ENVIRONMENTAL REPORT

King County
Solid Waste Transfer and Waste Management Plan Update

March 17, 2015
Draft

Prepared for:

King County
Department of
Natural Resources and Parks
Solid Waste Division

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Table of Contents

Attachments

Figures

Tables

Abbreviations and Acronyms

ADT	Average Daily Traffic
BCC	Bellevue City Code
CAA	Clean Air Act
CAAA	Clean Air Act Amendments
CADNA	Control of Accuracy and Debugging for Numerical Applications
CAD	computer aided design
CH	Commercial-haul
CO	carbon monoxide
dB	decibel levels
dBA	A-weighted decibel levels
division	Solid Waste Division
Ecology	Washington State Department of Ecology
EDNA	Environmental Designation for Noise Abatement
EPA	Environmental Protection Agency
FR	Federal Register
GHG	greenhouse gases
GIS	graphical information system
HC	hydrocarbons
HCM	Highway Capacity Manual
HHW	Household Hazardous Waste
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
L_{eq}	Equivalent Sound Level
L_{max}	Maximum Sound Level
L_n	Percent Sound Level
L_p	Sound Pressure Level
L_w	Sound Power Level
LOS	Level of Service
mg/m^3	milligrams per cubic meter
MPO	Metropolitan Planning Organization
MSAT	Mobile Source Area Toxics
NAAQS	National Ambient Air Quality Standards
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
PM_{10}	particulate matter less than 10 microns in diameter
ppbv	parts per billion by volume

ppmv	parts per million by volume
PSCAA	Puget Sound Clean Air Agency
PSRC	Puget Sound Regional Council
PWL	Sound Power Level
pW	1 pico-watt
RMC	Renton Municipal Code
SH	Self-haul
SLM	sound level meter
SMC	Shoreline Municipal Code
SPL	Sound Pressure Level
Scalehouse	Entry and exit point for each station
SIP	State Implementation Plan
SR	State Route
SO_x	sulfur oxides
Tipping floor	Main building where material is removed from vehicles
TMC	Tukwila Municipal Code
transactions	inbound trips
$\mu g/m^3$	micrograms per cubic meter
µPa	micro-pascals
v/c	volume-to-capacity
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

Introduction

Based on the extensive analysis developed in the Transfer Plan review by the King County Department of Natural Resources and Parks, Solid Waste Division (division), and following cooperative work with Council staff and the County auditor, a preliminary County report recommended revising the 2006 Solid Waste Transfer and Waste Management Plan and the pending Solid Waste Comprehensive Plan. These plans are intended to acknowledge continuing system attention to potential capital needs over time that may include capital projects such as recycling facilities, CDL facilities, a new northeast recycling and transfer station, or other capital projects to retain flexibility in the system.

This environmental report supports this plan revision effort by providing analysis of the transportation, noise and air quality implications of multiple concepts for operating the existing recycling and transfer stations with and without a new northeast recycling and transfer station.

Report Preparers

The division contracted with the URS Team to provide data collection and analysis. The primary consultants working on the project and providing project management oversight are AECOM (formerly URS) with team members Transpo Group and The Greenbusch Group, Inc. URS has extensive experience with the planning, design, construction oversight and operational aspects of recycling and solid waste transfer stations. All three firms conduct environmental and impact analysis on commercial and industrial facilities, including transfer stations, as a core portion of their business. Some of our specific project experience includes: design and construction management of the Seattle South Transfer Station; SWD Intermodal Facility Siting Study; Snohomish County Transfer Station Master Planning; Bow Lake Transfer Station Master Plan, Advanced Traffic Management System, and Noise Analysis and Compliance; First Avenue Transfer Station traffic impact analysis; and Waterfront Streetcar Maintenance Facility Siting Study and Design. All of these projects involved environmental review, permitting strategies, cost analysis and scheduling.

Greenbusch collected noise measurements and sound levels and provided noise modeling analysis. Transpo Group collected traffic counts and video, and provided traffic modeling and impact analysis. URS and Transpo Group jointly collected service time counts and origin/destination surveys.

Data Collection

To accomplish the goals of this review, extensive data was collected at the Shoreline, Houghton, Factoria, Renton and Bow Lake stations to understand the existing conditions and operations of each facility. Data was collected during weekdays and Saturdays. Data collected included:

- Traffic counts – the first step was to place tube counters at each station for a number of days (in Sept 2014) to determine the weekday and Saturday 3-hour peak period for the station. 24-hour tube counts were conducted over a two-week period at the approaches to each station.
- Service time counts – the second step was to return to the site during the station's 3-hour peak period. Each vehicle entering the site was tracked through license plate identification to measure delay and service times for various activities on-site. The processing times at the entry scale, exit scale, self-haul tipping floor area, and commercial tipping floor area were collected at each site. In addition, the processing time for the recycling area, household waste, and yard waste areas were measured at the transfer stations where that service is provided.
- Video – simultaneously to the service time counts, video was taken to document the traffic volumes at key locations as well as the vehicle type such as automobile, personal trucks, trailers and commercial hauler trucks.
- Customer origin/destination surveys – also simultaneously to the service time counts, customers were asked the origin of their trip to understand the distribution of customers using the station. This is useful information to consider with the potential future closure of stations (i.e. Houghton, Renton) or analyzing a potential shift in station operations (i.e. redirecting commercial haulers or restricting self-haul).
- Off-site traffic – traffic counts were collected at key intersections surrounding each station. This information was used to assess the impacts to the off-site intersections based on the site traffic anticipated under each of the concepts.
- Noise monitoring – at the same time as the tube counts and service time counts, noise measurements were taken to understand noise levels at the boundary of the station properties and to identify noise levels of vehicle types using the station. Noise measurements were taken at Bow Lake, Renton and Shoreline (Factoria 2012 noise measurements were used).

