rd/SE Eastgate Way	Signal	29.7	C	0.92
4	Richards Rd/SE 36th St	Signal	21.3	C	0.68
2010 Existing Condition					
1	Richards Rd/SE 30th St	Signal	8.8	A	0.55
2	Richards Rd/SE 32nd St	Signal	21.2	C	0.80
3	Richards Rd/SE Eastgate Way	Signal	39.4	D	1.07
4	Richards Rd/SE 36th St	Signal	27.0	C	0.70

Notes:

1. OWSC = One-way stop controlled intersection. AWSC = All-way stop controlled intersection. Signal = Signalized intersection. Unsignalized and signalized intersections were analyzed using Synchro.
2. Control delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the control delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst control delay, which is typically one of the stop controlled side street approaches. The control delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. V/C ratio is a measure that relates prevailing volume to the estimated capacity, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

4.0 Future Conditions: 2014 With-Project

This section describes the forecasted traffic conditions with the proposed project. The results are compared to 2014 baseline (without-project) traffic conditions to identify project impacts. The following paragraphs describe the project trip generation, forecasted traffic volumes, and traffic operations.

4.1 Forecasted Traffic Volumes

The 2014 with-project condition traffic volumes for the study area roadways were determined by calculating project-generated traffic volumes and assigning these volumes on the study roadways. The project-generated traffic was added to the 2014 without-project traffic volumes to obtain the 2014 with-project volumes for the study intersections.

Trip Credit

An area of land approximately 42,000 square feet in size along SE 30th Street has been acquired by King County to ease construction of the Factoria RTS. Facility improvements that acquired area include the actual transfer station building and administrative office space. Currently, the area is occupied by a light manufacturing industrial use, and employees use SE 30th Street to ingress to and egress from work. The weekday PM trip generation for the proposed land developments of the Factoria RTS was determined using the Institute of Transportation Engineers (ITE) *2008 Trip Generation Manual*, 8th Edition. Specifically, the following ITE land use codes (LUC) were used to estimate the trip generation:

- LUC 140 – Manufacturing for the existing operation
- LUC 710 – General Office Building for the proposed Factoria RTS

Trips generated from existing land use are subtracted from the future land use to estimate net new PM peak hour trips generated. Based on the ITE trip generation rate, the proposed development is expected to generate no new PM peak hour trips. **Table 4-1** summarizes the PM peak hour trip generation for the proposed development. **Figure 4-1** illustrates the trip credit distribution at each intersection.

Table 4-1. Trip Generation Summary

Land Use	ITE LUC (1)	Size / Area	Units (2)	Trip Generation Rate In	Trip Generation Rate Out	Trip Generation Rate Total	Peak Hour Trips In	Peak Hour Trips Out	Peak Hour Trips Total
Manufacturing	140	42	GFA	0.39	0.36	0.75	17	15	32
Office Building	710	3	GFA	0.25	1.23	1.49	1	4	5
					Net New PM Peak Hour Trips Generated =		***-16***	***-11***	***-27***

Notes:
(1) Institute of Transportation Engineers, *Trip Generation Manual*, 8th Edition, 2008 Land Use Code
(2) GFA = 1,000 Sq. Feet Gross Floor Area

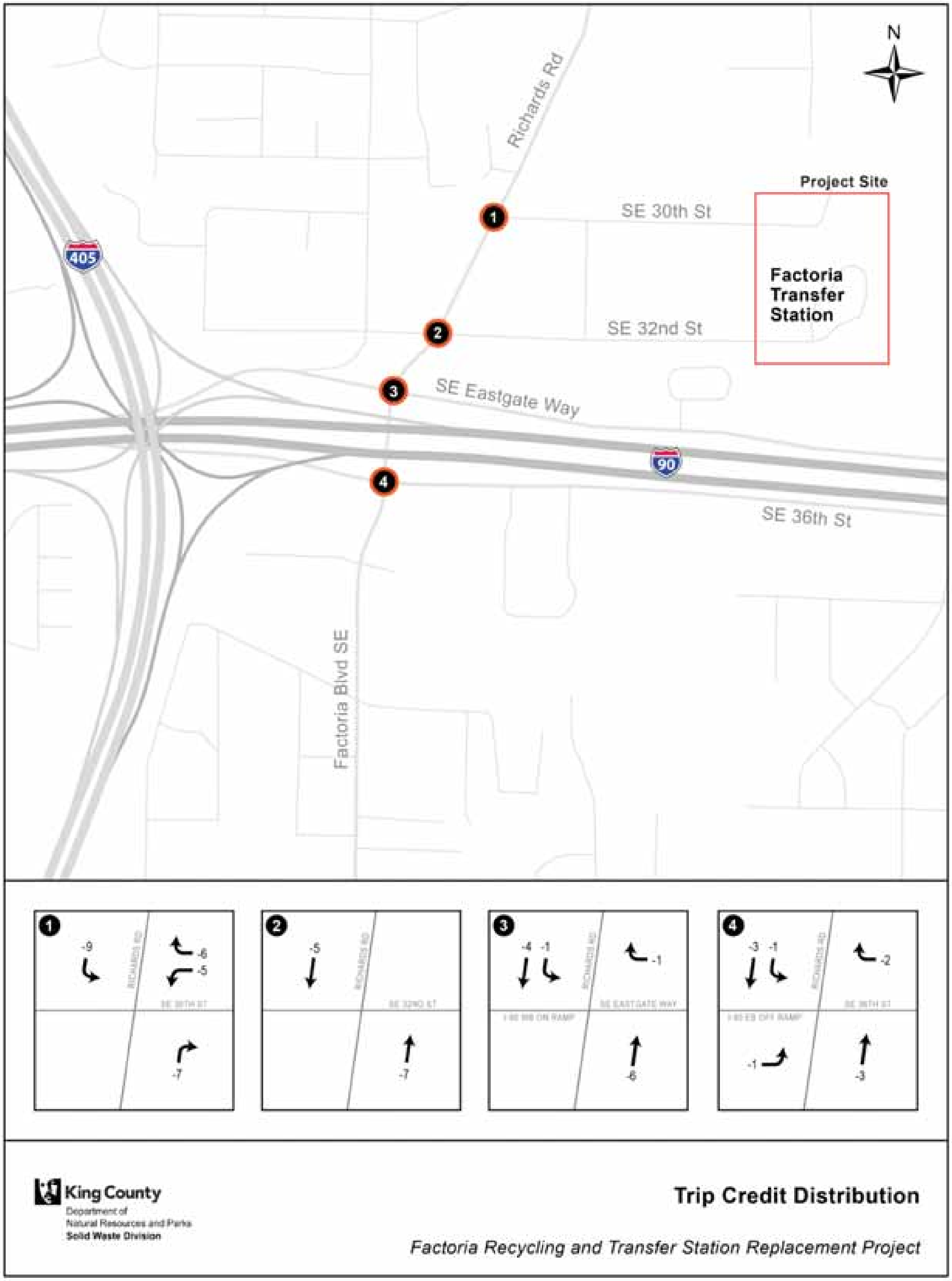

Figure 4-1. Trip Credit Distribution

Trip Generation

The King County Solid Waste Division forecasts the total annual waste tonnage based on historical data and the expected development in economic activities and population growth. Based on econometric model forecasting done by the King County Solid Waste Division, it is estimated that the tonnage of solid waste disposal will increase from the current 500 to 550 tons to approximately 600 tons per day in 2014.

The registry of the traffic volumes accessing the site in 2008 indicates that the facility generated 0.56 vehicles for every tonnage of solid waste collected on an average weekday. The total number of site access haulers in the future was estimated using the 3-year average of 0.59 vehicles per ton. The total numbers of haulers were distributed over the typical day based on the existing distribution pattern. **Table 4-2** shows site access volume for year 2014.

Table 4-2. Site Access Volume for Year 2014

Time/Year	2008	2014
6:00 AM	15	18
7:00 AM	10	12
8:00 AM	15	18
9:00 AM	19	23
10:00 AM	30	36
11:00 AM	34	41
12:00 PM	36	43
1:00 PM	41	49
2:00 PM	37	44
3:00 PM	32	38
4:00 PM	28	33
Vehicles	297	354
Tons	531	600

No specific time-stamp data are available for outbound haulers; therefore, they are considered to be the same in number as the inbound haulers from the same hour. Because site access volumes are registered in hourly fashion, 4:00 PM site access hourly volume data are considered to be the PM peak hour site access volume. **Table 4-3** shows the forecasted inbound and outbound trips by commercial and self-haulers for the future year 2014.

Table 4-3. PM Peak Hour Forecasted Trips by Commercial and Self-Haulers

Year	2008	2014 Additional Trips	2014
In	28	5	33
Out	28	5	33
Total	56	10	66

There are projected to be 10 additional commercial and self-hauler trips per hour, with 5 inbound and 5 outbound trips during the PM peak hour. The additional trips for commercial and self-haulers in 2014 may require one additional trip inbound and outbound by a facility transfer hauler in 2014. This estimate is conservative because there could be zero additional facility transfer hauler trips due to the improved compactor technology that will be used to load waste containers. **Table 4-4** shows the forecasted inbound and outbound trips by facility transfer haulers.

Table 4-4. PM Peak Hour Forecasted Trips by Facility Transfer Haulers

Year	2008	2014 Additional Trips
In	2	1
Out	2	1
Total	4	2

Combining **Table 4-2**, **Table 4-3**, and **Table 4-4**, by the year 2014, it is anticipated that there will be a net of 12 new trips during the PM peak hour.

Trip Distribution

The generated trips to and from the proposed project were distributed over the network using a select zone assignment procedure within the 2014 BKR model. **Figure 4-2** illustrates the distribution of the project trips in the study area.

The 2014 with-project PM peak hour traffic volume network is graphically depicted in **Figure 4-3**. These are the volumes used to estimate the project impact in the operational analysis.

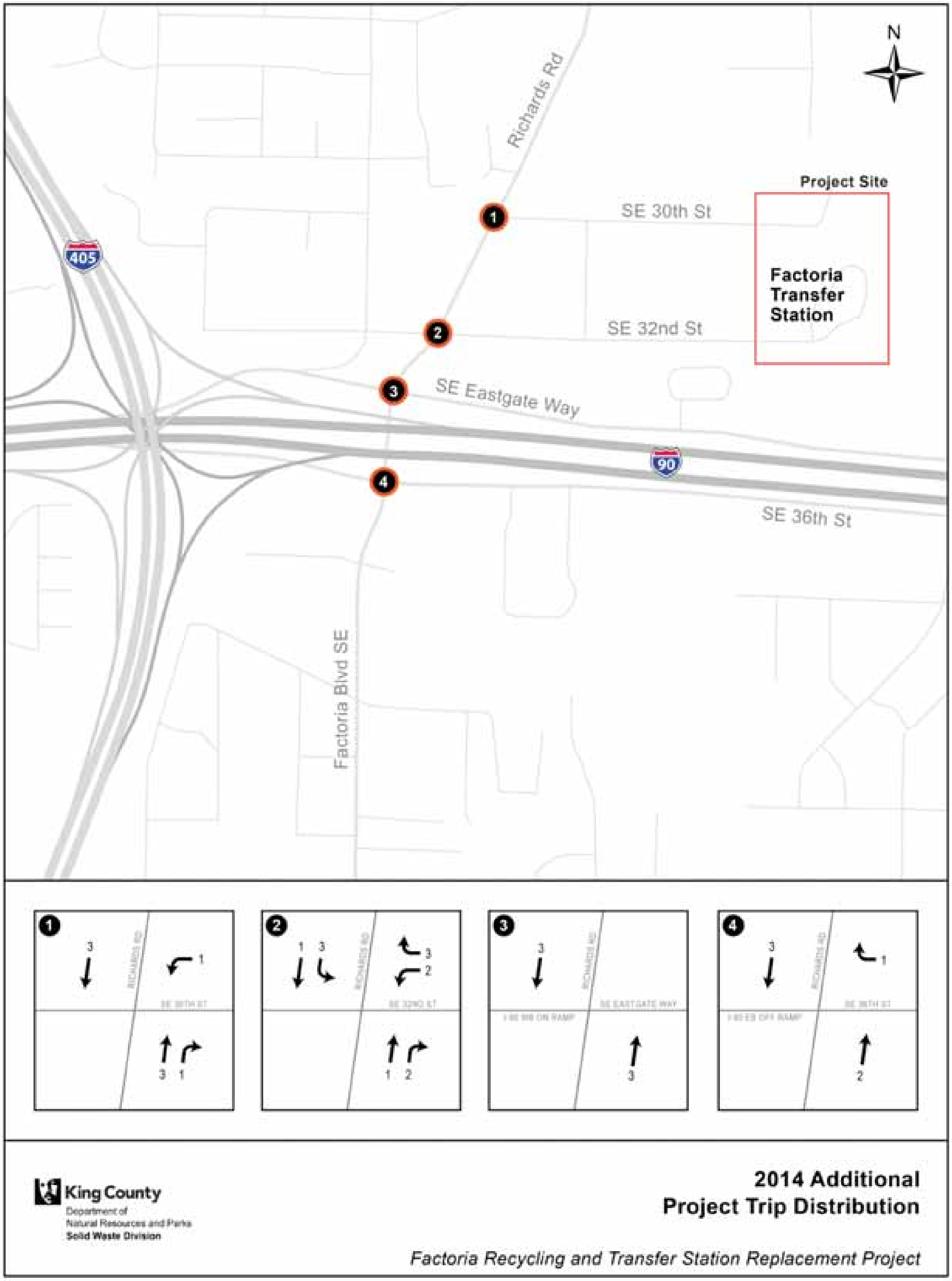

Figure 4-2. 2014 Additional Project Trip Distribution

4.2 Traffic Operations

This section summarizes 2014 with-project traffic operations at the study intersections. An LOS analysis was conducted for with-project conditions to quantify traffic operations. The same HCM 2000 methodologies were applied and all intersection parameters such as channelization, intersection control, and signal timings were held consistent with those used in the evaluation of 2014 without-project conditions to measure the degree of impact of the proposed project. The with-project traffic operational analysis utilized the traffic volumes illustrated in **Figure 4-3**. **Table 4-5** summarizes the with-project LOS analysis; without-project conditions are provided for comparison purposes. The detailed LOS worksheets are provided in **Appendix C**.

As Table 4-5 shows, under the 2014 with-project conditions, all signalized intersections will operate at LOS C or better. The V/C ratio will remain unchanged and the control delay will remain virtually unchanged because of the addition of only 12 trips added with the Factoria RTS project improvements. All of the intersections' V/C ratios will remain below 1 as well.

The Traffic Standards Code (BCC 14.10) requires that development proposals generating 30 or more PM peak hour trips undergo a concurrency analysis. It is estimated that the proposed Factoria RTS will generate a net of 12 new trips in 2014, which does not meet the threshold. Therefore, a concurrency analysis is not recommended.

In addition, an analysis of queue length at the study intersections was not conducted because the minor increase in turning movements will not affect storage queues at the intersections.

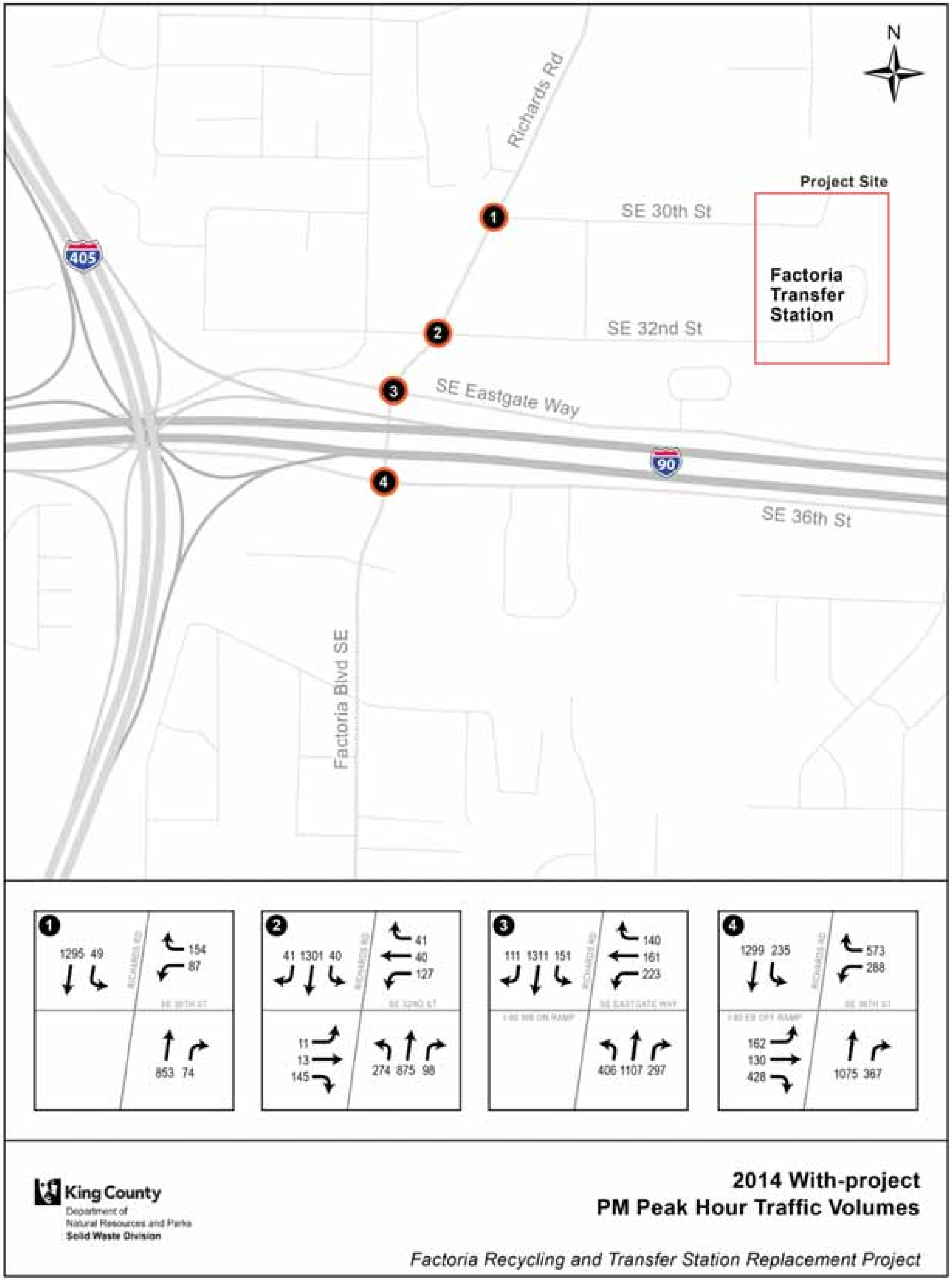

Figure 4-3. 2014 With-Project PM Peak Hour Traffic Volumes

Table 4-5. 2014 With-Project Conditions PM Peak Hour LOS Summary

Int. No.	Description	Control Type[1]	Delay/ Veh[2]	LOS[3]	V/C Ratio[4]
2014 With Project					
1	Richards Rd/SE 30th St	Signal	7.7	A	0.52
2	Richards Rd/SE 32nd St	Signal	24.8	C	0.85
3	Richards Rd/SE Eastgate Way	Signal	29.6	C	0.92
4	Richards Rd/SE 36th St	Signal	21.3	C	0.68
2014 Without Project					
1	Richards Rd/SE 30th St	Signal	7.8	A	0.52
2	Richards Rd/SE 32nd St	Signal	24.6	C	0.85
3	Richards Rd/SE Eastgate Way	Signal	29.7	C	0.92
4	Richards Rd/SE 36th St	Signal	21.3	C	0.68

Notes:

1. OWSC = One-way stop controlled intersection. AWSC = All-way stop controlled intersection. Signal = Signalized intersection. Unsignalized and signalized intersections were analyzed using Synchro.
2. Control delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the control delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst control delay, which is typically one of the stop controlled side street approaches. The control delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. V/C ratio is a measure that relates prevailing volume to the estimated capacity, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

5.0 Future Conditions: Construction Phase

This section describes the forecasted traffic conditions with the proposed project during the construction phase. Prior to the opening of the new Factoria RTS in 2014, SE 32nd Street will be closed for construction. Both commercial and self-hauler trips will be routed to the site through SE 30th Street. The results are compared to 2014 baseline (without-project) traffic conditions to identify construction impacts.