Concept Descriptions

Four concepts were developed by the division to address the Council request for optional operation scenarios. The general concept descriptions are:

- Concept 0 – No Northeast station, does not direct commercial haulers, no self-haul restrictions
- Concept 1 – Direct commercial haulers, no Northeast station
- Concept 2 – Restrict self-haul, no Northeast station
- Concept 3 – Build Northeast station

Tier 1/Tier 2 Screening

In order to evaluate a wide range of strategies and improvements for all stations under several concepts and scenarios, a screening process was necessary to use modeling and analysis effort wisely and efficiently. A two-tiered process was utilized to identify the most effective strategies for concepts and scenarios that did not meet the station capacity criteria.

The Tier 1 screening analyzed the reduction in transactions (inbound vehicle trips) that would result from strategy implementation. It is also considered factors of the environment such as noise and air quality, cost implications, economic and social justice, and regulatory requirements. Each strategy was analyzed individually, at each station, under each concept. The resulting peak-hour station traffic volumes were compared to the estimated station capacity to identify the potential benefits of the strategy.

For the Tier 2 screening, the full impact of information from Tier 1 was combined with detailed modeling using the VISSIM models developed for each station. Those strategies that had the most positive effect in reducing the number of inbound vehicle trips and also made sense from an operational or regulatory point of view were combined. Based on a review of the individual strategies and the assessments prepared for the Tier 1 screening, combinations were identified for detailed evaluation and modeling. See the division Strategy and Concept Combinations summary and the Traffic section of this report.

Transportation

This section of the report provides a comprehensive summary of the traffic analysis conducted for this study. This summary includes a review of the technical approach and key findings; including anticipated station constraints and the potential impacts of individual demand management or improvement strategies, as well as combinations of strategies identified for each station.

The methodology and scope of the traffic analysis focused on the following two objectives:

- **Evaluate on-site circulation** and capacity of existing and planned stations (given the forecasted tonnage) and identify anticipated constraints impacting station performance. Improvement strategies will be identified, and overall effectiveness tested and summarized.
- **Identify potential impacts to off-site intersections** related to the implementation of multiple operational concepts.

Subsequent sections of the report are organized in the following manner:

- Study Approach
- Trip Generation Methodology and Forecasts
- Station Assessments (Bow Lake, Renton, Factoria, Shoreline)

The first two sections provide a general overview of the study approach and trip generation methodology developed to forecast station-related traffic volumes for the future conditions. The station assessments conducted for each station provide a comprehensive review of the data collection conducted to support the analysis, forecast traffic volumes for the station and off-site intersections and anticipated station constraints, and potential improvement strategies.

Study Approach

This section provides an overview of the study approach (including common terminology used in the report), analysis periods, traffic analysis software and study parameters, as well as the process used to evaluate the effectiveness of the individual and combinations of strategies.

Report Terminology

Different terminology is used throughout this section of the report when describing the operations of the station:

- **Commercial-haul (CH)** – This is traffic that is associated with the commercial-haulers such as Waste Management, Republic, and Rabanco.
- **Self-Haul (SH)** – This includes all other traffic not related to the commercial-haulers. Users in this category may or may not have commercial accounts with King County. This traffic includes multiple vehicle types such as sedans, pick-up trucks, truck/trailer combinations, and commercial users such as landscape companies.
- **Scalehouse** – This is the entry and exit point for each station where vehicles are weighed and the transactions completed.

- **Tipping floor** – This is the main building where the material is removed from the vehicles. These are generally divided in to a commercial side and a self-haul side. Each station is configured differently and individual operations plans identified for each. These operations plans dictate how the commercial side of the tipping floor is managed as well as the procedures for clean-out of the self-haul area. Additional information on the operations of the individual stations are presented in the subsequent sections.
- **Recycling/yard waste/Household Hazardous Waste (HHW) areas** – In addition to the garbage, the transfer stations have areas to receive additional material such as yard waste, recycling, and/or HHW. The locations and configurations of these areas are unique to each station and are described further in the individual station assessment sections.

Analysis Period

The traffic analysis focuses primarily on the 2023 horizon year. As indicated by Solid Waste Division (division) staff, the 2023 horizon year represents the currently anticipated peak of the system tonnage for the next 15 years. Given the range of customers and the needs of the different population groups that utilize the transfer stations, from the commercial-haulers to the general public, both the weekday and Saturday peak periods were analyzed. The specific peak hours vary at each station and as such were identified through comprehensive hourly counts taken over a multiple-week period. Details for each station are presented in the individual station assessment sections.

The following analysis scenarios were identified for each analysis period at each station (weekday and Saturday):

1. Evaluate existing conditions
2. Evaluate future conditions (Concept 0, Concept 1 , Concept 2, Concept 3)
3. Evaluate improvement strategies (Concept 0, Concept 1 , Concept 2, Concept 3)

All cases were considered with and without the Renton station being open. All forecasts assume the closure of Houghton station by the 2023 analysis horizon year.

Traffic Analysis

This section describes performance measures and the analysis methodology used in the evaluation of the station operations.