5.1 Forecasted Traffic Volumes

Per Section 4.1, there will be a total of 66 commercial and self-hauler trips per hour, with 33 inbound and 33 outbound, accessing the Factoria RTS during the PM peak hour in 2014 with-project conditions. The existing Factoria RTS entrance on SE 32nd Street will be closed for construction prior to 2014. All the commercial and self-hauler trips will be accessing the site through SE 30th Street during construction. To establish the volumes during construction, these 66 trips were subtracted from the intersection volumes of Richards Road and SE 32nd Street, and then added to the intersection volumes of Richards Road and SE 30th Street based on the 2014 with-project traffic patterns. Traffic at the intersections of Richards Road/SE Eastgate Way and Richards Road/SE 36th Street will not be affected during the construction. **Figure 5-1** illustrates the PM peak hour volume network of the construction phase.

5.2 Traffic Operations

This section summarizes the traffic operations during construction. An LOS analysis was conducted to quantify traffic operations during construction. The same HCM 2000 methodologies were applied and all intersection parameters such as channelization, intersection control, and signal timings were held consistent with those used in the evaluation of 2014 without-project conditions to measure the degree of impact during construction. The traffic operational analysis during construction utilized the traffic volumes illustrated in **Figure 5-1**. **Table 5-1** summarizes the results of the LOS analysis for the construction phase. The 2014 without-project conditions are provided for comparison purposes. The detailed LOS worksheets are provided in **Appendix C**.

As **Table 5-1** shows, all signalized intersections will operate at LOS C or better during construction. The average control delay will increase by 0.5 second at the intersection of Richards Road and SE 30th Street and be reduced by 2.6 seconds at the intersection of Richards Road and SE 32nd Street due to shifting of the commercial and self-hauler trips during construction. The V/C ratios at all the study intersections will remain below 1.

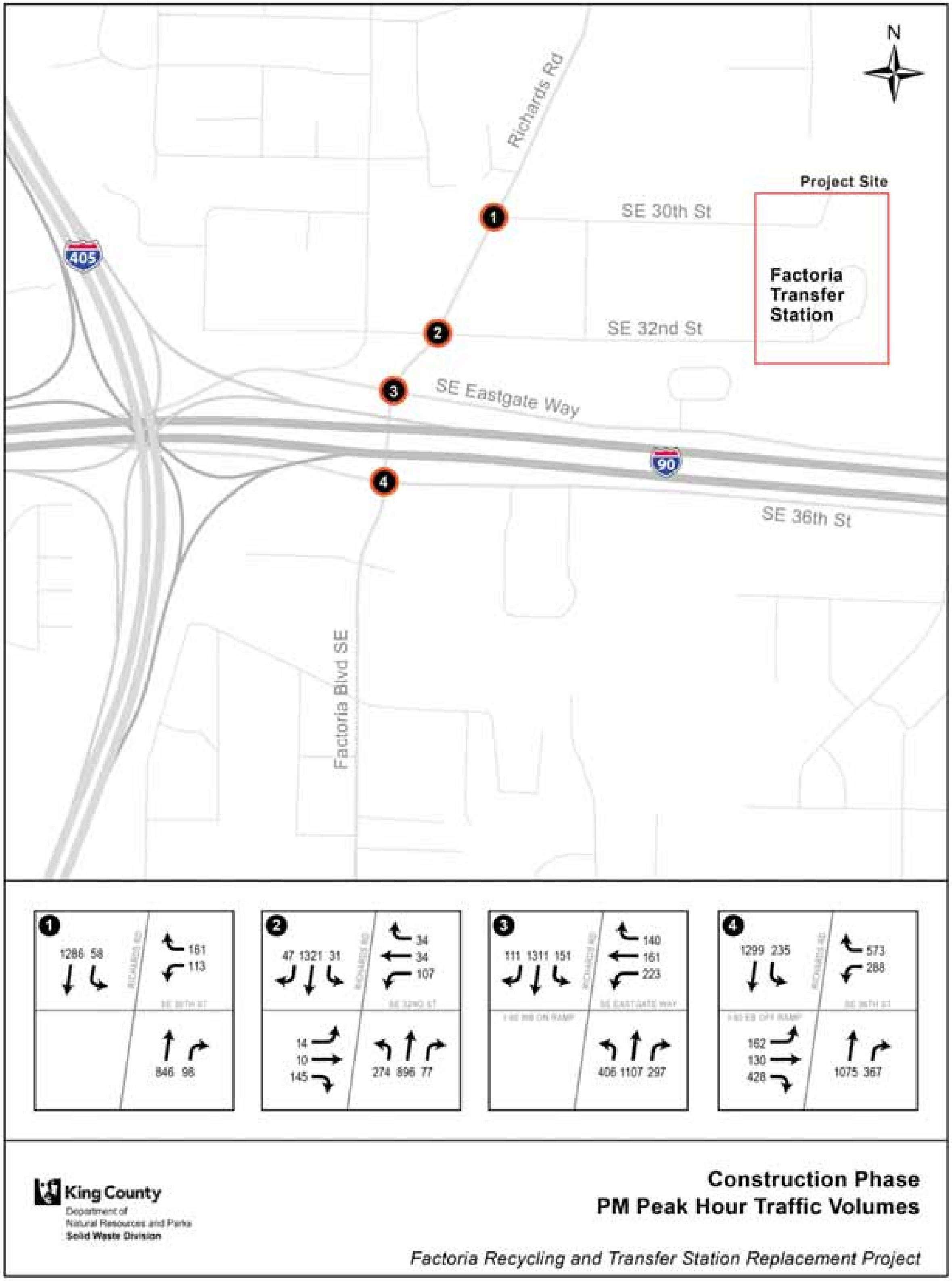

Figure 5-1. Construction Phase PM Peak Hour Traffic Volumes

Table 5-1. Construction Phase Conditions PM Peak Hour LOS Summary

Int. No.	Description	Control Type[1]	Delay/ Veh[2]	LOS[3]	V/C Ratio[4]
Construction Phase					
1	Richards Rd/SE 30th St	Signal	8.3	A	0.54
2	Richards Rd/SE 32nd St	Signal	22.0	C	0.83
3	Richards Rd/SE Eastgate Way	Signal	29.7	C	0.92
4	Richards Rd/SE 36th St	Signal	21.3	C	0.68
2014 Without Project					
1	Richards Rd/SE 30th St	Signal	7.8	A	0.52
2	Richards Rd/SE 32nd St	Signal	24.6	C	0.85
3	Richards Rd/SE Eastgate Way	Signal	29.7	C	0.92
4	Richards Rd/SE 36th St	Signal	21.3	C	0.68

Notes:

1. OWSC = One-way stop controlled intersection. AWSC = All-way stop controlled intersection. Signal = Signalized intersection. Unsignalized and signalized intersections were analyzed using Synchro.
2. Control delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the control delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst control delay, which is typically one of the stop controlled side street approaches. The control delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. V/C ratio is a measure that relates prevailing volume to the estimated capacity, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

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6.0 Future Conditions: 2042 Analysis

To support longer-range planning, a traffic analysis is also provided for the 2042 horizon year. A future 2042 LOS analysis is provided analyzing without and with the project.

6.1 Planned Transportation Improvements

No long-term (year 2042) transportation improvement projects that would enhance capacity were identified for the study intersections.

6.2 Without-Project Traffic Volumes

Year 2042 without-project traffic volumes were established based on a forecast from the BKR regional traffic forecasting model (see **Appendix E**). The model was derived from the City of Bellevue 2020 and 2030 BKR model as well as the 2020 and 2030 PSRC model. The 2030 BKR model includes the capacity improvement projects in the 2030 Comprehensive Transportation Plan. No additional projects were included between the years 2030 and 2042. Land uses for 2042 internal traffic analysis zones are extrapolated from 2020 and 2030 BKR model land uses. Trips for the 2042 external traffic analysis zones are extrapolated between 2030 and 2040 PSRC model trip productions and trip attractions.

Site access traffic volumes are addressed under the with-project conditions section. **Figure 6-1** shows the future 2042 without-project traffic volumes for the weekday PM peak hours. These volumes were used to estimate year 2042 without-project conditions operational analysis.

6.3 With-Project Traffic Volumes

The 2042 with-project condition traffic volumes for the study area roadways were determined by estimating project-generated traffic volumes and assigning these volumes on the study roadways. The project-generated traffic was added to the 2042 without-project traffic volumes to obtain the 2042 with-project volumes for the study intersections.

Trip Generation

Based on econometric model forecasting done by the King County Solid Waste Division, it is estimated that the tonnage of solid waste disposal will increase to approximately 900 tons per day in 2042. The total number of site access haulers in 2042 was estimated using the same factor for tons per truck as in the previous section. The total haulers were distributed over the typical day based on the existing distribution pattern. **Table 6-1** shows site access volume for year 2042. Site access volumes for year 2014 are shown for comparison purposes.

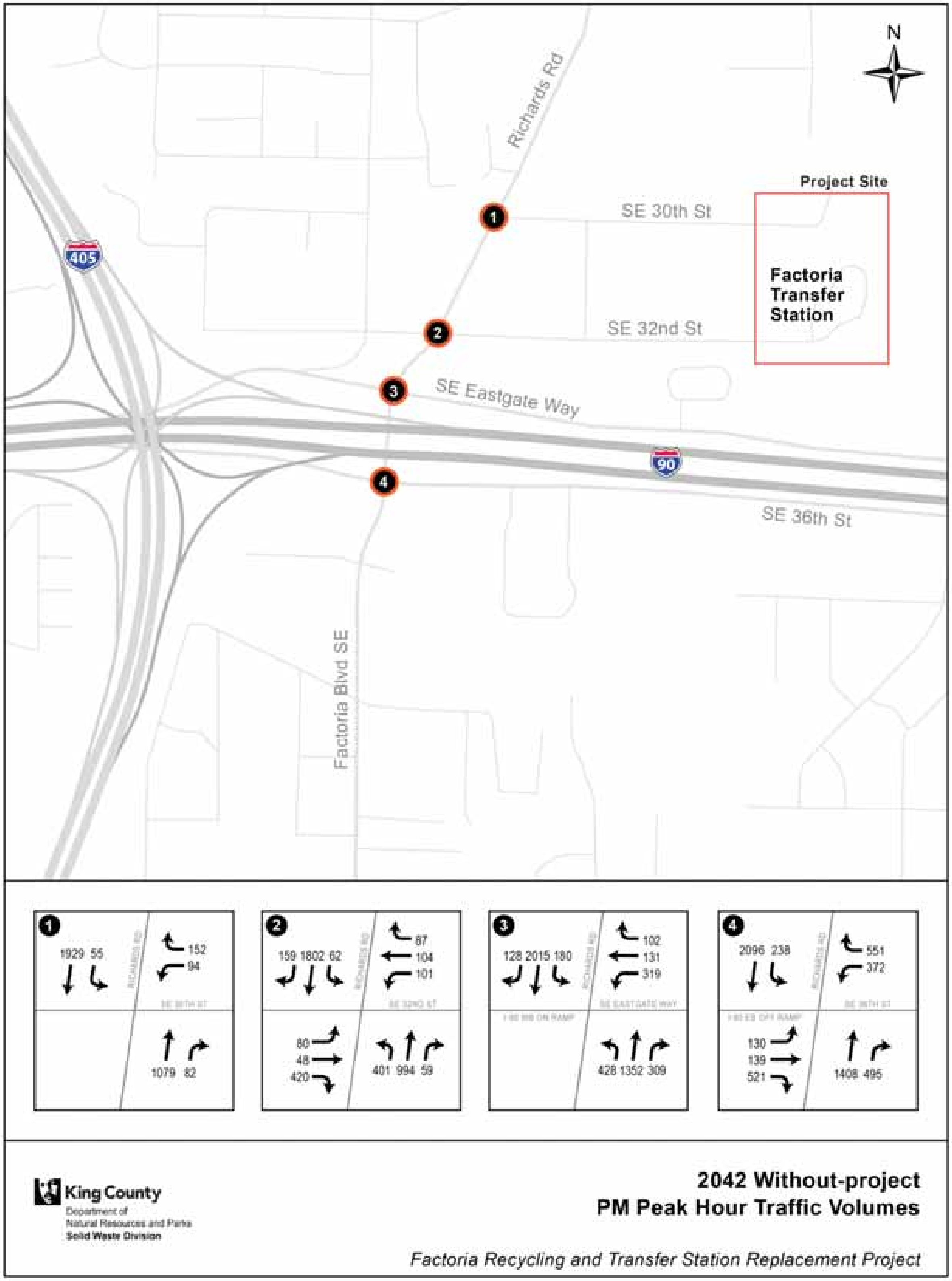

Figure 6-1. 2042 Without-Project PM Peak Hour Traffic Volumes

Table 6-1. Site Access Volume for Year 2042

Time/Year	2008	2014	2042
6:00 AM	15	18	27
7:00 AM	10	12	18
8:00 AM	15	18	27
9:00 AM	19	23	34
10:00 AM	30	36	54
11:00 AM	34	41	61
12:00 PM	36	43	64
1:00 PM	41	49	73
2:00 PM	37	44	66
3:00 PM	32	38	57
4:00 PM	28	33	50
Vehicles	297	354	531
Tons	531	600	900

No data are available for the outbound haulers; therefore, they are considered to be the same in number as the inbound haulers of the same hour. Because site access volumes are registered in hourly fashion, 4:00 PM site access hourly volume data are considered to be the PM peak hour site access volume. **Table 6-2** shows the forecasted inbound and outbound trips by commercial and self-haulers for the future year 2042. Project trips in 2014 are shown for comparison purposes.

Table 6-2. PM Peak Hour Forecasted Trips by Commercial and Self-Haulers

Year	2008	2014 Additional Trips	2014	2042 Additional Trips	2042
In	28	5	33	22	50
Out	28	5	33	22	50
Total	56	10	66	44	100

Comparing to 2008, there will be 44 additional commercial and self-hauler trips per hour with 22 inbound and 22 outbound trips during the PM peak hour. The additional trips for commercial and self-haulers in 2042 may require two additional trips inbound and outbound by facility transfer haulers in 2042. **Table 6-3** shows the forecasted inbound and outbound trips by facility transfer haulers. Project trips in 2014 are shown for comparison purposes.

Table 6-3. PM Peak Hour Forecasted Trips by Facility Transfer Haulers

Year	2008	2014 Additional trips	2042 Additional trips
In	2	1	2
Out	2	1	2
Total	4	2	4

Combining **Table 6-2** and **Table 6-3**, by the year 2042, there is expected to be a net of 48 new trips during the PM peak hour.

Trip Distribution

The generated trips to and from the proposed project were distributed over the network using a select zone assignment procedure within the 2042 BKR model. **Figure 6-2** illustrates the distribution of the project trips in the study area.

The 2042 with-project PM peak hour traffic volume network is graphically depicted in **Figure 6-3**. These are the volumes used to estimate project impact in the operations analysis.

6.4 Traffic Operations

This section summarizes 2042 without-project traffic operations at the study intersections. An LOS analysis was conducted for without-project conditions to quantify traffic operations. Under without-project conditions, the analysis uses the same methodologies discussed in the existing analysis. A peak hour factor of 0.9 was used for the future models to account for future variability. Synchro signal timing plans (green time and offsets) for the intersections were optimized for 2042. Signal cycle lengths remained unchanged from 2014 for all intersections except for the SE 32nd Street and Richards Road intersection, which increased to 150 seconds. The with-project traffic operational analysis utilizes the traffic volumes illustrated in **Figure 6-3**. **Table 6-4** summarizes the 2042 without-project and 2042 with-project LOS analysis. The detailed LOS worksheets are provided in **Appendix C**.

As **Table 6-4** shows, for the 2042 without-project analysis, the Richards Road/SE 32nd Street intersection will operate at LOS E with a 1.15 V/C ratio and the Richards Road/SE Eastgate Way intersection will operate at LOS D with a 1.34 V/C ratio. The intolerable delay with LOS E and V/C ratios greater than 1 are due to background traffic growth in the northbound and southbound directions. For the 2042 with-project conditions, all signalized intersections were calculated to operate at the same LOS as the without-project conditions. The maximum increase of Delay/Vehicle and V/C ratios for the with-project scenario is 0.2 second and 0.02, respectively.