Performance Measures. Several key performance measures were identified for each station. These performance measures focus on the individual operations of the station as well as the overall experience of the station users. The performance measures are used to define the station constraints and inform the identification of potential station improvements. The primary performance measures include:

- Service times[1] for commercial users – 16 minutes or less

[1] Measured scale to scale consistent with adopted service times identified in the Solid Waste Transfer and Management Plan, December 2007

- Service times[1] for self-haul customers – 30 minutes or less
- Inbound queuing and potential impacts to off-station roadways and/or driveways

In addition to these primary performance measures, the internal queuing at either the tipping floor or outbound scale was considered due to its potential impact to overall station operations.

On-Site Traffic Analysis. The transfer stations are a complex transportation network with multiple service points and circulation needs. This includes the inbound process at the scalehouse, the primary tipping floor, additional material stations, and the outbound operations at the scalehouse. This interconnected system is further complicated by the presence of commercial and self-haul traffic that utilizes different areas of the tipping floor and depending on the station, potentially separate scale.

The on-site evaluation of each station was conducted using VISSIM. VISSIM is a microscopic traffic simulation model that was used to model the transfer station as one connected network including all circulation roadways, scalehouse operations, tipping floor access and capacity, and activity for other material such as yard waste, recycling, or HHW. In addition, the VISSIM model includes the multiple vehicle types observed for each station. **Figure 1** provides an image of the Shoreline area that highlights the areas that were included in the VISSIM model.

Figure 1
Example VISSIM MODEL (Shoreline)

Before the VISSIM model was used for any analysis of existing and forecast conditions, a comprehensive calibration process was completed for each weekday and Saturday peak period model. The existing conditions in the model were calibrated to match conditions as they were observed in the field at each station. Existing operational information was collected during the weekday and Saturday peak 3-hour periods. Each vehicle entering the stations during this time was tracked through license plate identification to measure delay and service times for various activities on-site. The processing times at the entry scale, exit scale, self-haul tipping floor area, and commercial tipping floor area were recorded. In addition, the processing time for the recycling area, household waste, and yard waste areas were measured at the transfer stations where that service is provided. Default values in the VISSIM model such as vehicle travel speeds and dwell times at the various areas at the stations were modified from the default values in the model to match the observed data. The scope of the extensive data collection at each station is reviewed in more detail in the station assessment section. A summary of the scope is included in **Attachment A (Project Scope)**.

Off-Site Traffic Analysis. The off-site analysis was conducted using Synchro[2] software. This program is used to evaluate the capacity of intersections based on the geometry, number of lanes, signal timing (if signalized), relative to current Highway Capacity Manual standards[3]. Synchro is used by all agencies in which the stations are located. Synchro provides a level of service (LOS) grade that can be used to assess overall intersection capacity and opperational performance. The operational characteristics of an intersection are determined by calculating the intersection's LOS. The intersection as a whole and its individual turning movements can be described alphabetically with a range of LOS (A through F), with LOS A indicating free-flow traffic, and LOS F indicating extreme congestion and long vehicle delays. LOS is measured in average control delay per vehicle and is typically reported for the intersection as a whole at signalized intersections and for the approach or turning movement that experiences the most delay at two-way stop-controlled intersections. Control delay is defined as the combination of initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. **Attachment B (LOS Definitions)** provides a more detailed explanation of intersection LOS criteria.

The specific study areas identified for the off-site analyses are dicussed in more detail in the indivudal station assessment sections.The off-site study intersections were evaluated for each station during each station's respective weekday and Saturday station peak-hour period.

Tier 1/Tier 2 Screening Methodology

In order to evaluate a wide range of strategies and improvements for all stations under several concepts and scenarios, a screening process was necessary to use modeling and analysis effort wisely and efficiently. A two-tiered process was utilized to identify the most impactful strategies for which further VISSIM modeling was conducted. This modeling focused on stations and scenarios that did not meet the capacity criteria[4] defined for each station.

The Tier 1 screening analyzed the reduction in transactions (inbound trips) that would result from implementation of the potential demand management strategies which included the following:

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[2] Synchro, Trafficware, version 8.0

[3] LOS, delays, and volume-to-capacity (v/c) ratios were calculated using the *Highway Capacity Manual* (*HCM*) *2010* methodology. 2000 HCM methodology used where signal phasing was not compatible with 2010 methodology.

[4] Criteria defined based on on-site service times and vehicle queuing thresholds (see Traffic Analysis – Performance Measures section)

- Extend Operating Hours
- Provide wait time information
- Lower cost curbside bulky waste collection
- Mandatory curbside garbage collection
- Lower regional direct fee to encourage haulers to use their own transfer stations
- Ban materials:
  - Ban yard/wood waste from both disposal and recycling
  - Ban HHW only transactions
- Incentive/peak pricing
- Adjust minimum fee
  - Factoria Only – double the minimum fee
  - System-wide minimum fee increase
- Drop Box
  - Provide a drop box in the northeast
  - Provide a drop box in the southeast
- Ban non-system Self-Haul (effective 2029)

Although summarized in other sections of the report, the Tier 1 screening process also considered factors of the environment such as noise and air quality, cost implications, economic and social justice, and regulatory requirements. Each strategy was analyzed individually, at each station. The resulting peak-hour station volumes were compared to the estimated station capacity[5] figure to identify the potential benefits of the specific strategy.

For the Tier 2 screening, the information from the Tier 1 evaluation was combined with detailed modeling using the VISSIM models developed for each station. The individual strategies that had the most effect on the inbound trips and also aligned with operational or regulatory requirements at each station were combined.

Station Traffic – Trip Generation Methodology

A multi-step process was utilized to estimate the peak-hour demand trip generation for each station. The forecasting process relied on annual tonnage forecasts provided by division staff for each of the stations. The process used to develop the peak-hour trip generation forecasts are shown in **Figure 2** and generally considers the following:

- Annual tonnage by type (i.e., garbage, recycle, yard waste, HHW)
- Average load (in tons) per vehicle for all material
- Weekday/Saturday allocation
- Consideration of peak month and seasonal variations, the division targets the 90th percentile demand for purposes of evaluating station capacity
- Weekday and Saturday hourly distribution of traffic for commercial-haul, self-haul, transfer trailers, and recyclables haul vehicles

[5] Estimated peak-hour station capacity was developed for the Concept 0 assumptions considering the adopted service times and queueing criteria defined previously.

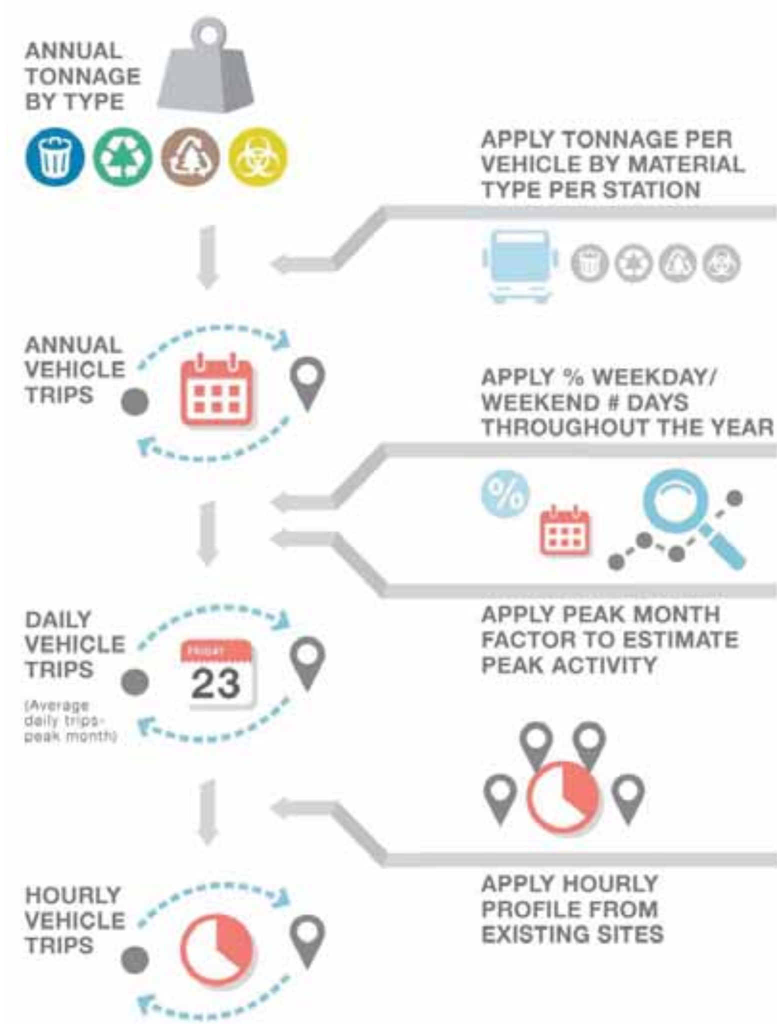

Figure 2
Trip Generation Process

Figure 2 summarizes the (Saturday) Average Daily Traffic (ADT) for each station, with and without the Renton station over multiple horizon years. As shown in the figure the peak demands for the system are anticipated to occur in 2023. Future decreases in overall trip generation for each station is expected to occur at a fairly nominal annual percentage.

As noted in the list above, the "average" daily vehicle demands at each station were adjusted to represent the 90th percentile volumes. The 90th percentile factor was calculated from data provided from King County. In order to get a large sample set to more accurately determine the 90th percentile, the hourly transactions were provided for each station by King County for the period that included January to December 2013. This information included customer type (i.e., if the customer was a self-haul or commercial vehicle). The hourly transactions were summarized by daily totals as well as weekday and Saturday transaction totals. From this data set, the 90th percentile and 50th percentile (i.e., median) transactions per day were calculated for commercial and self-haul separately, as well as combined, as the total daily transactions. The 90th percentile daily transactions were then divided by the 50th percentile daily transactions to determine the 90th percentile percent increase relative the 50th percentile daily transaction for each station.

Peak demands factors are typically used in the industry as it provides a reasonable worst-case of peak conditions. The use of the 90th percentile factor accounts for the seasonal nature of the facilities and helps ensure that traffic volumes do not exceed the station capacity and impact adjacent city streets on a regular basis. Furthermore, the division designs the facilities for the 90th percentile demand, so it is appropriate that the traffic analysis applies a similar standard.

Trip generation estimates prepared for each station and each concept considered the local factors such as tonnage per vehicle and hourly distribution patterns to estimate peak-hour activity. Detailed forecasts and description of the calculation factors are provided for each station in the station assessment section.