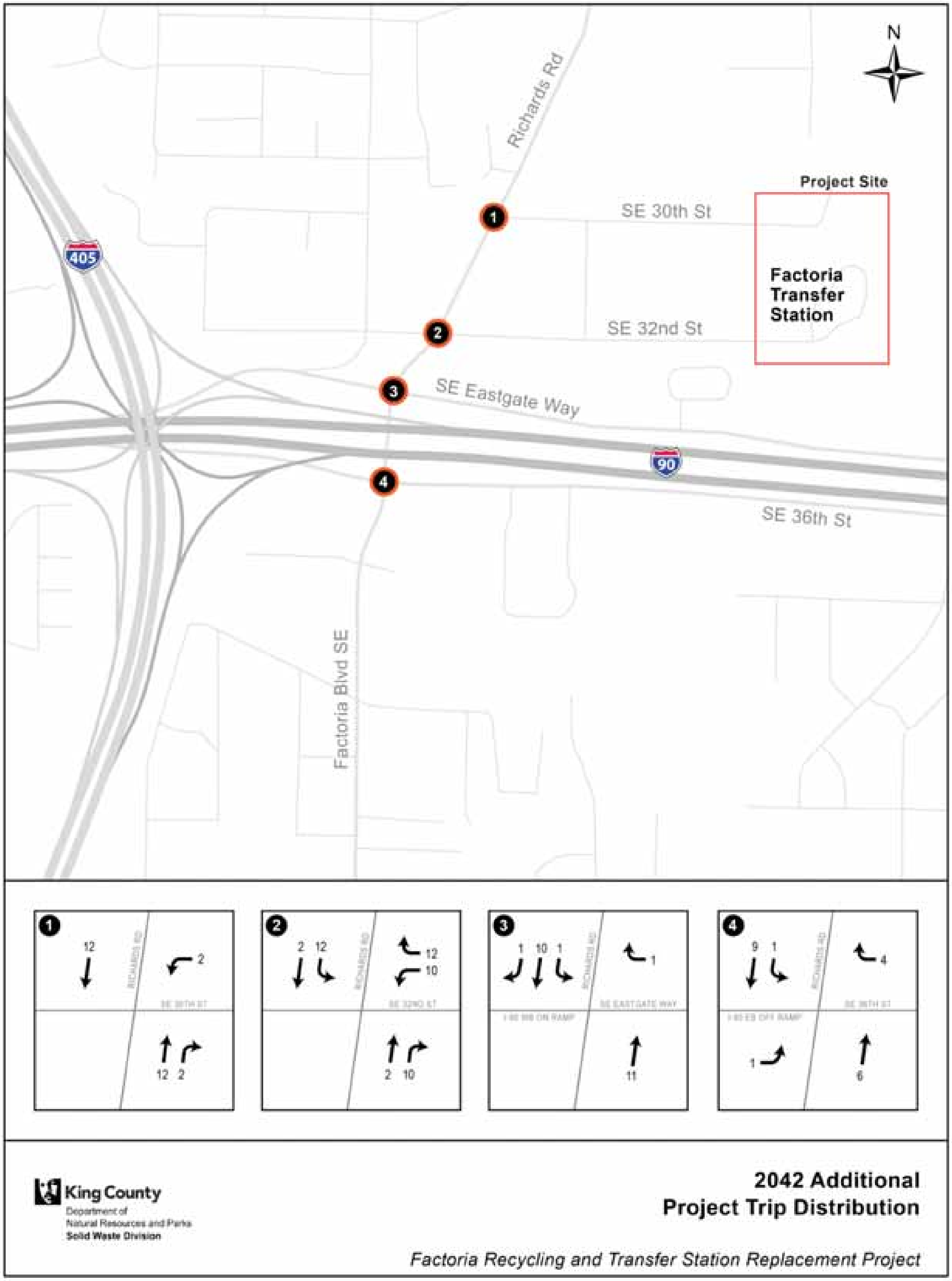

Figure 6-2. 2042 Additional Project Trip Distribution

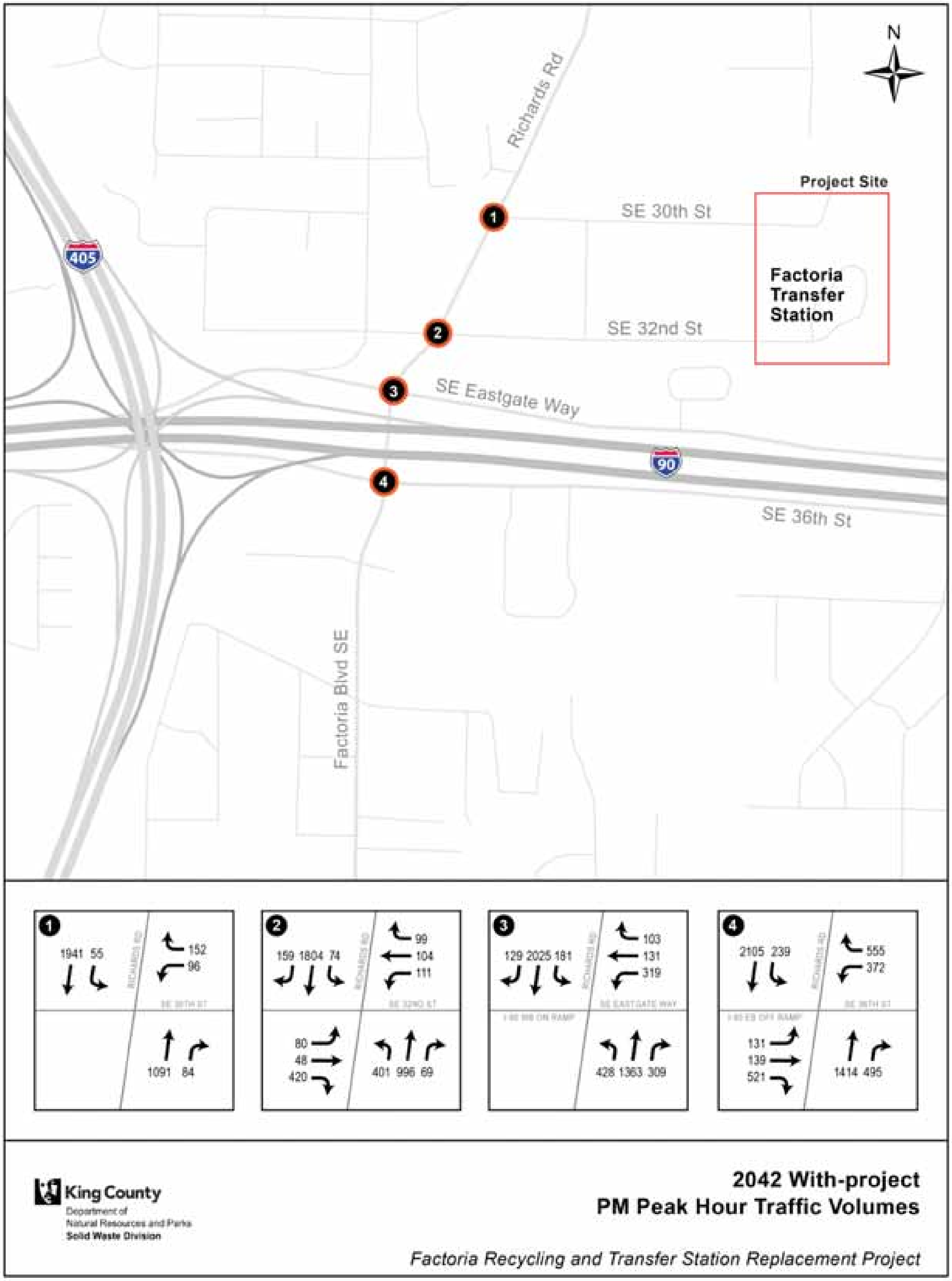

Figure 6-3. 2042 With-Project PM Peak Hour Traffic Volumes

Table 6-4. 2042 PM Peak Hour LOS Summary

Int. No.	Description	Control Type[1]	Delay/ Veh[2]	LOS[3]	V/C Ratio[4]
2042 With Project					
1	Richards Rd/SE 30th St	Signal	9.1	A	0.73
2	Richards Rd/SE 32nd St	Signal	**79.0**	**E**	**1.17**
3	Richards Rd/SE Eastgate Way	Signal	44.8	D	**1.36**
4	Richards Rd/SE 36th St	Signal	24.3	C	0.81
2042 Without Project					
1	Richards Rd/SE 30th St	Signal	8.9	A	0.72
2	Richards Rd/SE 32nd St	Signal	**79.6**	**E**	**1.15**
3	Richards Rd/SE Eastgate Way	Signal	46.4	D	**1.34**
4	Richards Rd/SE 36th St	Signal	24.1	C	0.80

Notes:

1. OWSC = One-way stop controlled intersection. AWSC = All-way stop controlled intersection. Signal = Signalized intersection. Unsignalized and signalized intersections were analyzed using Synchro.
2. Control delay, measured in seconds per vehicle, is a measure of all the delay contributable to traffic control measures, such as traffic signals or stop signs. At signalized intersections and all-way stop controlled intersections, the delay reported is the average of all the control delay experienced for all the movements. At one-way or two-way stop controlled intersections, the reported delay is for only one movement: the movement experiencing the worst control delay, which is typically one of the stop controlled side street approaches. The control delay reported at two-way stop controlled intersections is not a valid indication of the operations at the entire intersection.
3. LOS is the level of service, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.
4. V/C ratio is a measure that relates prevailing volume to the estimated capacity, a concept based on the 2000 *Highway Capacity Manual* for unsignalized and signalized intersections.

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7.0 Mitigation

All the study intersections will remain at the same LOS without and with the proposed Factoria RTS improvements. The V/C ratios remained constant for the 2014 analysis and increased by a maximum of 0.02 for the 2042 analysis. As a result of the minor changes, no mitigation is proposed for this development.

The City of Bellevue analyzes projects in terms of Mobility Management Areas (MMA). The study intersections impact two of these MMAs: the Richards Valley MMA and the Factoria MMA. Intersections of Richards Road/SE 30th Street and Richards Road/SE 32nd Street are within the Richards Valley MMA. Intersections of Richards Road/SE Eastgate Way and Richards Road/SE 36th Street are within the Factoria MMA. Each MMA has an overall V/C ratio threshold and LOS threshold established by the City. The V/C threshold is 0.95 for the Factoria MMA and 0.85 for the Richards Valley MMA per the current City of Bellevue Traffic Standards Code. The LOS threshold is E+ for the Factoria MMA and D+ for the Richards Valley MMA. The City has not identified the future thresholds for these MMAs in year 2042. The analysis indicates that the Factoria RTS will not degrade the area-wide LOSs in 2042. Therefore, no mitigation is proposed.

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8.0 References

City of Bellevue. 2009. City of Bellevue Traffic Data Book.

Institute of Transportation Engineers. 2008. *ITE Trip Generation Manual*.

Transportation Research Board. 2003. *Highway Capacity Manual*.

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APPENDIX A

Existing Counts

Data provided by the City of Bellevue

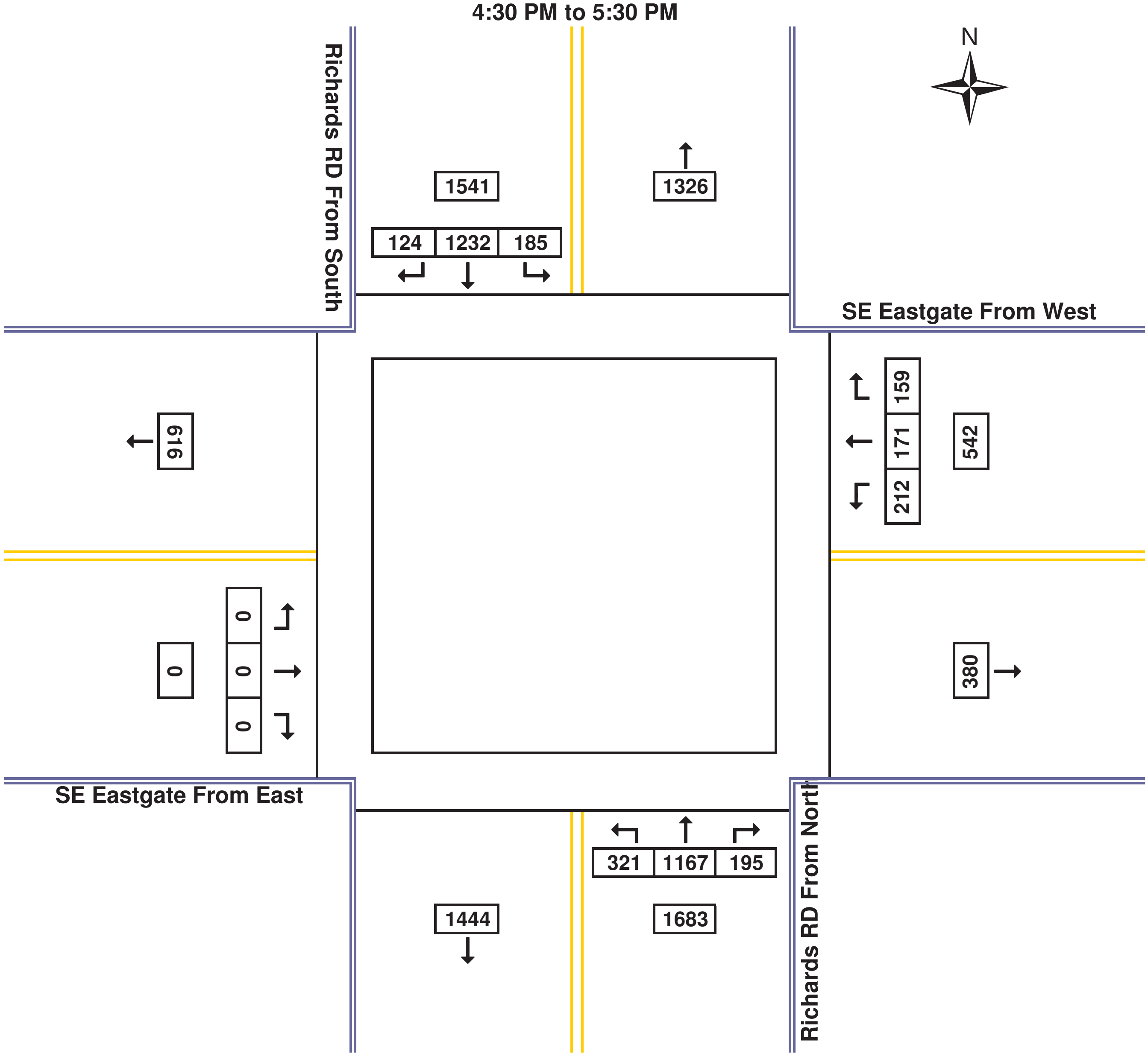
Intersection Turning Movement Counts
Peak Hour Summary Sheet

Data Year: 2008
Int ID: 105

Peak Period: PM
Control Type: Actuated

Richards RD & SE Eastgate way

4:30 PM to 5:30 PM



Approach	PHF	%Trk	Volume
EB	0.00	0%	0
WB	0.88	1%	542
NB	0.97	1%	1683
SB	0.90	1%	1541
Interection	0.95	2%	3766

Intersection Turning Movement Counts
Peak Hour Calculation Sheet

Data Year: ***2008***

15-Minutes Interval Summary

4:00 PM to 6:00 PM

Interval Start Time	SB Richards RD From South				WB SE Eastgate From West				NB Richards RD From North				EB SE Eastgate From East				Interval Total
	L	T	R	Truck	L	T	R	Truck	L	T	R	Truck	L	T	R	Truck	
4:00 PM	40	270	26	9	42	28	50	0	85	220	46	11	0	0	0	0	807
4:15 PM	38	296	38	13	59	39	56	2	96	240	49	12	0	0	0	0	911
4:30 PM	41	310	40	11	60	40	49	1	79	290	51	9	0	0	0	0	960
4:45 PM	49	340	37	8	55	48	45	0	77	300	58	9	0	0	0	0	1009
5:00 PM	50	300	29	7	51	46	36	0	80	297	46	15	0	0	0	0	935
5:15 PM	45	282	18	2	46	37	29	2	85	280	40	8	0	0	0	0	862
5:30 PM	37	270	16	3	41	34	21	3	97	270	42	6	0	0	0	0	828
5:45 PM	30	259	20	1	54	39	22	0	120	255	38	6	0	0	0	0	837
Total Survey	330	2327	224	54	408	311	308	8	719	2152	370	76	0	0	0	0	7149

Rolling Hour Summary

4:00 PM to 6:00 PM

Interval Start Time	SB Richards RD From South				WB SE Eastgate From West				NB Richards RD From North				EB SE Eastgate From East				Interval Total
	L	T	R	Truck	L	T	R	Truck	L	T	R	Truck	L	T	R	Truck	
4:00 PM	168	1216	141	41	216	155	200	3	337	1050	204	41	0	0	0	0	3687
4:15 PM	178	1246	144	39	225	173	186	3	332	1127	204	45	0	0	0	0	3815
4:30 PM	185	1232	124	28	212	171	159	3	321	1167	195	41	0	0	0	0	3766
4:45 PM	181	1192	100	20	193	165	131	5	339	1147	186	38	0	0	0	0	3634
5:00 PM	162	1111	83	13	192	156	108	5	382	1102	166	35	0	0	0	0	3462
		0.02				0.01				0.02				#####			

Peak Hour Summary

4:30 PM to 5:30 PM

By Approach	SB Richards RD From South				WB SE Eastgate From West				NB Richards RD From North				EB SE Eastgate From East				Total
	In	Out	Total	Truck	In	Out	Total	Truck	In	Out	Total	Truck	In	Out	Total	Truck	
Volume	1541	1326	2867	41	542	380	922	5	1683	1444	3127	45	0	616	616	0	3766
PHF	0.90				0.88				0.97				0.00				0.95

By Movement	SB Richards RD From South				WB SE Eastgate From West				NB Richards RD From North				EB SE Eastgate From East				Total
	L	T	R	Total	L	T	R	Total	L	T	R	Total	L	T	R	Total	
Volume	185	1232	124	1541	212	171	159	542	321	1167	195	1683	0	0	0	0	3815
PHF	0.93	0.91	0.78	0.90	0.88	0.89	0.71	0.88	0.67	0.97	0.84	0.97	0.00	0.00	0.00	0.00	0.95

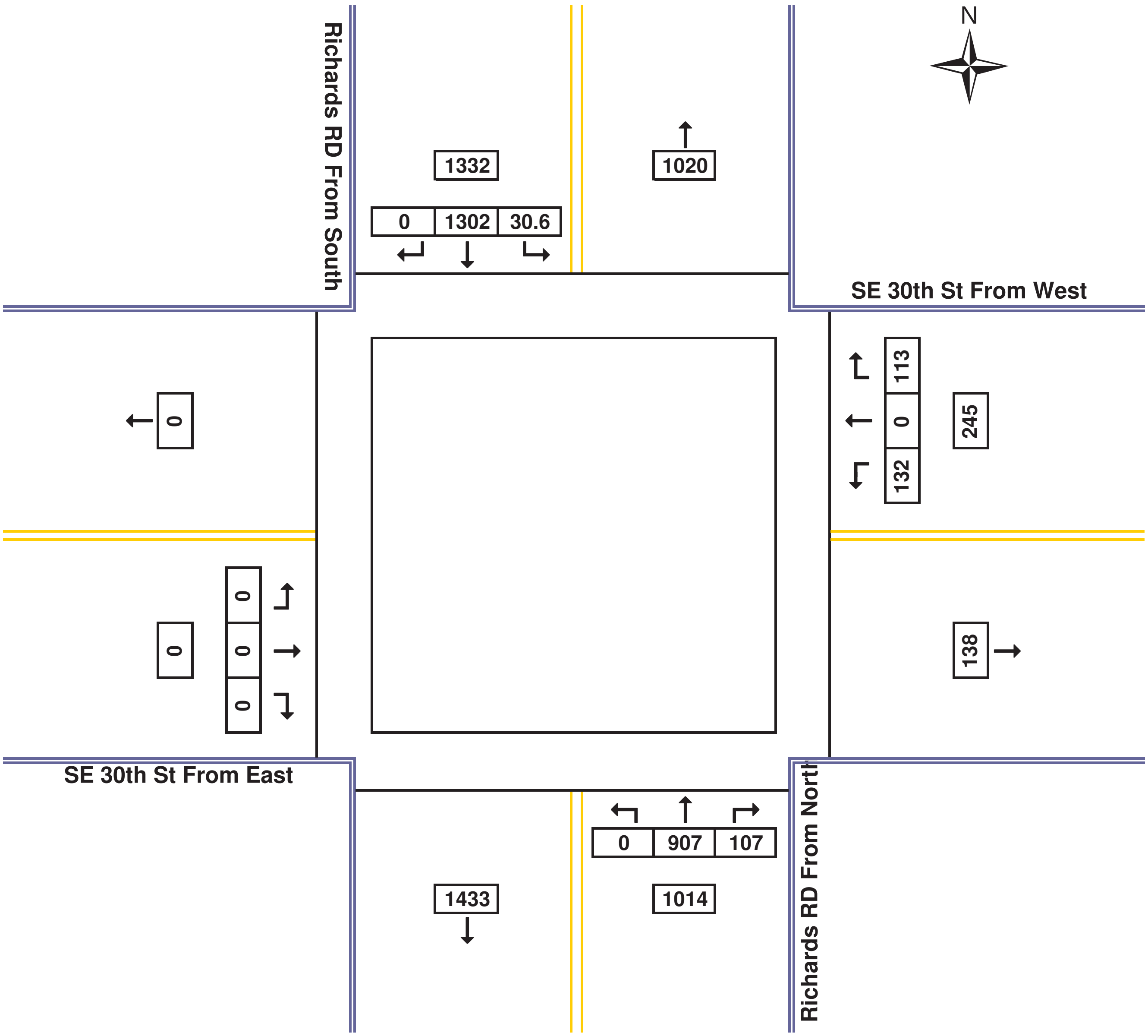
Intersection Turning Movement Counts
Peak Hour Summary Sheet

Data Year: 2007
Int ID: 132

Peak Period: PM
Control Type: Actuated

Richards RD & SE 30th St

4:30 PM to 5:30 PM



Approach	PHF	%Trk	Volume
EB	0.00	####	0
WB	0.83	4%	244.8
NB	0.96	1%	1013.9
SB	0.97	1%	1332.1
Interection	0.98	3%	2590.8

Intersection Turning Movement Counts
Peak Hour Calculation Sheet

Data Year: ***2007***

15-Minutes Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	SB Richards RD From South L	SB T	SB R	SB Truck	WB SE 30th St From West L	WB T	WB R	WB Truck	NB Richards RD From North L	NB T	NB R	NB Truck	EB SE 30th St From East L	EB T	EB R	EB Truck	Interval Total
4:00 PM	9	249	0	4	30	0	18	1	0	188	17	8	0	0	0	0	511
4:15 PM	5	327	0	8	21	0	22	1	0	212	24	7	0	0	0	0	611
4:30 PM	7	331	0	8	30	0	25	3	0	208	29	6	0	0	0	0	630
4:45 PM	8	334	0	8	39	0	28	5	0	203	33	5	0	0	0	0	645
5:00 PM	2	284	0	3	36	0	38	2	0	234	24	6	0	0	0	0	618
5:15 PM	13	327	0	4	24	0	20	5	0	244	19	2	0	0	0	0	647
5:30 PM	15	315	0	8	32	0	27	3	0	201	25	3	0	0	0	0	615
5:45 PM	10	288	0	4	16	0	12	1	0	179	13	5	0	0	0	0	518
Total Survey	69	2455	0	47	228	0	190	21	0	1669	184	42	0	0	0	0	4795

Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start Time	SB Richards RD From South L	SB T	SB R	SB Truck	WB SE 30th St From West L	WB T	WB R	WB Truck	NB Richards RD From North L	NB T	NB R	NB Truck	EB SE 30th St From East L	EB T	EB R	EB Truck	Interval Total
4:00 PM	29	1241	0	28	120	0	93	10	0	811	103	26	0	0	0	0	2397
4:15 PM	22	1276	0	27	126	0	113	11	0	857	110	24	0	0	0	0	2504
4:30 PM	30	1276	0	23	129	0	111	15	0	889	105	19	0	0	0	0	2540
4:45 PM	38	1260	0	23	131	0	113	15	0	882	101	16	0	0	0	0	2525
5:00 PM	40	1214	0	19	108	0	97	11	0	858	81	16	0	0	0	0	2398

Peak Hour Summary
4:30 PM to 5:30 PM

By Approach	SB Richards RD From South In	SB Out	SB Total	SB Truck	WB SE 30th St From West In	WB Out	WB Total	WB Truck	NB Richards RD From North In	NB Out	NB Total	NB Truck	EB SE 30th St From East In	EB Out	EB Total	EB Truck	Total
Volume	1332	1020	2352	28	244.8	137.7	382.5	15	1014	1433	2447	26	0	0	0	0	2590.8
PHF	0.97				0.83				0.96				0.00				0.98

By Movement	SB Richards RD From South L	SB T	SB R	SB Total	WB SE 30th St From West L	WB T	WB R	WB Total	NB Richards RD From North L	NB T	NB R	NB Total	EB SE 30th St From East L	EB T	EB R	EB Total	Total
Volume	30.6	1302	0	1332	131.6	0	113.2	244.8	0	906.8	107.1	1014	0	0	0	0	2540
PHF	0.51	0.97	0.00	0.97	0.84	0.00	0.74	0.83	0.00	0.93	0.81	0.96	0.00	0.00	0.00	0.00	0.98

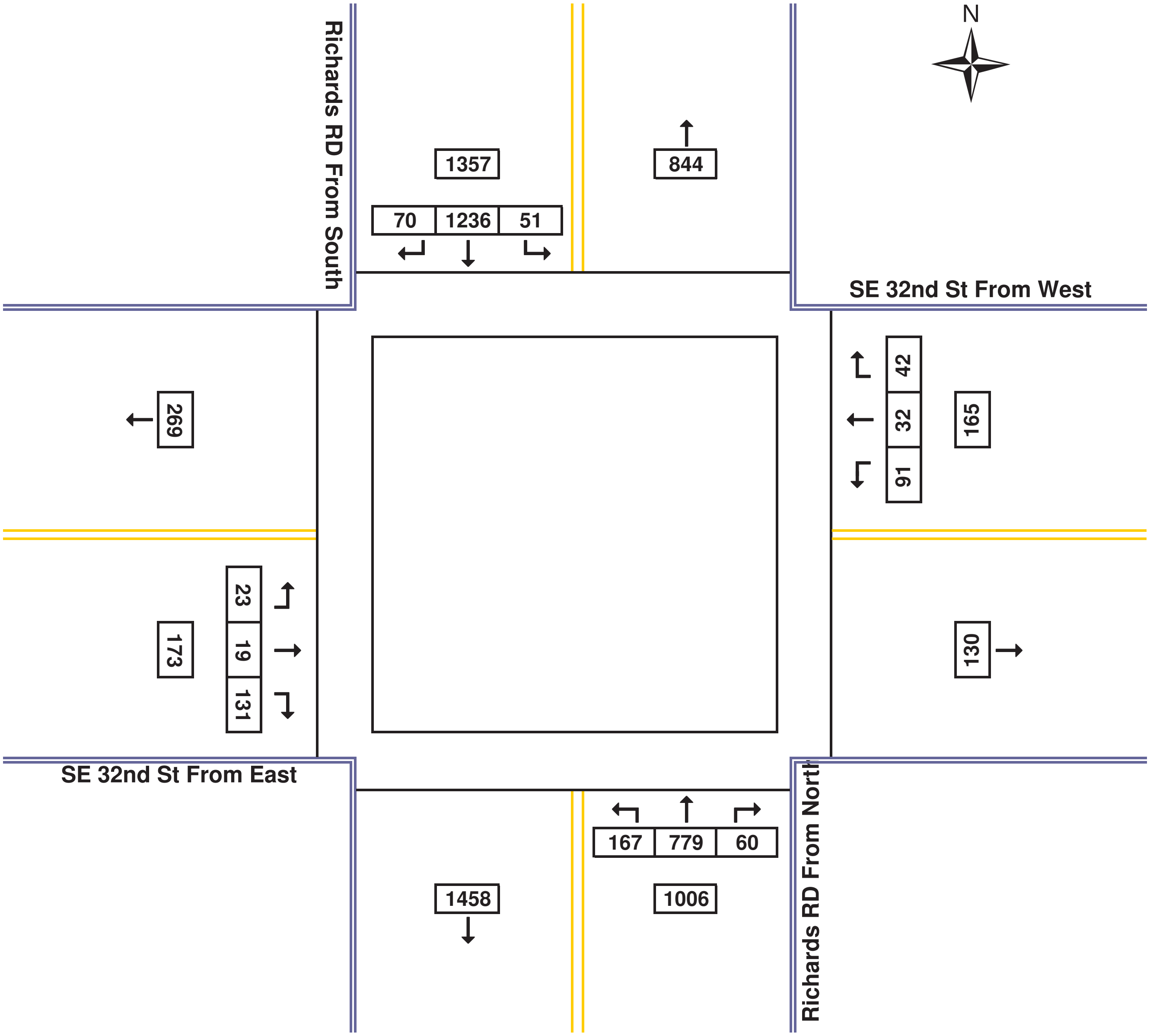
Intersection Turning Movement Counts
Peak Hour Summary Sheet

Data Year: 2008
Int ID: 85

Peak Period: PM
Control Type: Actuated

Richards RD & SE 32nd St

4:30 PM to 5:30 PM



Approach	PHF	%Trk	Volume
EB	0.70	2%	173
WB	0.69	4%	165
NB	0.84	1%	1006
SB	0.96	1%	1357
Interection	0.96	2%	2701

Intersection Turning Movement Counts
Peak Hour Calculation Sheet

Data Year: 2008

15-Minutes Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	SB				WB				NB				EB				Interval Total
	Richards RD From South				SE 32nd St From West				Richards RD From North				SE 32nd St From East				
	L	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	
4:00 PM	10	270	17	3	30	2	12	6	33	180	21	10	7	1	28	2	611
4:15 PM	6	270	15	3	13	2	11	1	28	179	16	3	6	2	28	0	576
4:30 PM	15	284	22	2	24	6	12	2	43	173	11	3	6	2	32	3	630
4:45 PM	14	316	6	6	23	9	10	2	43	175	18	3	4	2	15	0	635
5:00 PM	8	316	23	1	29	8	9	3	38	198	7	3	6	1	43	1	686
5:15 PM	14	320	19	8	15	9	11	1	43	233	24	6	7	14	41	3	750
5:30 PM	13	307	15	2	28	9	23	2	56	219	16	2	1	4	34	2	725
5:45 PM	14	323	12	5	17	4	16	4	56	208	17	3	1	3	38	1	709
Total Survey	94	2406	129	30	179	49	104	21	340	1565	130	33	38	29	259	12	5322

Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start Time	SB				WB				NB				EB				Interval Total
	Richards RD From South				SE 32nd St From West				Richards RD From North				SE 32nd St From East				
	L	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	
4:00 PM	45	1140	60	14	90	19	45	11	147	707	66	19	23	7	103	5	2452
4:15 PM	43	1186	66	12	89	25	42	8	152	725	52	12	22	7	118	4	2527
4:30 PM	51	1236	70	17	91	32	42	8	167	779	60	15	23	19	131	7	2701
4:45 PM	49	1259	63	17	95	35	53	8	180	825	65	14	18	21	133	6	2796
5:00 PM	49	1266	69	16	89	30	59	10	193	858	64	14	15	22	156	7	2870
		0.01				0.05				0.01				0.04			

Peak Hour Summary
4:30 PM to 5:30 PM

By Approach	SB				WB				NB				EB				Total
	Richards RD From South				SE 32nd St From West				Richards RD From North				SE 32nd St From East				
	In	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	
Volume	1357	844	2201	17	165	130	295	11	1006	1458	2464	19	173	269	442	7	2701
PHF	0.96				0.69				0.84				0.70				0.96

By Movement	SB				WB				NB				EB				Total
	Richards RD From South				SE 32nd St From West				Richards RD From North				SE 32nd St From East				
	L	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	
Volume	51	1236	70	1357	91	32	42	165	167	779	60	1006	23	19	131	173	2870
PHF	0.85	0.96	0.76	0.96	0.76	0.89	0.46	0.69	0.75	0.84	0.63	0.84	0.82	0.34	0.76	0.70	0.96

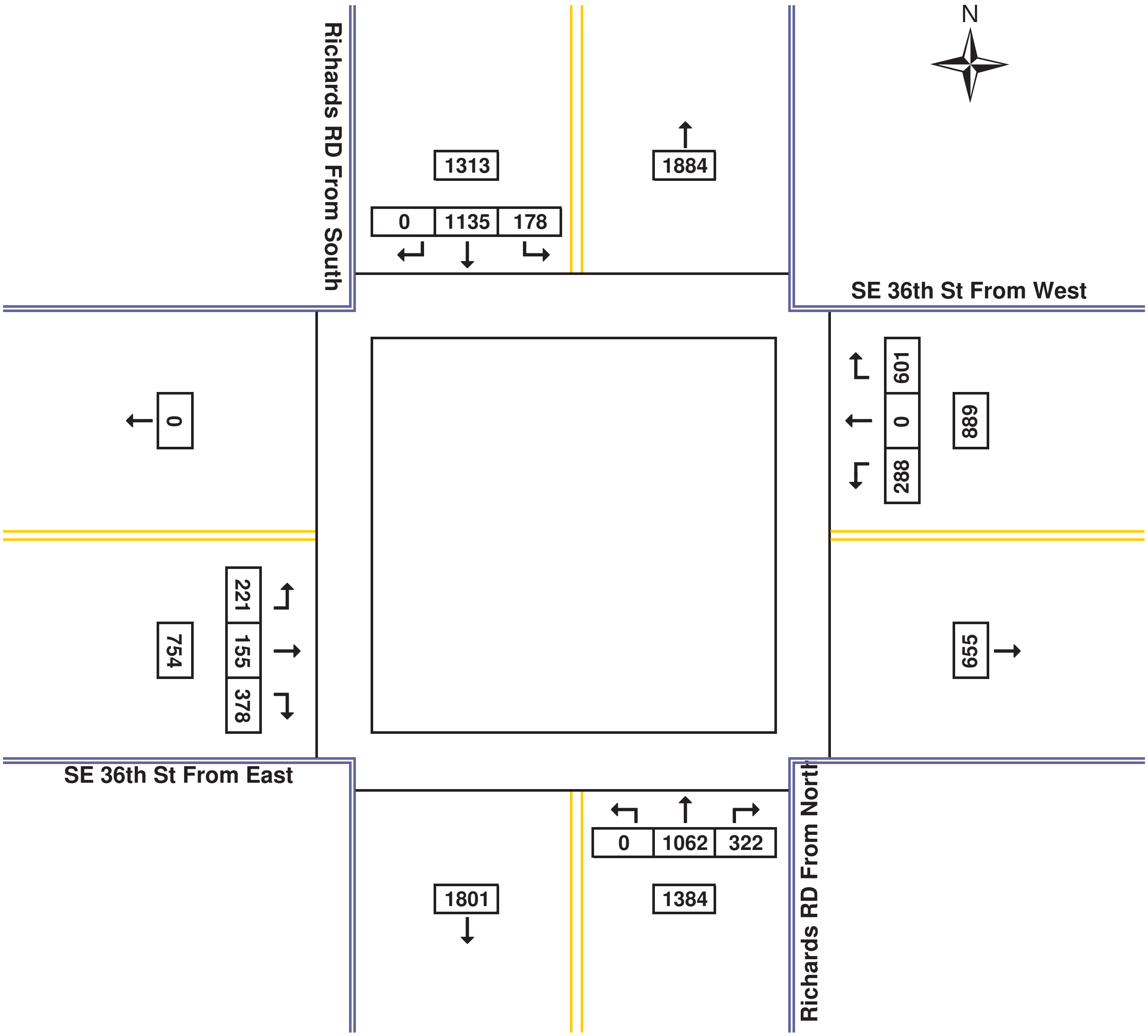
Intersection Turning Movement Counts
Peak Hour Summary Sheet

Data Year: 2008
Int ID: 204

Peak Period: PM
Control Type: Actuated

Richards RD & SE 36th St

4:30 PM to 5:30 PM



Approach	PHF	%Trk	Volume
EB	0.98	3%	754
WB	0.97	1%	889
NB	0.95	0%	1384
SB	0.90	0%	1313
Interection	0.96	1%	4340

Intersection Turning Movement Counts
Peak Hour Calculation Sheet

Data Year: 2008

15-Minutes Interval Summary
4:00 PM to 6:00 PM

Interval Start Time	SB				WB				NB				EB				Interval Total
	Richards RD From South				SE 36th St From West				Richards RD From North				SE 36th St From East				
	L	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	
4:00 PM	36	228	0	0	59	0	93	2	0	240	76	3	56	29	92	6	909
4:15 PM	55	229	0	0	54	0	93	2	0	215	81	3	59	28	85	8	899
4:30 PM	41	250	0	0	85	0	145	5	0	250	91	3	61	42	82	2	1047
4:45 PM	46	290	0	0	69	0	135	2	0	289	74	2	53	28	104	5	1088
5:00 PM	41	282	0	0	72	0	157	2	0	254	81	1	56	37	100	3	1080
5:15 PM	50	313	0	0	62	0	164	6	0	269	76	3	51	48	92	4	1125
5:30 PM	54	285	0	0	82	0	89	6	0	252	93	3	49	42	78	3	1024
5:45 PM	39	260	0	0	66	0	67	6	0	162	81	3	52	32	109	8	868
Total Survey	362	2137	0	0	549	0	943	31	0	1931	653	21	437	286	742	39	8040

Rolling Hour Summary
4:00 PM to 6:00 PM

Interval Start Time	SB				WB				NB				EB				Interval Total
	Richards RD From South				SE 36th St From West				Richards RD From North				SE 36th St From East				
	L	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	**L**	**T**	**R**	**Truck**	
4:00 PM	178	997	0	0	267	0	466	11	0	994	322	11	229	127	363	21	3943
4:15 PM	183	1051	0	0	280	0	530	11	0	1008	327	9	229	135	371	18	4114
4:30 PM	178	1135	0	0	288	0	601	15	0	1062	322	9	221	155	378	14	4340
4:45 PM	191	1170	0	0	285	0	545	16	0	1064	324	9	209	155	374	15	4317
5:00 PM	184	1140	0	0	282	0	477	20	0	937	331	10	208	159	379	18	4097
		0.00				0.02				0.01				0.02			

Peak Hour Summary
4:30 PM to 5:30 PM

By Approach	SB				WB				NB				EB				Total
	Richards RD From South				SE 36th St From West				Richards RD From North				SE 36th St From East				
	In	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	**In**	**Out**	**Total**	**Truck**	
Volume	1313	1884	3197	0	889	655	1544	20	1384	1801	3185	11	754	0	754	21	4340
PHF	0.90				0.97				0.95				0.98				0.96

By Movement	SB				WB				NB				EB				Total
	Richards RD From South				SE 36th St From West				Richards RD From North				SE 36th St From East				
	L	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	**L**	**T**	**R**	**Total**	
Volume	178	1135	0	1313	288	0	601	889	0	1062	322	1384	221	155	378	754	4340
PHF	0.81	0.91	0.00	0.90	0.85	0.00	0.92	0.97	0.00	0.92	0.87	0.95	0.91	0.81	0.87	0.98	0.96

APPENDIX B

Level of Service Concept

LEVEL OF SERVICE CONCEPT

Because intersection capacity and traffic flow performance, or “level of service”, are prime factors in the process of developing and evaluating alternatives, a brief description is presented here for the benefit of the lay reader.