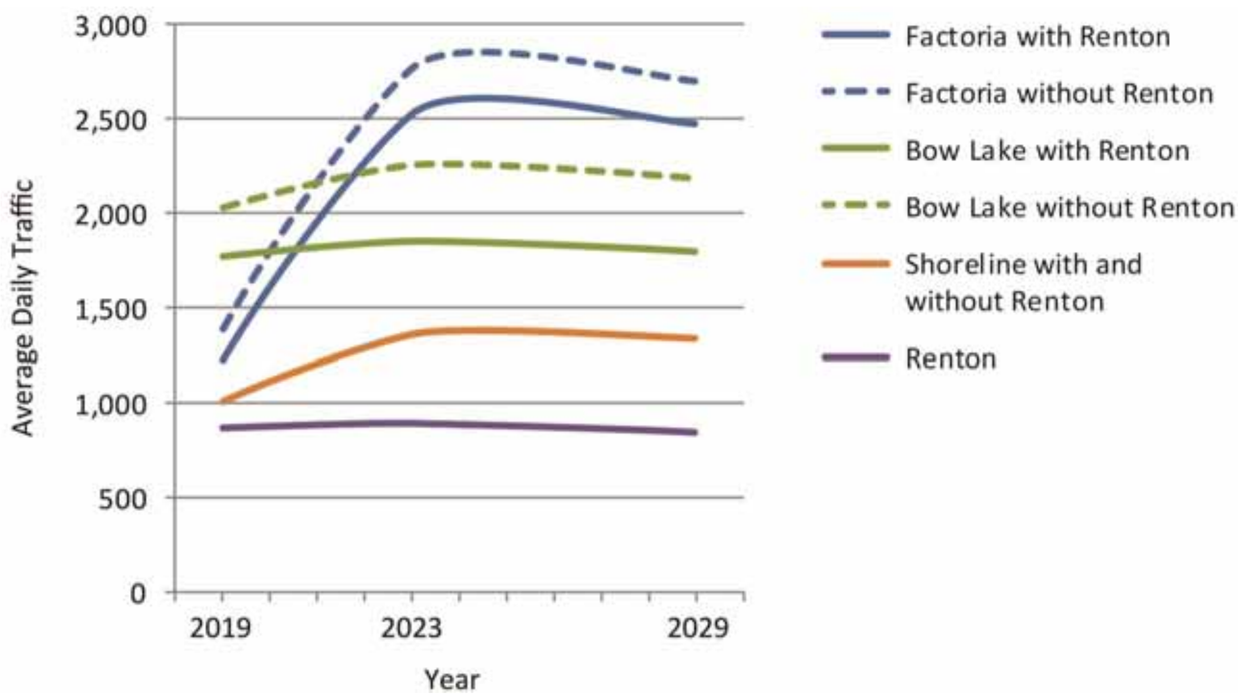

Figure 3
Concept 0 - Saturday ADT for each Station

Station Assessments

Bow Lake

Station Description – Access and Circulation

Primary vehicle access to the Bow Lake station is provided along the north leg of the S 188th St / Orillia Rd S intersection. Both the general public and division trucks utilize the S 188th St / Orillia Rd S intersection to access the station. The transfer station site vicinity is shown in **Figure 4**.

The tipping floor is divided into two main sections, commercial and self-haul areas. The self-haul area is located in the western portion of the building and is accessed via the southwest corner and the exit of the building is located via the northwest corner. Commercial vehicles access the building from the southeast corner and exit the building through the northeast corner of the building.

In the self-haul area there is a total of 15 stalls used for garbage. There are four stalls on the commercial side of the floor. This station also includes a separate recycling area which is located south of the tipping floor building. **Figure 5** shows the building configuration and vehicle circulation and access.