The ratio of existing traffic volume to available capacity provides a measure of the intensity of traffic loading relative to the ability of the street intersection to accommodate the traffic. The number of lanes, presence of turn lanes, type of traffic control, signal phasing, etc., are important factors in determining capacity. As the volume-to-capacity (v/c) ratio approaches a value of 1.0 at signalized intersections, extreme congestion sets in, with long backups and several complete changes of the signal cycles occur before a motorist can proceed. Motorists at stop-sign controlled intersection approaches face extremely long delays when the v/c ratio approaches 1.0. As traffic queues lengthen, this congestion can also impede access to and from upstream abutting property.

The term “level of service” is used to describe traffic flow at intersections. For signalized intersections, the level of service is based on control delay per vehicle (see **table A-1**). Control delay is a measure of all the delay contributable to traffic control measures, such as a traffic signal. Control delay includes initial acceleration delay, queue move-up time, stopped delay, and final acceleration delay.

Table A-1
Level of Service and Volume/Capacity Ratio Relationships for Signalized Intersections

Level of Service	**General Description**	**Control Delay** (seconds/vehicle)[1]	**Intersection V/C Ratio**[2]
A	Free flow	≤ 10.0	≤ 0.60
B	Stable flow (slight delays)	10.1 to 20.0	0.61 to 0.70
C	Stable flow (acceptable delays)	20.1 to 35.0	0.71 to 0.80
D	Approaching unstable flow (tolerable delay - occasionally wait through more than one signal cycle before proceeding)	35.1 to 55.0	0.81 to 0.90
E	Unstable flow (intolerable delay, intersection operating at capacity)	55.1 to 80.0	0.91 to 1.00
F	Forced flow (jammed)	> 80.0	> 1.00

1. For operational analysis method which requires detailed geometric, traffic, and signal information usually used for existing conditions analysis.
2. For planning-level analysis method. Planning-level analysis is used when there is less certainty in the input when default values are typically relied upon and future traffic forecasts are used.

Source: “Highway Capacity Manual”, Transportation Research Board, 1997; and “Interim Materials on Highway Capacity”, *Circular 212*, Transportation Research Board, 1980.

Level of service A is a condition of unimpeded flow, while level of service C is often used in the design of new urban streets as the lowest acceptable level for peak periods. Congestion begins to occur at level of service D (v/c from 0.81 to 0.90). Because of funding and/or environmental constraints for improvements, this level of service is being used by more and more cities as an adequate level, particularly for improvements to congested existing facilities. Increasingly unstable traffic flow with excessive delay and congestion occurs as level of service E (capacity) is approached (v/c = 0.91 to 1.00). For v/c > 1.00, level of service F (forced flow) is obtained, and the intersection is overloaded or is jammed due to traffic backups from overloaded downstream intersections.

It should be noted that equal v/c ratios at several locations do not necessarily indicate equal overall performance of intersections. One intersection may experience a high v/c ratio for a considerable period of the day while at another intersection the peak period lasts a short time. In addition, a low level of service is more tolerable at a low-volume intersection than a high-volume location.

The general level of service concept also holds for stop-sign controlled intersections, although the capacity of the stop-sign controlled approaches is less than that of the signalized intersection approach. **Table A-2** shows the level of service criteria for unsignalized intersections.

Table A-2
Level of Service Criteria for Unsignalized Intersections

Control Delay (d)[1]	**Level of Service**
$d \leq 10$	A
$10 < d \leq 15$	B
$15 < d \leq 25$	C
$25 < d \leq 35$	D
$35 < d \leq 50$	E
$d > 50$	F[2]

1. Control delay is measured in seconds per vehicle.
2. For level of service F, when demand volume exceeds the capacity of the lane, extreme delays will be encountered with queuing which may cause severe congestion affecting other traffic movements in the intersection. This condition usually warrants improvements to the intersection.

Source: "Highway Capacity Manual", Transportation Research Board, 1997.

Capacity analysis for two-way stop-sign controlled intersections is based on the assumption that major street traffic is not affected by the minor street movements, and that left-turns from the major streets to the minor streets are influenced only by opposing major street through flow. Therefore, the level of service calculated for two-way stop intersections is therefore based on delay experienced by only the minor street movements and the major street left-turn movement.

APPENDIX C

Synchro Worksheets

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	17	16	133	97	27	34	210	945	80	46	1305	58
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.98		1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1681	1487	1728	3403		1728	3428	
Flt Permitted	0.51	1.00	1.00		0.74	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	901	1766	1501		1303	1487	1728	3403		1728	3428	
Peak-hour factor, PHF	0.82	0.50	0.76	0.76	0.89	0.50	0.75	0.84	0.63	0.85	0.96	0.76
Adj. Flow (vph)	21	32	175	128	30	68	280	1125	127	54	1359	76
RTOR Reduction (vph)	0	0	0	0	0	0	0	10	0	0	5	0
Lane Group Flow (vph)	21	32	175	0	158	68	280	1242	0	54	1430	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	11.2	11.2	75.0		11.2	75.0	14.7	44.6		4.2	34.1	
Effective Green, g (s)	13.2	13.2	75.0		13.2	75.0	16.7	46.6		6.2	36.1	
Actuated g/C Ratio	0.18	0.18	1.00		0.18	1.00	0.22	0.62		0.08	0.48	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	159	311	1501		229	1487	385	2114		143	1650	
v/s Ratio Prot		0.02					c0.16	0.37		0.03	c0.42	
v/s Ratio Perm	0.02		0.12		c0.12	0.05						
v/c Ratio	0.13	0.10	0.12		0.69	0.05	0.73	0.59		0.38	0.87	
Uniform Delay, d1	26.1	25.9	0.0		29.0	0.0	27.0	8.5		32.6	17.3	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.23	1.73		1.00	1.00	
Incremental Delay, d2	0.1	0.1	0.2		6.7	0.1	5.5	1.2		0.6	6.4	
Delay (s)	26.2	26.0	0.2		35.7	0.1	38.9	15.8		33.2	23.7	
Level of Service	C	C	A		D	A	D	B		C	C	
Approach Delay (s)		6.2			25.0			20.0			24.1	
Approach LOS		A			C			C			C	

Intersection Summary			
HCM Average Control Delay	21.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	73.0%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	228	167	113	423	1122	261	173	1248	114
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1772	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.99	1.00	0.95	1.00	1.00	0.20	1.00	1.00
Satd. Flow (perm)				1698	1772	1599	1711	3421	1583	368	6194	1531
Peak-hour factor, PHF	0.25	0.25	0.25	0.88	0.89	0.71	0.67	0.97	0.84	0.93	0.91	0.78
Adj. Flow (vph)	0	0	0	259	188	159	631	1157	311	186	1371	146
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	17	0	0	0
Lane Group Flow (vph)	0	0	0	220	227	159	631	1157	294	186	1371	146
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Perm		Free	Prot		Perm	Perm		custom
Protected Phases					4		1	6			2	2
Permitted Phases				4		Free			6	2		4 1
Actuated Green, G (s)				23.8	23.8	150.0	45.0	116.2	116.2	66.2	66.2	140.0
Effective Green, g (s)				25.8	25.8	150.0	47.0	118.2	118.2	68.2	68.2	144.0
Actuated g/C Ratio				0.17	0.17	1.00	0.31	0.79	0.79	0.45	0.45	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				292	305	1599	536	2696	1247	167	2816	1531
v/s Ratio Prot							c0.37	0.34			0.22	0.04
v/s Ratio Perm				c0.13	0.13	0.10			0.19	c0.51		0.05
v/c Ratio				0.75	0.74	0.10	1.18	0.43	0.24	1.11	0.49	0.10
Uniform Delay, d1				59.1	59.0	0.0	51.5	5.1	4.1	40.9	28.6	0.1
Progression Factor				1.00	1.00	1.00	0.76	0.81	0.85	0.71	0.75	1.00
Incremental Delay, d2				9.4	8.3	0.1	96.0	0.4	0.4	91.7	0.0	0.0
Delay (s)				68.5	67.3	0.1	135.0	4.6	3.9	120.8	21.4	0.1
Level of Service				E	E	A	F	A	A	F	C	A
Approach Delay (s)		0.0			50.1			43.7			30.4	
Approach LOS		A			D			D			C	

Intersection Summary			
HCM Average Control Delay	39.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.07		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	62.2%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	88	162	908	88	54	1321
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.98		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3486		1770	3539
Flt Permitted	0.95	1.00	1.00		0.14	1.00
Satd. Flow (perm)	1703	1524	3486		267	3539
Peak-hour factor, PHF	0.84	0.74	0.93	0.81	0.51	0.97
Adj. Flow (vph)	105	219	976	109	106	1362
RTOR Reduction (vph)	0	172	8	0	0	0
Lane Group Flow (vph)	105	47	1077	0	106	1362
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	9.7	9.7	23.9		34.5	34.5
Effective Green, g (s)	11.7	11.7	25.9		36.5	36.5
Actuated g/C Ratio	0.22	0.22	0.48		0.67	0.67
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	368	329	1666		391	2383
v/s Ratio Prot	c0.06		c0.31		0.04	c0.38
v/s Ratio Perm		0.03			0.14	
v/c Ratio	0.29	0.14	0.65		0.27	0.57
Uniform Delay, d1	17.8	17.2	10.7		5.1	4.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	0.2	0.7		0.1	0.2
Delay (s)	18.2	17.4	11.3		5.2	4.9
Level of Service	B	B	B		A	A
Approach Delay (s)	17.7		11.3			4.9
Approach LOS	B		B			A

Intersection Summary			
HCM Average Control Delay	8.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	54.2	Sum of lost time (s)	9.0
Intersection Capacity Utilization	49.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	203	160	384	304	0	578	0	1025	349	202	1274	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1613	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1613	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.91	0.81	0.87	0.85	0.90	0.92	0.90	0.92	0.87	0.81	0.91	0.25
Adj. Flow (vph)	223	198	441	358	0	628	0	1114	401	249	1400	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	127	0	0	0
Lane Group Flow (vph)	201	220	441	358	0	628	0	1114	274	249	1400	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	25.5	25.5	150.0	20.1		140.0		61.0	81.1	23.4	89.4	
Effective Green, g (s)	27.5	27.5	150.0	22.1		144.0		63.0	85.1	25.4	91.4	
Actuated g/C Ratio	0.18	0.18	1.00	0.15		0.96		0.42	0.57	0.17	0.61	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	298	296	1531	489		1531		1833	877	295	3055	
v/s Ratio Prot	0.12	c0.14		c0.11		0.06		c0.26	0.13	c0.14	0.28	
v/s Ratio Perm			0.29			0.35			0.05			
v/c Ratio	0.67	0.74	0.29	0.73		0.41		0.61	0.31	0.84	0.46	
Uniform Delay, d1	57.1	57.9	0.0	61.1		0.2		33.9	17.1	60.4	15.9	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	0.76	1.00	
Incremental Delay, d2	4.7	8.5	0.0	4.8		0.1		1.5	0.1	16.8	0.4	
Delay (s)	61.8	66.4	0.0	66.0		0.3		35.4	17.1	62.4	16.3	
Level of Service	E	E	A	E		A		D	B	E	B	
Approach Delay (s)		31.4			24.1			30.6			23.3	
Approach LOS		C			C			C			C	

Intersection Summary			
HCM Average Control Delay	27.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.70		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.4%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	13	145	125	40	38	274	881	96	37	1305	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	1.00	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1685	1487	1728	3404		1728	3439	
Flt Permitted	0.49	1.00	1.00		0.77	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	871	1766	1501		1345	1487	1728	3404		1728	3439	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	12	14	161	139	44	42	304	979	107	41	1450	46
RTOR Reduction (vph)	0	0	0	0	0	0	0	8	0	0	3	0
Lane Group Flow (vph)	12	14	161	0	183	42	304	1078	0	41	1493	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	13.9	13.9	75.0		13.9	75.0	11.0	41.5		4.6	35.1	
Effective Green, g (s)	15.9	15.9	75.0		15.9	75.0	13.0	43.5		6.6	37.1	
Actuated g/C Ratio	0.21	0.21	1.00		0.21	1.00	0.17	0.58		0.09	0.49	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	185	374	1501		285	1487	300	1974		152	1701	
v/s Ratio Prot		0.01					c0.18	0.32		0.02	c0.43	
v/s Ratio Perm	0.01		0.11		c0.14	0.03						
v/c Ratio	0.06	0.04	0.11		0.64	0.03	1.01	0.55		0.27	0.88	
Uniform Delay, d1	23.6	23.5	0.0		27.0	0.0	31.0	9.7		31.9	16.9	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.94		1.00	1.00	
Incremental Delay, d2	0.1	0.0	0.1		3.7	0.0	53.5	1.0		0.3	6.8	
Delay (s)	23.7	23.5	0.1		30.6	0.0	92.4	10.1		32.3	23.7	
Level of Service	C	C	A		C	A	F	B		C	C	
Approach Delay (s)		3.4			24.9			28.1			23.9	
Approach LOS		A			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	223	161	141	406	1110	297	152	1312	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1771	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.99	1.00	0.95	1.00	1.00	0.19	1.00	1.00
Satd. Flow (perm)				1698	1771	1599	1711	3421	1583	351	6194	1531
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	248	179	157	451	1233	330	169	1458	123
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	23	0	0	0
Lane Group Flow (vph)	0	0	0	208	219	157	451	1233	307	169	1458	123
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Split		Free	Prot		Perm	Perm		custom
Protected Phases				4	4		1	6			2	2
Permitted Phases						Free			6	2		4 1
Actuated Green, G (s)				22.5	22.5	150.0	30.8	117.5	117.5	81.7	81.7	140.0
Effective Green, g (s)				24.5	24.5	150.0	32.8	119.5	119.5	83.7	83.7	144.0
Actuated g/C Ratio				0.16	0.16	1.00	0.22	0.80	0.80	0.56	0.56	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				277	289	1599	374	2725	1261	196	3456	1531
v/s Ratio Prot				0.12	c0.12		c0.26	0.36			0.24	0.04
v/s Ratio Perm						0.10			0.19	c0.48		0.04
v/c Ratio				0.75	0.76	0.10	1.21	0.45	0.24	0.86	0.42	0.08
Uniform Delay, d1				59.8	59.9	0.0	58.6	4.8	3.8	28.2	19.2	0.1
Progression Factor				1.00	1.00	1.00	0.75	0.34	0.23	0.64	0.68	1.00
Incremental Delay, d2				9.7	9.7	0.1	112.5	0.5	0.4	21.3	0.0	0.0
Delay (s)				69.6	69.6	0.1	156.5	2.1	1.3	39.5	13.0	0.1
Level of Service				E	E	A	F	A	A	D	B	A
Approach Delay (s)		0.0			50.9			36.5			14.7	
Approach LOS		A			D			D			B	

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	91	160	850	80	58	1292
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.99		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3493		1770	3539
Flt Permitted	0.95	1.00	1.00		0.17	1.00
Satd. Flow (perm)	1703	1524	3493		326	3539
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	101	178	944	89	64	1436
RTOR Reduction (vph)	0	140	8	0	0	0
Lane Group Flow (vph)	101	38	1025	0	64	1436
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	9.4	9.4	25.7		34.5	34.5
Effective Green, g (s)	11.4	11.4	27.7		36.5	36.5
Actuated g/C Ratio	0.21	0.21	0.51		0.68	0.68
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	360	322	1795		376	2397
v/s Ratio Prot	c0.06		0.29		0.02	c0.41
v/s Ratio Perm		0.02			0.10	
v/c Ratio	0.28	0.12	0.57		0.17	0.60
Uniform Delay, d1	17.8	17.2	9.0		4.3	4.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	0.2	0.3		0.1	0.3
Delay (s)	18.2	17.3	9.3		4.4	5.0
Level of Service	B	B	A		A	A
Approach Delay (s)	17.7		9.3			5.0
Approach LOS	B		A			A

Intersection Summary			
HCM Average Control Delay	7.8	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	53.9	Sum of lost time (s)	6.0
Intersection Capacity Utilization	48.2%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
204: I-90 Off & Richards Road