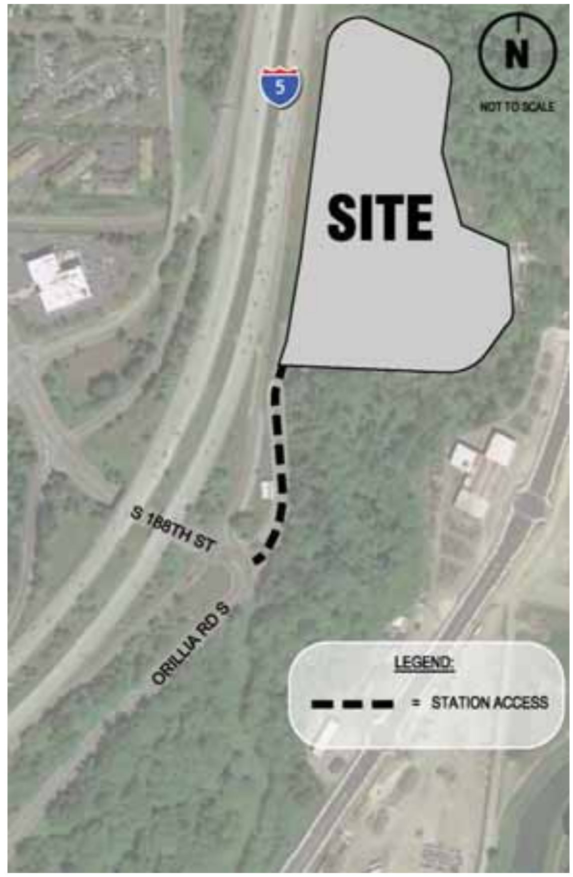

Figure 4
Bow Lake Site Vicinity

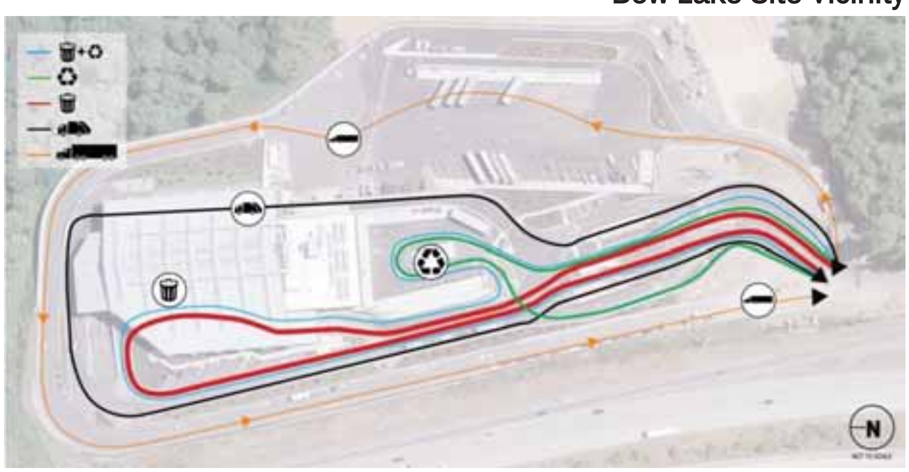

Figure 5
Bow Lake On-Site Future Building Configuration and Circulation Patterns

Station Data

Data Collection. Extensive data collection was conducted to support the development of the VISSIM model and establish the existing conditions on the station. While this information was largely used to calibrate the VISSIM model, it also assists in providing the existing context against which the future conditions can be compared. A general outline of the data collected as well as a map of the specific locations for video collection, traffic counts, and service time studies is included in **Attachment C (On-Site Data Collection Summary).**

Customer Origin/Destination Surveys

In addition to the traffic volume, queuing, and service time data, customer origin/destination data was collected to identify the general distribution of customer traffic utilizing this station during the days the surveys were conducted. The survey was conducted during the 3-hour period. The following questions were asked of customers as they exited the facility:

- Where are you coming from (zip code and closest intersection)?
- Are you coming from a home or business?

Not all customers participated in the survey so the information shown in **Table 1** represents all answered surveys of the customers that utilized the station during the observation period. The response rate on the weekday was approximately 65 percent, whereas the response rate on Saturday was approximately 80 percent. It is important to note that the lower response rate on the weekday is primarily due to commercial vehicles not being asked to participate in the survey.

Reponses from customers were mapped to the nearest major intersection using a graphical information system (GIS). This information is shown in **Attachment D (Customer Origin/Destination Data)**. The responses from the surveys indicated the following distribution of customers utilizing the Bow Lake station. Information is presented for the weekday and Saturday time periods show a similar general distribution of customers.

Table 1
Bow Lake Customer Trip Origin Summary

Trip Origin	Survey Respondents - Weekday		Survey Respondents - Saturday	
	Number	**Percentage**	**Survey Origin**	**Percentage**
Kent	25	27%	34	23%
Tukwila	6	6%	6	4%
Seattle	8	9%	14	10%
King County (excluding Seattle/Tukwila/Kent)	51	55%	91	61%
Snohomish County	3	3%	2	1%
Pierce County	0	0%	2	1%
Total	93	100%	149	100%

Existing Traffic Volumes. Based on the data collected for the station, the weekday peak period (3 hours) was defined to be 11:30 a.m. to 2:30 p.m. and the Saturday period was 10:45 a.m. to 1:45 p.m. **Figure 6** shows the weekday and Saturday daily station traffic volumes.

Figure 6
Bow Lake Existing Typical Weekday and Saturday Traffic Volume Patterns

Future (2023) Traffic Volumes. As noted previously, 2023 represents the peak demand within the system and thus correlates to the highest traffic volumes at the transfer stations included in this study. Future traffic volumes at the stations were forecast based on the methodologies described previously. Three (3)-hour peak volumes were developed based on annual tonnage forecasts developed for the station, distribution of weekday and Saturday activity, tonnage per vehicle, seasonal factors, and hourly trip generation patterns for the station. The detailed calculations showing all the key assumptions are included in **Attachment E (Trip Generation Forecasts)**.

Traffic volume forecasts were developed for Concept 0, Concept 1, Concept 2, Concept 3, both with and without the Renton station operational. All concepts assumed that the Houghton station was closed. **Figure 7** summarizes the peak-hour demand volumes for each of the concepts (self-haul and commercial-haul) traffic for weekday and Saturday conditions, with- and without-Renton. Although only the peak-hour demand is shown in this figure, the peak-hour volumes are generally anticipated to occur for multiple hours as shown in the **Figure 6** hourly profile.