5/17/2011

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	163	130	428	288	0	574	0	1076	367	236	1299	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	181	144	476	320	0	638	0	1196	408	262	1443	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	144	0	0	0
Lane Group Flow (vph)	159	166	476	320	0	638	0	1196	264	262	1443	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	20.2	20.2	150.0	19.5		140.0		64.8	84.3	25.5	95.3	
Effective Green, g (s)	22.2	22.2	150.0	21.5		144.0		66.8	88.3	27.5	97.3	
Actuated g/C Ratio	0.15	0.15	1.00	0.14		0.96		0.45	0.59	0.18	0.65	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	241	238	1531	476		1531		1943	910	320	3252	
v/s Ratio Prot	0.10	c0.10		c0.10		0.06		c0.27	0.13	c0.15	0.29	
v/s Ratio Perm			0.31			0.36			0.04			
v/c Ratio	0.66	0.70	0.31	0.67		0.42		0.62	0.29	0.82	0.44	
Uniform Delay, d1	60.3	60.7	0.0	60.9		0.2		31.8	15.3	58.9	13.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	0.85	0.14	
Incremental Delay, d2	4.9	7.0	0.0	2.9		0.1		1.5	0.1	13.1	0.4	
Delay (s)	65.2	67.7	0.0	63.8		0.3		33.3	15.4	63.4	2.3	
Level of Service	E	E	A	E		A		C	B	E	A	
Approach Delay (s)		27.0			21.5			28.7			11.7	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	21.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	11	13	145	127	40	41	274	875	98	40	1301	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.98		1.00	1.00	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1685	1487	1728	3403		1728	3439	
Flt Permitted	0.49	1.00	1.00		0.77	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	866	1766	1501		1344	1487	1728	3403		1728	3439	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	12	14	161	141	44	46	304	972	109	44	1446	46
RTOR Reduction (vph)	0	0	0	0	0	0	0	8	0	0	3	0
Lane Group Flow (vph)	12	14	161	0	185	46	304	1073	0	44	1489	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	14.0	14.0	75.0		14.0	75.0	10.9	41.4		4.6	35.1	
Effective Green, g (s)	16.0	16.0	75.0		16.0	75.0	12.9	43.4		6.6	37.1	
Actuated g/C Ratio	0.21	0.21	1.00		0.21	1.00	0.17	0.58		0.09	0.49	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	185	377	1501		287	1487	297	1969		152	1701	
v/s Ratio Prot		0.01					c0.18	0.32		0.03	c0.43	
v/s Ratio Perm	0.01		0.11		c0.14	0.03						
v/c Ratio	0.06	0.04	0.11		0.64	0.03	1.02	0.54		0.29	0.88	
Uniform Delay, d1	23.5	23.4	0.0		26.9	0.0	31.1	9.7		32.0	16.9	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.94		1.00	1.00	
Incremental Delay, d2	0.1	0.0	0.1		3.7	0.0	56.5	1.0		0.4	6.7	
Delay (s)	23.6	23.4	0.1		30.6	0.0	95.6	10.2		32.4	23.6	
Level of Service	C	C	A		C	A	F	B		C	C	
Approach Delay (s)		3.4			24.5			28.9			23.8	
Approach LOS		A			C			C			C	

Intersection Summary			
HCM Average Control Delay	24.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.85		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	78.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	223	161	140	406	1107	297	151	1311	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1771	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.99	1.00	0.95	1.00	1.00	0.19	1.00	1.00
Satd. Flow (perm)				1698	1771	1599	1711	3421	1583	353	6194	1531
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	248	179	156	451	1230	330	168	1457	123
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	23	0	0	0
Lane Group Flow (vph)	0	0	0	208	219	156	451	1230	307	168	1457	123
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Split		Free	Prot		Perm	Perm		custom
Protected Phases				4	4		1	6			2	2
Permitted Phases						Free			6	2		4 1
Actuated Green, G (s)				22.5	22.5	150.0	30.8	117.5	117.5	81.7	81.7	140.0
Effective Green, g (s)				24.5	24.5	150.0	32.8	119.5	119.5	83.7	83.7	144.0
Actuated g/C Ratio				0.16	0.16	1.00	0.22	0.80	0.80	0.56	0.56	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				277	289	1599	374	2725	1261	197	3456	1531
v/s Ratio Prot				0.12	c0.12		c0.26	0.36			0.24	0.04
v/s Ratio Perm						0.10			0.19	c0.48		0.04
v/c Ratio				0.75	0.76	0.10	1.21	0.45	0.24	0.85	0.42	0.08
Uniform Delay, d1				59.8	59.9	0.0	58.6	4.8	3.8	28.0	19.2	0.1
Progression Factor				1.00	1.00	1.00	0.75	0.34	0.23	0.65	0.68	1.00
Incremental Delay, d2				9.7	9.7	0.1	112.5	0.5	0.4	19.8	0.0	0.0
Delay (s)				69.6	69.6	0.1	156.6	2.1	1.3	37.9	13.0	0.1
Level of Service				E	E	A	F	A	A	D	B	A
Approach Delay (s)		0.0			51.0			36.6			14.5	
Approach LOS		A			D			D			B	

Intersection Summary			
HCM Average Control Delay	29.6	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	87	154	853	74	49	1295
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.99		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3497		1770	3539
Flt Permitted	0.95	1.00	1.00		0.18	1.00
Satd. Flow (perm)	1703	1524	3497		330	3539
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	97	171	948	82	54	1439
RTOR Reduction (vph)	0	135	7	0	0	0
Lane Group Flow (vph)	97	36	1023	0	54	1439
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	9.3	9.3	25.9		34.7	34.7
Effective Green, g (s)	11.3	11.3	27.9		36.7	36.7
Actuated g/C Ratio	0.21	0.21	0.52		0.68	0.68
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	356	319	1807		379	2405
v/s Ratio Prot	c0.06		0.29		0.02	c0.41
v/s Ratio Perm		0.02			0.08	
v/c Ratio	0.27	0.11	0.57		0.14	0.60
Uniform Delay, d1	17.9	17.3	8.9		4.2	4.7
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.4	0.2	0.2		0.1	0.3
Delay (s)	18.3	17.4	9.2		4.2	4.9
Level of Service	B	B	A		A	A
Approach Delay (s)	17.8		9.2			4.9
Approach LOS	B		A			A

Intersection Summary			
HCM Average Control Delay	7.7	HCM Level of Service	A
HCM Volume to Capacity ratio	0.52		
Actuated Cycle Length (s)	54.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	48.3%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	162	130	428	288	0	573	0	1075	367	235	1299	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	180	144	476	320	0	637	0	1194	408	261	1443	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	143	0	0	0
Lane Group Flow (vph)	158	166	476	320	0	637	0	1194	265	261	1443	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	20.2	20.2	150.0	19.5		140.0		64.9	84.4	25.4	95.3	
Effective Green, g (s)	22.2	22.2	150.0	21.5		144.0		66.9	88.4	27.4	97.3	
Actuated g/C Ratio	0.15	0.15	1.00	0.14		0.96		0.45	0.59	0.18	0.65	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	241	238	1531	476		1531		1946	911	319	3252	
v/s Ratio Prot	0.10	c0.10		c0.10		0.06		c0.27	0.13	c0.15	0.29	
v/s Ratio Perm			0.31			0.36			0.04			
v/c Ratio	0.66	0.70	0.31	0.67		0.42		0.61	0.29	0.82	0.44	
Uniform Delay, d1	60.3	60.7	0.0	60.9		0.2		31.7	15.3	58.9	13.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	0.85	0.14	
Incremental Delay, d2	4.8	7.0	0.0	2.9		0.1		1.5	0.1	13.1	0.4	
Delay (s)	65.1	67.7	0.0	63.8		0.3		33.1	15.3	63.4	2.3	
Level of Service	E	E	A	E		A		C	B	E	A	
Approach Delay (s)		26.9			21.5			28.6			11.6	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	21.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	14	10	145	107	34	34	274	896	77	31	1321	47
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1685	1487	1728	3414		1728	3437	
Flt Permitted	0.53	1.00	1.00		0.77	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	938	1766	1501		1349	1487	1728	3414		1728	3437	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	16	11	161	119	38	38	304	996	86	34	1468	52
RTOR Reduction (vph)	0	0	0	0	0	0	0	5	0	0	2	0
Lane Group Flow (vph)	16	11	161	0	157	38	304	1077	0	34	1518	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	12.5	12.5	75.0		12.5	75.0	11.9	44.5		3.0	35.6	
Effective Green, g (s)	14.5	14.5	75.0		14.5	75.0	13.9	46.5		5.0	37.6	
Actuated g/C Ratio	0.19	0.19	1.00		0.19	1.00	0.19	0.62		0.07	0.50	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	181	341	1501		261	1487	320	2117		115	1723	
v/s Ratio Prot		0.01					c0.18	0.32		0.02	c0.44	
v/s Ratio Perm	0.02		0.11		c0.12	0.03						
v/c Ratio	0.09	0.03	0.11		0.60	0.03	0.95	0.51		0.30	0.88	
Uniform Delay, d1	24.8	24.6	0.0		27.6	0.0	30.2	7.9		33.3	16.7	
Progression Factor	1.00	1.00	1.00		1.00	1.00	1.26	0.92		1.00	1.00	
Incremental Delay, d2	0.1	0.0	0.1		2.7	0.0	34.8	0.8		0.5	6.8	
Delay (s)	24.9	24.6	0.1		30.3	0.0	72.8	8.1		33.8	23.5	
Level of Service	C	C	A		C	A	E	A		C	C	
Approach Delay (s)		3.7			24.4			22.3			23.8	
Approach LOS		A			C			C			C	

Intersection Summary			
HCM Average Control Delay	22.0	HCM Level of Service	C
HCM Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	75.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	77.6%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	223	161	140	406	1107	297	151	1311	111
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.99	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1771	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.99	1.00	0.95	1.00	1.00	0.19	1.00	1.00
Satd. Flow (perm)				1698	1771	1599	1711	3421	1583	353	6194	1531
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	248	179	156	451	1230	330	168	1457	123
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	23	0	0	0
Lane Group Flow (vph)	0	0	0	208	219	156	451	1230	307	168	1457	123
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Split		Free	Prot		Perm	Perm		custom
Protected Phases				4	4		1	6			2	2
Permitted Phases						Free			6	2		4 1
Actuated Green, G (s)				22.5	22.5	150.0	30.8	117.5	117.5	81.7	81.7	140.0
Effective Green, g (s)				24.5	24.5	150.0	32.8	119.5	119.5	83.7	83.7	144.0
Actuated g/C Ratio				0.16	0.16	1.00	0.22	0.80	0.80	0.56	0.56	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				277	289	1599	374	2725	1261	197	3456	1531
v/s Ratio Prot				0.12	c0.12		c0.26	0.36			0.24	0.04
v/s Ratio Perm						0.10			0.19	c0.48		0.04
v/c Ratio				0.75	0.76	0.10	1.21	0.45	0.24	0.85	0.42	0.08
Uniform Delay, d1				59.8	59.9	0.0	58.6	4.8	3.8	28.0	19.2	0.1
Progression Factor				1.00	1.00	1.00	0.75	0.34	0.23	0.64	0.69	1.00
Incremental Delay, d2				9.7	9.7	0.1	112.5	0.5	0.4	20.1	0.0	0.0
Delay (s)				69.6	69.6	0.1	156.6	2.1	1.3	38.0	13.2	0.1
Level of Service				E	E	A	F	A	A	D	B	A
Approach Delay (s)		0.0			51.0			36.6			14.7	
Approach LOS		A			D			D			B	

Intersection Summary			
HCM Average Control Delay	29.7	HCM Level of Service	C
HCM Volume to Capacity ratio	0.92		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	61.9%	ICU Level of Service	B
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	113	161	846	98	58	1286
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.98		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3484		1770	3539
Flt Permitted	0.95	1.00	1.00		0.17	1.00
Satd. Flow (perm)	1703	1524	3484		311	3539
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	126	179	940	109	64	1429
RTOR Reduction (vph)	0	139	9	0	0	0
Lane Group Flow (vph)	126	40	1040	0	64	1429
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	10.3	10.3	25.7		34.4	34.4
Effective Green, g (s)	12.3	12.3	27.7		36.4	36.4
Actuated g/C Ratio	0.22	0.22	0.51		0.67	0.67
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	383	343	1764		359	2355
v/s Ratio Prot	c0.07		0.30		0.02	c0.40
v/s Ratio Perm		0.03			0.10	
v/c Ratio	0.33	0.12	0.59		0.18	0.61
Uniform Delay, d1	17.7	16.9	9.5		4.7	5.1
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.5	0.2	0.3		0.1	0.3
Delay (s)	18.3	17.0	9.8		4.8	5.4
Level of Service	B	B	A		A	A
Approach Delay (s)	17.5		9.8			5.4
Approach LOS	B		A			A

Intersection Summary			
HCM Average Control Delay	8.3	HCM Level of Service	A
HCM Volume to Capacity ratio	0.54		
Actuated Cycle Length (s)	54.7	Sum of lost time (s)	6.0
Intersection Capacity Utilization	48.6%	ICU Level of Service	A
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	162	130	428	288	0	573	0	1075	367	235	1299	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	0.99	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1610	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	180	144	476	320	0	637	0	1194	408	261	1443	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	143	0	0	0
Lane Group Flow (vph)	158	166	476	320	0	637	0	1194	265	261	1443	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	20.2	20.2	150.0	19.5		140.0		64.9	84.4	25.4	95.3	
Effective Green, g (s)	22.2	22.2	150.0	21.5		144.0		66.9	88.4	27.4	97.3	
Actuated g/C Ratio	0.15	0.15	1.00	0.14		0.96		0.45	0.59	0.18	0.65	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	241	238	1531	476		1531		1946	911	319	3252	
v/s Ratio Prot	0.10	c0.10		c0.10		0.06		c0.27	0.13	c0.15	0.29	
v/s Ratio Perm			0.31			0.36			0.04			
v/c Ratio	0.66	0.70	0.31	0.67		0.42		0.61	0.29	0.82	0.44	
Uniform Delay, d1	60.3	60.7	0.0	60.9		0.2		31.7	15.3	58.9	13.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	0.86	0.14	
Incremental Delay, d2	4.8	7.0	0.0	2.9		0.1		1.5	0.1	13.1	0.4	
Delay (s)	65.1	67.7	0.0	63.8		0.3		33.1	15.3	63.7	2.3	
Level of Service	E	E	A	E		A		C	B	E	A	
Approach Delay (s)		26.9			21.5			28.6			11.7	
Approach LOS		C			C			C			B	

Intersection Summary			
HCM Average Control Delay	21.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.68		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	74.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	48	420	101	104	87	401	994	59	62	1802	159
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.98	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1707	1487	1728	3426		1728	3413	
Flt Permitted	0.28	1.00	1.00		0.80	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	490	1766	1501		1391	1487	1728	3426		1728	3413	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	89	53	467	112	116	97	446	1104	66	69	2002	177
RTOR Reduction (vph)	0	0	0	0	0	0	0	3	0	0	5	0
Lane Group Flow (vph)	89	53	467	0	228	97	446	1167	0	69	2174	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	25.0	25.0	150.0		25.0	150.0	32.0	102.3		7.7	78.0	
Effective Green, g (s)	27.0	27.0	150.0		27.0	150.0	34.0	104.3		9.7	80.0	
Actuated g/C Ratio	0.18	0.18	1.00		0.18	1.00	0.23	0.70		0.06	0.53	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	88	318	1501		250	1487	392	2382		112	1820	
v/s Ratio Prot		0.03					c0.26	0.34		0.04	c0.64	
v/s Ratio Perm	c0.18		0.31		0.16	0.07						
v/c Ratio	1.01	0.17	0.31		0.91	0.07	1.14	0.49		0.62	1.19	
Uniform Delay, d1	61.5	52.0	0.0		60.3	0.0	58.0	10.6		68.3	35.0	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.62	0.29		1.00	1.00	
Incremental Delay, d2	99.1	0.1	0.5		33.8	0.1	85.6	0.6		6.9	93.3	
Delay (s)	160.6	52.1	0.5		94.1	0.1	121.7	3.7		75.2	128.3	
Level of Service	F	D	A		F	A	F	A		E	F	
Approach Delay (s)		28.4			66.0			36.3			126.7	
Approach LOS		C			E			D			F	

Intersection Summary			
HCM Average Control Delay	79.6	HCM Level of Service	E
HCM Volume to Capacity ratio	1.15		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	104.8%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	319	131	102	428	1352	309	180	2015	128
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1750	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.98	1.00	0.95	1.00	1.00	0.13	1.00	1.00
Satd. Flow (perm)				1698	1750	1599	1711	3421	1583	239	6194	1531
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	354	146	113	476	1502	343	200	2239	142
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	20	0	0	0
Lane Group Flow (vph)	0	0	0	248	252	113	476	1502	323	200	2239	142
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Split		Free	Prot		Perm	Perm		custom
Protected Phases				4	4		1	6			2	2
Permitted Phases						Free			6	2		4 1
Actuated Green, G (s)				25.2	25.2	150.0	23.0	114.8	114.8	86.8	86.8	140.0
Effective Green, g (s)				27.2	27.2	150.0	25.0	116.8	116.8	88.8	88.8	144.0
Actuated g/C Ratio				0.18	0.18	1.00	0.17	0.78	0.78	0.59	0.59	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				308	317	1599	285	2664	1233	141	3667	1531
v/s Ratio Prot				c0.15	0.14		c0.28	0.44			0.36	0.05
v/s Ratio Perm						0.07			0.20	c0.84		0.04
v/c Ratio				0.81	0.79	0.07	1.67	0.56	0.26	1.42	0.61	0.09
Uniform Delay, d1				58.9	58.7	0.0	62.5	6.5	4.6	30.6	19.6	0.1
Progression Factor				1.00	1.00	1.00	0.66	0.33	0.23	0.19	0.17	1.00
Incremental Delay, d2				13.4	12.1	0.1	312.2	0.6	0.4	192.1	0.0	0.0
Delay (s)				72.3	70.8	0.1	353.8	2.7	1.4	197.8	3.3	0.1
Level of Service				E	E	A	F	A	A	F	A	A
Approach Delay (s)		0.0			58.4			74.5			18.2	
Approach LOS		A			E			E			B	

Intersection Summary			
HCM Average Control Delay	46.4	HCM Level of Service	D
HCM Volume to Capacity ratio	1.34		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	94	152	1079	82	55	1929
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.99		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3502		1770	3539
Flt Permitted	0.95	1.00	1.00		0.15	1.00
Satd. Flow (perm)	1703	1524	3502		272	3539
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	104	169	1199	91	61	2143
RTOR Reduction (vph)	0	142	5	0	0	0
Lane Group Flow (vph)	104	27	1285	0	61	2143
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	10.2	10.2	46.5		55.5	55.5
Effective Green, g (s)	12.2	12.2	48.5		57.5	57.5
Actuated g/C Ratio	0.16	0.16	0.64		0.76	0.76
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	274	246	2244		325	2688
v/s Ratio Prot	c0.06		0.37		0.01	c0.61
v/s Ratio Perm		0.02			0.13	
v/c Ratio	0.38	0.11	0.57		0.19	0.80
Uniform Delay, d1	28.4	27.1	7.7		4.4	5.5
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.9	0.2	0.2		0.1	1.6
Delay (s)	29.2	27.3	7.9		4.5	7.2
Level of Service	C	C	A		A	A
Approach Delay (s)	28.1		7.9			7.1
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	8.9	HCM Level of Service	A
HCM Volume to Capacity ratio	0.72		
Actuated Cycle Length (s)	75.7	Sum of lost time (s)	6.0
Intersection Capacity Utilization	65.8%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	130	139	521	372	0	551	0	1408	495	238	2096	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1614	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1614	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	144	154	579	413	0	612	0	1564	550	264	2329	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	132	0	0	0
Lane Group Flow (vph)	130	168	579	413	0	612	0	1564	418	264	2329	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	20.7	20.7	150.0	23.0		140.0		61.0	84.0	25.3	91.3	
Effective Green, g (s)	22.7	22.7	150.0	25.0		144.0		63.0	88.0	27.3	93.3	
Actuated g/C Ratio	0.15	0.15	1.00	0.17		0.96		0.42	0.59	0.18	0.62	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	246	244	1531	553		1531		1833	907	318	3119	
v/s Ratio Prot	0.08	c0.10		c0.12		0.07		c0.36	0.19	c0.15	0.46	
v/s Ratio Perm			0.38			0.33			0.08			
v/c Ratio	0.53	0.69	0.38	0.75		0.40		0.85	0.46	0.83	0.75	
Uniform Delay, d1	58.7	60.3	0.0	59.5		0.2		39.3	17.6	59.1	20.0	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.08	0.24	
Incremental Delay, d2	0.9	6.3	0.1	4.8		0.1		5.3	0.1	12.9	1.3	
Delay (s)	59.7	66.6	0.1	64.3		0.3		44.6	17.7	76.4	6.0	
Level of Service	E	E	A	E		A		D	B	E	A	
Approach Delay (s)		21.6			26.1			37.6			13.2	
Approach LOS		C			C			D			B	

Intersection Summary			
HCM Average Control Delay	24.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	93.4%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	80	48	420	111	104	99	401	996	69	74	1804	159
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	2.0		3.0	2.0	3.0	3.0		3.0	3.0	
Lane Util. Factor	1.00	1.00	1.00		1.00	1.00	1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85		1.00	0.85	1.00	0.99		1.00	0.99	
Flt Protected	0.95	1.00	1.00		0.97	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1678	1766	1501		1705	1487	1728	3421		1728	3413	
Flt Permitted	0.25	1.00	1.00		0.79	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	446	1766	1501		1379	1487	1728	3421		1728	3413	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	89	53	467	123	116	110	446	1107	77	82	2004	177
RTOR Reduction (vph)	0	0	0	0	0	0	0	3	0	0	5	0
Lane Group Flow (vph)	89	53	467	0	239	110	446	1181	0	82	2176	0
Heavy Vehicles (%)	4%	4%	4%	5%	5%	5%	1%	1%	1%	1%	1%	1%
Turn Type	Perm		Free	Perm		Free	Prot			Prot		
Protected Phases		8			4		1	6		5	2	
Permitted Phases	8		Free	4		Free						
Actuated Green, G (s)	25.0	25.0	150.0		25.0	150.0	31.0	100.1		9.9	79.0	
Effective Green, g (s)	27.0	27.0	150.0		27.0	150.0	33.0	102.1		11.9	81.0	
Actuated g/C Ratio	0.18	0.18	1.00		0.18	1.00	0.22	0.68		0.08	0.54	
Clearance Time (s)	5.0	5.0			5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	2.0	2.0			2.0		2.0	2.0		2.0	2.0	
Lane Grp Cap (vph)	80	318	1501		248	1487	380	2329		137	1843	
v/s Ratio Prot		0.03					c0.26	0.35		0.05	c0.64	
v/s Ratio Perm	c0.20		0.31		0.17	0.07						
v/c Ratio	1.11	0.17	0.31		0.96	0.07	1.17	0.51		0.60	1.18	
Uniform Delay, d1	61.5	52.0	0.0		61.0	0.0	58.5	11.7		66.7	34.5	
Progression Factor	1.00	1.00	1.00		1.00	1.00	0.63	0.28		1.00	1.00	
Incremental Delay, d2	134.4	0.1	0.5		46.5	0.1	99.7	0.7		4.6	87.3	
Delay (s)	195.9	52.1	0.5		107.5	0.1	136.3	4.0		71.4	121.8	
Level of Service	F	D	A		F	A	F	A		E	F	
Approach Delay (s)		33.6			73.7			40.2			120.0	
Approach LOS		C			E			D			F	

Intersection Summary			
HCM Average Control Delay	79.0	HCM Level of Service	E
HCM Volume to Capacity ratio	1.17		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	105.4%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	0	0	319	131	103	428	1363	309	181	2025	129
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	12	11	12	12	12	11	11	12	12	11	11
Total Lost time (s)				3.0	3.0	2.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Util. Factor				0.95	0.95	1.00	1.00	0.95	1.00	1.00	0.86	1.00
Frt				1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected				0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)				1698	1750	1599	1711	3421	1583	1770	6194	1531
Flt Permitted				0.95	0.98	1.00	0.95	1.00	1.00	0.13	1.00	1.00
Satd. Flow (perm)				1698	1750	1599	1711	3421	1583	235	6194	1531
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	0	0	354	146	114	476	1514	343	201	2250	143
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	21	0	0	0
Lane Group Flow (vph)	0	0	0	248	252	114	476	1514	322	201	2250	143
Heavy Vehicles (%)	0%	0%	0%	1%	1%	1%	2%	2%	2%	2%	2%	2%
Turn Type				Split		Free	Prot		Perm	Perm		custom
Protected Phases				4	4		1	6			2	2
Permitted Phases						Free			6	2		4 1
Actuated Green, G (s)				24.9	24.9	150.0	24.0	115.1	115.1	86.1	86.1	140.0
Effective Green, g (s)				26.9	26.9	150.0	26.0	117.1	117.1	88.1	88.1	144.0
Actuated g/C Ratio				0.18	0.18	1.00	0.17	0.78	0.78	0.59	0.59	0.96
Clearance Time (s)				5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)				2.0	2.0		2.0	2.0	2.0	2.0	2.0	2.0
Lane Grp Cap (vph)				305	314	1599	297	2671	1236	138	3638	1531
v/s Ratio Prot				c0.15	0.14		c0.28	0.44			0.36	0.05
v/s Ratio Perm						0.07			0.20	c0.86		0.04
v/c Ratio				0.81	0.80	0.07	1.60	0.57	0.26	1.46	0.62	0.09
Uniform Delay, d1				59.1	59.0	0.0	62.0	6.5	4.5	31.0	20.1	0.1
Progression Factor				1.00	1.00	1.00	0.66	0.32	0.20	0.23	0.22	1.00
Incremental Delay, d2				14.4	13.0	0.1	282.0	0.6	0.4	209.1	0.0	0.0
Delay (s)				73.6	72.0	0.1	323.1	2.7	1.3	216.3	4.4	0.1
Level of Service				E	E	A	F	A	A	F	A	A
Approach Delay (s)		0.0			59.3			67.8			20.6	
Approach LOS		A			E			E			C	

Intersection Summary			
HCM Average Control Delay	44.8	HCM Level of Service	D
HCM Volume to Capacity ratio	1.36		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	9.0
Intersection Capacity Utilization	75.3%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	96	152	1091	84	55	1941
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0	3.0	3.0		3.0	3.0
Lane Util. Factor	1.00	1.00	0.95		1.00	0.95
Frt	1.00	0.85	0.99		1.00	1.00
Flt Protected	0.95	1.00	1.00		0.95	1.00
Satd. Flow (prot)	1703	1524	3501		1770	3539
Flt Permitted	0.95	1.00	1.00		0.14	1.00
Satd. Flow (perm)	1703	1524	3501		265	3539
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	107	169	1212	93	61	2157
RTOR Reduction (vph)	0	142	5	0	0	0
Lane Group Flow (vph)	107	27	1300	0	61	2157
Heavy Vehicles (%)	6%	6%	2%	2%	2%	2%
Turn Type		Perm			pm+pt	
Protected Phases	4		6		5	2
Permitted Phases		4			2	
Actuated Green, G (s)	10.3	10.3	46.7		55.7	55.7
Effective Green, g (s)	12.3	12.3	48.7		57.7	57.7
Actuated g/C Ratio	0.16	0.16	0.64		0.76	0.76
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	2.0		2.0	2.0
Lane Grp Cap (vph)	276	247	2243		320	2687
v/s Ratio Prot	c0.06		0.37		0.02	c0.61
v/s Ratio Perm		0.02			0.13	
v/c Ratio	0.39	0.11	0.58		0.19	0.80
Uniform Delay, d1	28.5	27.2	7.8		4.5	5.6
Progression Factor	1.00	1.00	1.00		1.00	1.00
Incremental Delay, d2	0.9	0.2	0.2		0.1	1.7
Delay (s)	29.4	27.4	8.0		4.6	7.4
Level of Service	C	C	A		A	A
Approach Delay (s)	28.2		8.0			7.3
Approach LOS	C		A			A

Intersection Summary			
HCM Average Control Delay	9.1	HCM Level of Service	A
HCM Volume to Capacity ratio	0.73		
Actuated Cycle Length (s)	76.0	Sum of lost time (s)	6.0
Intersection Capacity Utilization	66.2%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	131	139	521	372	0	555	0	1414	495	239	2105	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width	11	11	11	11	11	11	11	11	11	11	11	11
Total Lost time (s)	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0	3.0	
Lane Util. Factor	0.95	*0.90	1.00	0.97		1.00		*0.80	1.00	1.00	0.91	
Frt	1.00	1.00	0.85	1.00		0.85		1.00	0.85	1.00	1.00	
Flt Protected	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1625	1613	1531	3319		1531		4364	1546	1745	5014	
Flt Permitted	0.95	1.00	1.00	0.95		1.00		1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1625	1613	1531	3319		1531		4364	1546	1745	5014	
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	146	154	579	413	0	617	0	1571	550	266	2339	0
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	132	0	0	0
Lane Group Flow (vph)	131	169	579	413	0	617	0	1571	418	266	2339	0
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	1%	1%	1%	0%	0%	0%
Turn Type	Split		custom	Prot		custom			custom	Prot		
Protected Phases	8	8		7		7		6	6	5	2	
Permitted Phases			8 7 2			2 8			7			
Actuated Green, G (s)	20.8	20.8	150.0	23.0		140.0		60.7	83.7	25.5	91.2	
Effective Green, g (s)	22.8	22.8	150.0	25.0		144.0		62.7	87.7	27.5	93.2	
Actuated g/C Ratio	0.15	0.15	1.00	0.17		0.96		0.42	0.58	0.18	0.62	
Clearance Time (s)	5.0	5.0		5.0		5.0		5.0	5.0	5.0	5.0	
Vehicle Extension (s)	2.0	2.0		2.0		2.0		2.0	2.0	2.0	2.0	
Lane Grp Cap (vph)	247	245	1531	553		1531		1824	904	320	3115	
v/s Ratio Prot	0.08	c0.10		c0.12		0.07		c0.36	0.19	c0.15	0.47	
v/s Ratio Perm			0.38			0.34			0.08			
v/c Ratio	0.53	0.69	0.38	0.75		0.40		0.86	0.46	0.83	0.75	
Uniform Delay, d1	58.7	60.2	0.0	59.5		0.2		39.7	17.7	59.0	20.2	
Progression Factor	1.00	1.00	1.00	1.00		1.00		1.00	1.00	1.06	0.23	
Incremental Delay, d2	1.1	6.3	0.1	4.8		0.1		5.6	0.1	12.8	1.3	
Delay (s)	59.8	66.6	0.1	64.3		0.3		45.3	17.9	75.5	6.0	
Level of Service	E	E	A	E		A		D	B	E	A	
Approach Delay (s)		21.7			25.9			38.2			13.1	
Approach LOS		C			C			D			B	

Intersection Summary			
HCM Average Control Delay	24.3	HCM Level of Service	C
HCM Volume to Capacity ratio	0.81		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	93.5%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX D

Transfer Truck Travel Time/Routing Study

HDR ONE COMPANY *Many Solutions*℠

Technical Memo

To:	Eric Mead		
From:	Cary Stewart, Tony Wang, Aziz Rahman	Project:	FACTORIA RECYCLING AND TRANSFER STATION PROJECT
CC:	WD Baldwin		
Date:	May 11, 2010	Job No:	124743

RE: Transfer Truck Travel Time/ Routing Study- Travel Time Summary

The following is a summary of the truck travel time and routing study for the new Factoria Recycling and Transfer Station (FRTS). The FRTS is located at the ends of SE 30th and SE 32nd Streets east of Richards Road in Bellevue, WA. There are four potential routes with driving times of ten minutes or less to 405 South at Coal Creek Parkway. The roadway characteristics for each of the routes are presented in Table 1. Each of these routes starts at the east end of SE 32nd Street and then proceeds to Richards Road where a left (south direction) or right (north direction) turn is made depending on the route.

Route 1: Left turn onto Richards Rd/Factoria Blvd SE then turning right onto Coal Creek Pkwy SE then turning left onto the 405 South on-ramp

Route 2: Left turn onto Richards Rd then right turn onto WB 90 on-ramp, exiting WB 90 at E Mercer Way and then returning to EB 90 then onto 405 South

Route 3: Right turn onto Richards Rd then left turn onto Lake Hills Connector Rd then turning left onto SE 8th then turning left onto 405 South

Route 4: Left turn on Richards Rd then turning left onto SE Eastgate Way then turning right onto WB 90 then onto 405 South

Table 1 Roadway Characteristics

	Route 1	Route 2	Route 3	Route 4
Number of: Right-turns	1	1	1	1
Left-turns	2	3	2	2
Signals	14	4	9	7
Stop signs	0	0	0	0
Tight turns for trucks	-	LT @ E Mercer Way & I-90 East On-ramp	LT @ Lake Hill Connector Rd & SE 8th Pl	LT @ SE Eastgate Way & 156th Ave SE
Length(mi)	2.8	5.4	5.7	5.2
Adjacent Land Uses[1]	10% R/ 90% C	10% R / 90% F	25% R/25% V/ 50% F	25% C/ 75% F

[1] R – residential; C – commercial/office professional; V – vacant; F - freeway

Currently, the transfer trucks exiting the FRTS primarily use Route 1. The purpose of this study was to assess alternative travel routes for the FRTS transfer trucks.

HDR staff utilized a GPS enabled passenger car to follow the transfer trucks for Route 1 to collect travel time data. To confirm representative travel times for the transfer trucks 6 trips were done for Route 1. It was determined from this that the travel time by passenger car for each of the other routes should be similar to the travel times by transfer trucks along the same routes. HDR then performed 2 trips on the other three routes utilizing the GPS enabled passenger car. HDR staff believes that 2 trips for each of the other 3 travel routes are adequate because they were done at peak hours and represent worst case travel times.

GPS logged data are presented in speed - distance curves included with this memo. These curves illustrate the speed of the vehicle along each of the routes versus the distance traveled. A dip in the graph represents a stop, often at a traffic signal red light. Due to the signalized intersections, the travel time on the arterial portion of Route 1 does not show significant differences between peak and non-peak hours. However, freeway portions of all routes have significant travel time differences between peak and non-peak hours. Therefore, transfer truck drivers should consider peak hour freeway congestion when selecting a travel route. Table 2 presents the travel times for all of the travel routes. Figure 1 through Figure 4 present the travel time summary for individual routes.

Table 2 Average Travel Time and Average Stop Rate for Routes 1 through 4.

	Distance (mile)	Average Speed (mph)	Average Travel Time (m:s)	Average Stop Rate (# per run)	Travel Time	
					Min.	Max.
Route 1	2.8	20.0	8:21	5.8	6:49	9:15
Route 2*	5.4	37.9	8:30	2.0	8:15	8:44
Route 3*	5.7	28.2	12:11	3.5	10:57	13:26
Route 4*	5.2	26.8	11:35	8.5	10:52	12:18

*: Freeway portions of all routes have significant travel time difference during peak and non-peak

SUMMARY

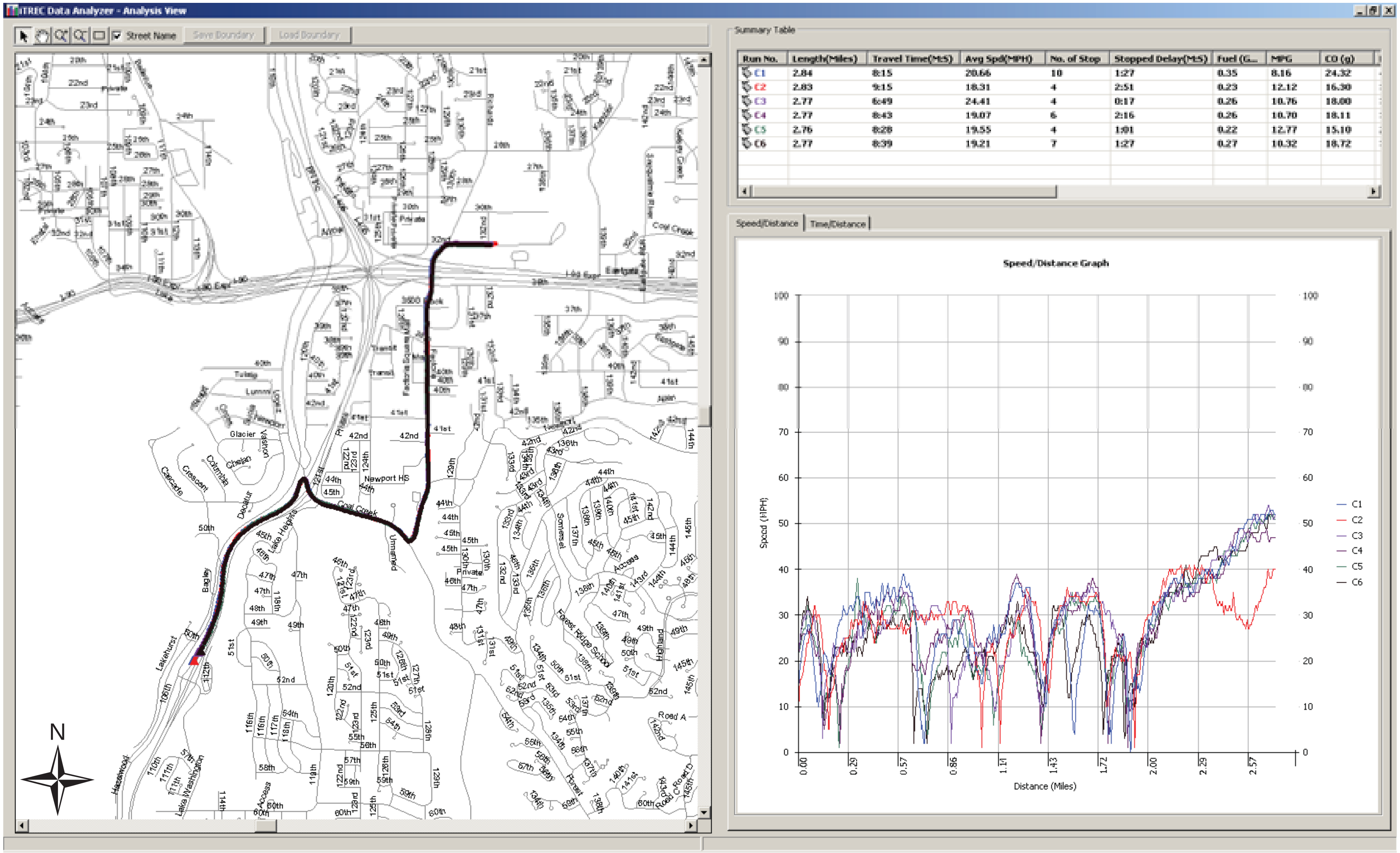
Route 1, typically used by transfer trucks now provides the shortest route and the shortest average travel time. It also has more stops that could result in higher fuel use and more emissions during acceleration.