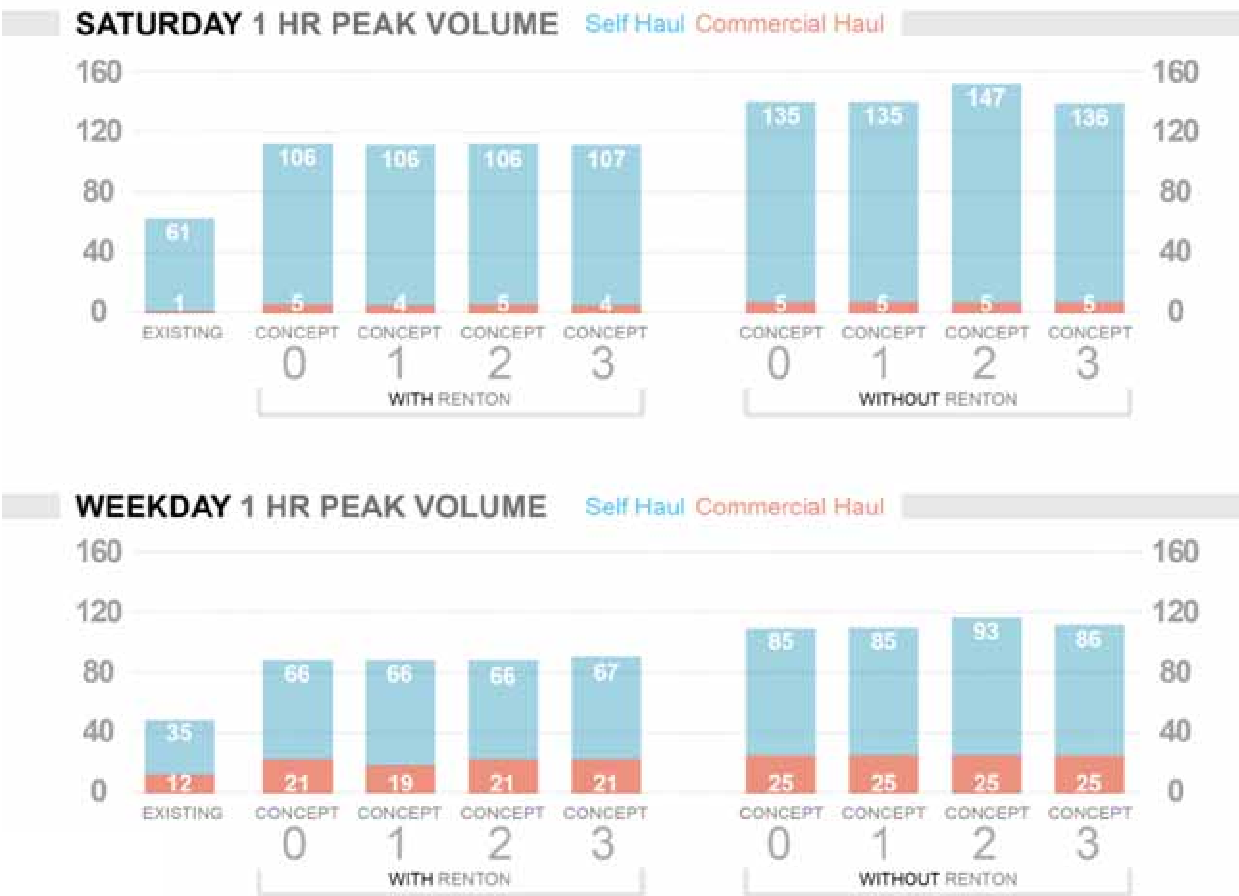

Figure 7
Bow Lake Existing and Concept Peak-Hour Volumes

As shown in **Figure 7**, the forecast peak-hour traffic volumes for all concepts are similar under all scenarios, weekday and Saturday as well as with- and without-Renton. The largest variance in volumes occurs under the Saturday without-Renton conditions where Concept 2 shows 12 additional vehicles in the peak-hour, as compared to Concepts 0, 1, and 3.

On-Site Analysis Results

The on-site service times and inbound vehicle queues were calculated using the methodology described previously. The results of the service time analysis for all concepts, with and without the Renton station are shown in **Table 2**. The existing conditions and adopted service times are included for comparison purposes.

Table 2
Bow Lake Existing and Concept Service Times Summary

Scenario	With-Renton Station					Without-Renton Station			
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday Peak-Hour		Saturday Peak-Hour	
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)		CH (h:mm)	SH (h:mm)	CH (h:mm)	SH (h:mm)
Standard[3]	*00:16*	*00:30*	*00:16*	*00:30*		*00:16*	*00:30*	*00:16*	*00:30*
Existing[4]	00:13	00:26	00:13	00:27					
Concept 0 (2023)	00:20	00:28	00:17	00:26		00:22	00:29	00:18	00:27
Concept 1 (2023)	00:19	00:27	00:17	00:26		00:21	00:29	00:18	00:27
Concept 2 (2023)	00:20	00:28	00:17	00:26		00:20	00:28	00:19	00:26
Concept 3 (2023)	00:18	00:28	00:17	00:27		00:22	00:29	00:18	00:27

1. CH = Commercial-Haul
2. SH = Self-Haul
3. Adopted standards as defined in King County Transfer Plan (December 2007)
4. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 2**, all concepts exceed the adopted service times for the commercial-haul vehicles for all scenarios evaluated. Service time standards for self-haul vehicles are met. However, queueing at the inbound scalehouse is impacting these service time results by effectively metering traffic. The service times for all concepts are generally similar. Service times on the weekday and Saturday and both with- and without-Renton range between 17 to 22 minutes for commercial-haul, and between 26 to 29 minutes for self-haul vehicles. The commercial-haul service times exceed the adopted standard of 16 minutes under all scenarios whereas the self-haul service times are below the adopted standard of 30 minutes under all scenarios. Relative to existing conditions, the weekday with-Renton commercial-haul service times increase by 5 to 7 seconds, and the self-haul service times increase by 1 to 2 seconds. The Saturday with-Renton conditions commercial-haul service times increase by approximately 4 seconds relative to existing, and the self-haul service times remain the same or improve by approximately 1-minute relative to the existing service times.

The results of the queuing analysis for all concepts, with and without the Renton station are shown in **Table 3**. The existing conditions and queue thresholds are included for comparison purposes.