Route 2 provides a similar average travel time as Route 1 but has the advantage of providing fewer opportunities for stopping. However, Route 2 also has the longest portion on the freeway. When congestion levels on the freeway are free flow this will result in lower fuel usage and less emissions.

Routes 3 and 4 are only viable if the freeways are congestion free.

As part of the Facility Master Plan, HDR will use this memo as part of the information to complete a traffic impact analysis to assess the impact of the FRTS on traffic within the project area.

Figure 1 Route 1 Travel Time Summary



Run No.	Length(Miles)	Travel Time(M:S)	Avg Spd(MPH)	No. of Stop	Stopped Delay(M:S)	Fuel (G...	MPG	CO (g)
C1	2.84	8:15	20.66	10	1:27	0.35	8.16	24.32
C2	2.83	9:15	18.31	4	2:51	0.23	12.12	16.30
C3	2.77	6:49	24.41	4	0:17	0.26	10.76	18.00
C4	2.77	8:43	19.07	6	2:16	0.26	10.70	18.11
C5	2.76	8:28	19.55	4	1:01	0.22	12.77	15.10
C6	2.77	8:39	19.21	7	1:27	0.27	10.32	18.72

Figure 2 Route 2 Travel Time Summary

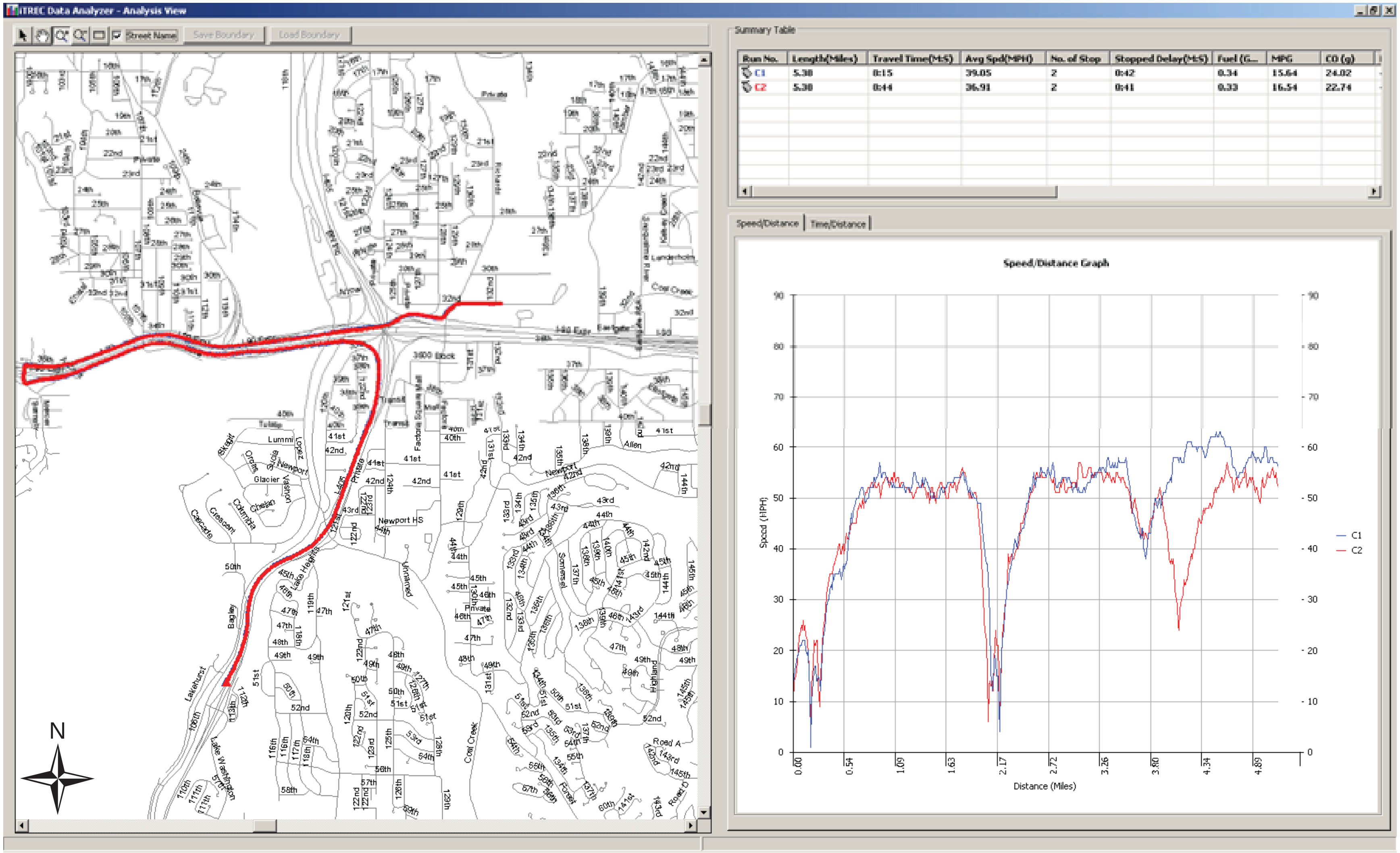


Figure 3 Route 3 Travel Time Summary

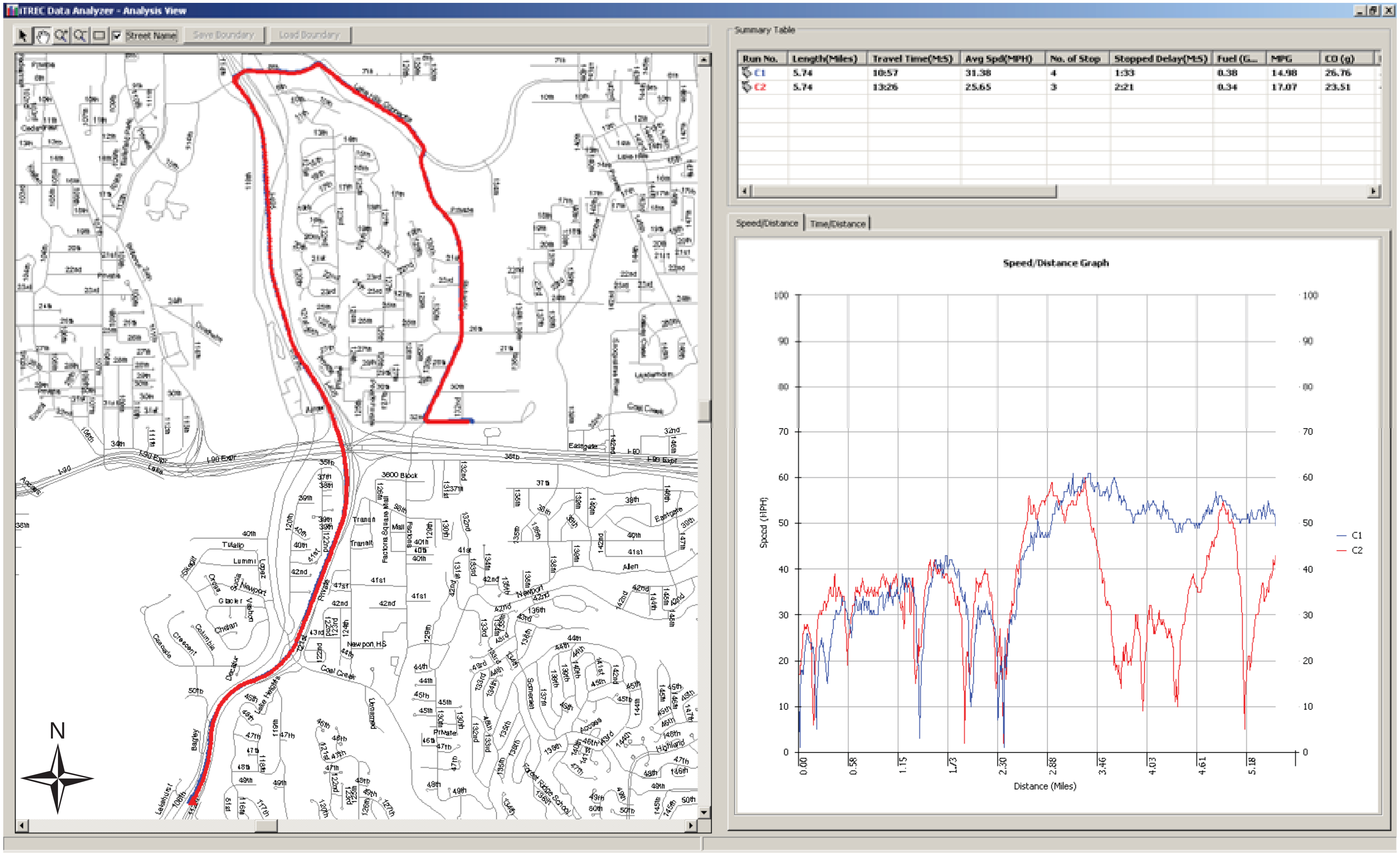
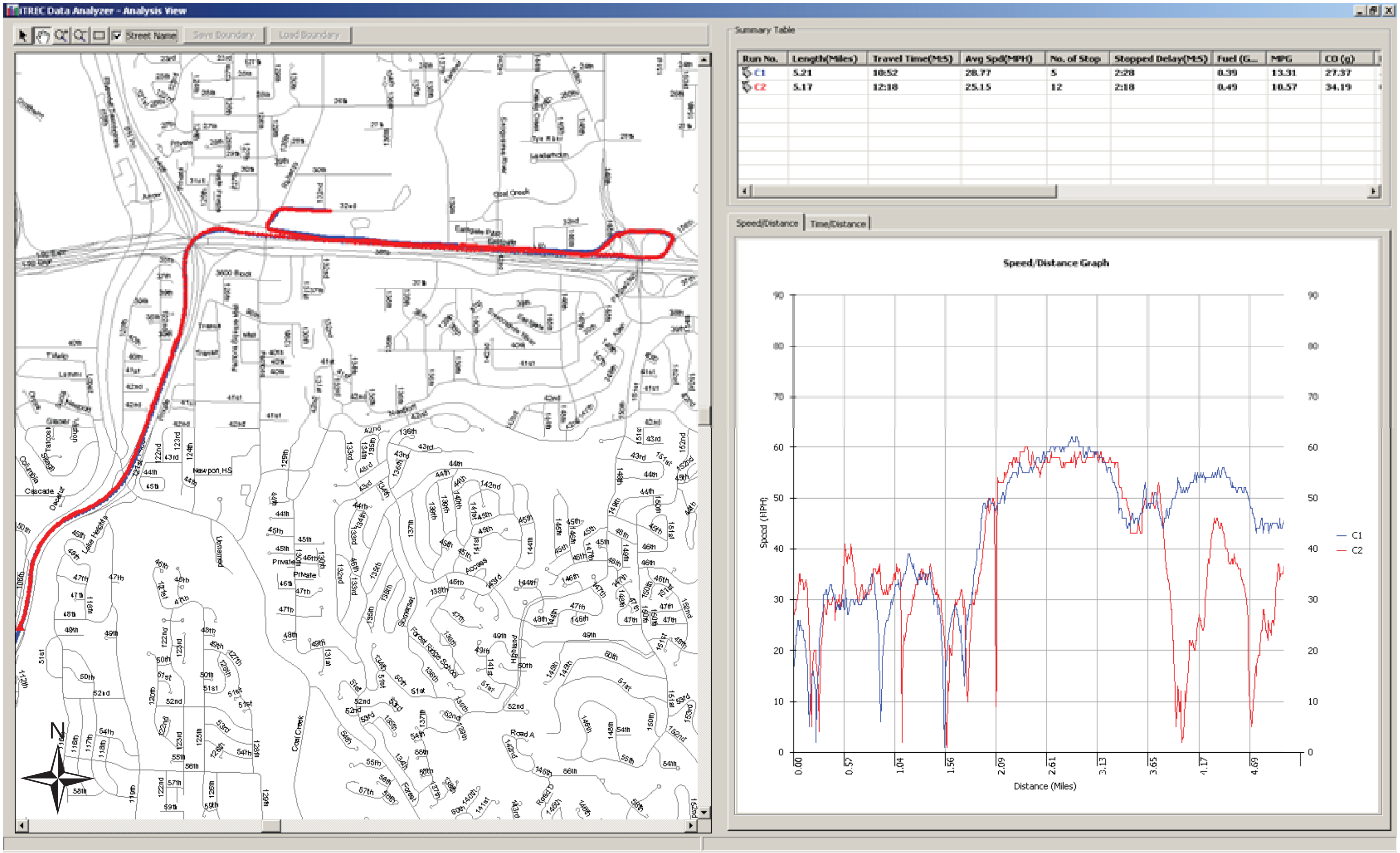


Figure 4 Route 4 Travel Time Summary



APPENDIX E
Model Land Use and Traffic Forecast

FORECASTS FOR 2014 and 2042 BKR LAND USE and EXTERNAL TRIPS

HDR was provided by the City of Bellevue with three sets of EMME BKR (Bellevue-Kirkland-Redmond) travel demand forecasting model platforms, which are described as in the following:

- MP0-R10: 2008 Base Year BKR Travel Demand Forecasting Model Platform Release 10
- MP12-R5: 2020 Future Year BKR Travel Demand Forecasting Model Platform Release 5
- MP30-R5.5: 2030 Future Year BKR Travel Demand Forecasting Model Platform Release 5.5

The BKR model platforms consists of internal traffic analysis zones (TAZs) and external TAZs. The internal TAZs are TAZ 1-450 and TAZ 576-626, which are designated for BKR jurisdictional areas including the BKR fringe areas with adjacent counties; and the external TAZs are TAZ 451-575 for the rest of the Puget Sound four county areas.

For the internal area trip generation process, BKR models use its internal TAZ land uses, such as:

- Residential households
- Retail employees
- FIRES (Finance, Insurance, Real Estate, and Services) employees
- Education (School) employees
- WTCU (Warehouse, Transportation, Communication and Utilities) employees
- Manufacturing employees, and
- FTE_University students/staff

For the external areas, the BKR model platforms relies on the Puget Sound Regional Council (PSRC) EMME travel demand models in terms of trip generations for the following trip purposes:

- Home-Based Work and College (HBW + COL)
- Home-Based Other (HBO)
- Non-Home Based and Commercial Truck Vehicle (NHB + CMV), and
- Home-Based K-12 School (SCH)

Based on the above model platforms, HDR used an interpolation method to figure out an annual compounding growth rate. The formula for annual growth rate is derived as shown below:

$$Y = A * (1 + x)^{n}$$

Y is set to be the future year households, employees or trips;

A is set to be the base year households, employees or trips;

n is the number of years from base year to future year;

x is set to be the annual growth rate: $x = (Y/A)^{1/n} - 1$

For instance, the annual growth rate from 2008 to 2020 is hence as follows:

$$x = (2020LU / 2008LU)^{(1/12)} - 1$$

And then, $2014LU = 2008LU * (1 + x)^{6}$

In addition, the annual growth rate from 2020 to 2030 is

$$x = (2030LU / 2020LU)^{(1/10)} -1$$

And assume 2030-2040 is based on the same annual growth rate as during 2020-2030, therefore, 2042 land use forecast is based on the formula below:

$$2042LU = 2030LU * (1 + x)^{12}$$

By using these land use interpolation formulas above, the forecasts for the 2014 and 2042 households, employees and external trips are calculated for each of the TAZs in the BKR model platforms. The summary results are shown in Tables 1-4.

Table 1 shows the interpolated summary of 2014 BKR land use data forecasts;

Table 2 shows the interpolated summary of 2042 BKR land use data forecasts;

Table 3 shows the interpolated summary of 2014 PSRC external trip productions and attractions; and

Table 3 shows the interpolated summary of 2042 PSRC external trip productions and attractions.

To create the 2014 and 2042 BKR model platforms, four-step BKR model runs were performed based on the 2014 and 2042 land use and external trip forecasts, as well as on the updated local BKR area and regional transportation system improvements.

Table 1: 2014 Internal BKR Land Use Data Forecasts Based on MP0-R10 and MP12-R5 BKR Model Platforms

2008 Household #	2020 Household #	2008-2020 Annual Growth Rate	2014 Household #
169,528	183,451	0.660%	176,352
2008 Employee #	**2020 Employee #**	**2008-2020 Annual Growth Rate**	**2014 Employee #**
306,803	404,023	2.320%	352,073

Table 2: 2042 Internal BKR Land Use Data Forecasts Based on MP12-R5 and 2030 MP30-R5.5-BKR Model

2020 Household #	2030 Household #	2020-2030 Annual Growth Rate	2042 Household #
183,451	210,417	1.381%	248,058
2020 Employee #	**2030 Employee #**	**2020-2030 Annual Growth Rate**	**2042 Employee #**
404,022	463,022	1.372%	545,303

Table 3: 2014 BKR External PSRC Model Trip Productions and Attractions Summary				
YEAR	2010	2020	2010-2020 Annual Growth Rate	2014
HBWPRO + COLPRO	2,546,463	2,946,224	1.469%	2,699,409
HBWATT + COLATT	2,418,936	2,778,218	1.394%	2,556,708
HBOPRO	5,200,643	6,028,766	1.489%	5,517,287
HBOATT	4,873,253	5,617,148	1.431%	5,158,195
NHBPRO + CMVPRO	3,733,833	4,226,996	1.248%	3,923,789
NHBATT + CMVATT	3,633,209	4,121,120	1.268%	3,821,029
SCHPRO	980,856	1,059,869	0.778%	1,011,729
SCHATT	976,619	1,052,933	0.755%	1,006,457

Table 4: 2042 BKR External PSRC Model Trip Productions and Attractions Summary				
YEAR	2020	2030	2020-2030 Annual Growth Rate	2042
HBWPRO + COLPRO	2,946,224	3,205,237	0.846%	3,546,283
HBWATT + COLATT	2,778,218	2,971,382	0.674%	3,220,988
HBOPRO	6,028,766	6,601,376	0.911%	7,360,744
HBOATT	5,617,148	6,078,537	0.793%	6,682,499
NHBPRO + CMVPRO	4,226,996	4,653,030	0.965%	5,221,324
NHBATT + CMVATT	4,121,120	4,495,822	0.874%	4,990,703
SCHPRO	1,059,869	1,149,129	0.812%	1,266,219
SCHATT	1,052,933	1,139,881	0.797%	1,253,747