Table 3
Bow Lake Existing and Concept Inbound Queuing Summary

Scenario	With-Renton Station			Without-Renton Station	
	Weekday (Vehicles)[1]	Saturday (Vehicles)		Weekday (Vehicles)	Saturday (Vehicles)
Threshold[2]	*32*	*32*		*32*	*32*
Existing[3]	2	3			
Concept 0 (2023)	17	99		98	205
Concept 1 (2023)	18	98		95	202
Concept 2 (2023)	17	99		128	235
Concept 3 (2023)	20	102		98	205

1. Vehicle length assumed to be 32 feet.
2. Threshold of 32 vehicle queue is approximate distance to adjacent intersection from station access (Orillia Rd S / S 188th St)
3. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 3**, under the with-Renton scenario, inbound queues forecasted for the weekday peak-hour do not exceed the defined threshold (32 vehicles). However, during the Saturday peak-hour for this same scenario (with-Renton), all queues are forecast to exceed the threshold. For the without-Renton scenarios, the queues generally exceed the adopted service time by approximately 300 percent in the case of Concepts 0 to 3 during weekday conditions and exceed the threshold by approximately 600 percent for Concepts 0 to 3 during Saturday conditions. Relative to existing conditions, future conditions under all Concepts result in longer queues, forecasting increases of 15 to 233 vehicles with the Concepts compared to existing conditions.

Summary of Constraints

The main constraints at the Bow Lake station were found to be the capacity of the inbound scales and the outbound scales as it relates to the ability to process the forecast peak-hour demands for the station.

Inbound Scale Capacity – Capacity constraints exist at the inbound scale resulting in vehicle queues that extend back to and onto Orillia Road. The service time results are affected by the capacity of the inbound scale. As evidenced by the fact that despite the variance in weekday and Saturday vehicle demands, the on-station service times are approximately the same. This indicates that the inbound scale is operating at its maximum capacity and lacks the capacity to accommodate the forecasted demand.

Outbound Scale Capacity – Due to the capacity restriction on the inbound scale, the analysis of the unmitigated concepts does not identify capacity constraints on the outbound scale. At the current rate vehicles are processed at the inbound scale, the outbound scale is not identified as a constraint. However, if the inbound scale capacity is increased the capacity of the existing outbound scale were identified as a constraint, as evidence by on-site queuing that would extend from the scalehouse into the self-haul tipping floor area, as well as self-haul and commercial-haul service times.

Analysis of Improvement Strategies

The Tier 1 screening primarily focused on the overall reduction in station traffic anticipated under the particular strategy. The strategies analyzed are listed in **Tier 1/Tier 2 Screening Methodology**. The anticipated peak-hour demand reduction in station traffic under both the with- and without-Renton scenarios during the weekday and Saturday peak hours for each of the individual strategies is summarized in **Attachment F (Demand Management Strategy Trip Reductions)**. The percent reductions applied to the unadjusted peak-hour demands are based on data provided by the division. Reductions range from 0 to 34 percent of the peak-hour demand.

It is important to note that not all improvement strategies are as effective if combined. Thus, the identification of the improvement combinations accounts for the relationship to one another. In addition to the transportation demand strategies noted above, potential physical station improvements were identified to address the operational constraints. These improvements considered the addition of a third inbound and a third outbound scale.

Strategy combinations were identified based on the results of the Tier 1 screening process. The Tier 2 screening process included the testing of the strategy combinations using VISSIM. The effectiveness of the strategies were tested for the without-Renton scenario as that time period representing the period with the highest peak-hour demand for the stations. The following combinations were identified for detailed evaluation:

Combination A – Additional inbound scale

Combination B –

B1. Additional inbound scale and additional outbound scale

B2. Additional inbound scale, additional outbound scale, and outbound queue pocket (on-station)

Due to similar peak-hour demands for the concepts, the Tier 2 evaluation utilizing VISSIM applied the following strategy combinations to Concept 0 (weekday and Saturday) only. The results of the strategy combinations tested for the specific concepts are shown and discussed below.

Concept 0

Strategy combinations A and B were tested on Concept 0. The queue and service times of the combinations are shown in **Table 4**.

Table 4
Bow Lake Combinations Service Times and Queues (Concept 0 – 2023 Without-Renton)

Scenario	Service Times					Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)			
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*		*32*	*32*
Existing[6]	00:13	00:26	00:13	00:27		2	3
Concept 0	00:22	00:29	00:18	00:27		98	205
Concept 0 + Combination A	00:45	00:57	00:52	1:10		4	52
Concept 0 + Combination B1	00:31	00:45	00:26	00:36		3	7
Concept 0 + Combination B2	00:17	00:35	00:13	00:28		3	6

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet.
4. Adopted standards as defined in King County Transfer Plan (December 2007)
5. Threshold - Threshold of 32 vehicle queue is approximate distance to adjacent intersection from station access (Orillia Rd S / S 188th St)
6. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 4**, Concept 0 with the addition of Combination B2 meets the adopted service times for the Saturday peak demand, but exceeds the adopted service times for the weekday period. The commercial-haul service times exceed the standard by 1-minute and the self-haul times exceed the standard by 5 minutes. Relative to the existing service times, Combination B2 results in the most similar performance levels.

Although the self-haul service times with Combination B2 appear to be worse on station on the weekday compared with Concept 0 by itself, the queues have been reduced by 95 vehicles. As noted previously, the unmitigated service times for Concept 0 are skewed due to the forecasted queueing and the metering effect of the inbound scalehouse. The inbound vehicle queues for the weekday and Saturday conditions are well under the threshold, with a maximum queue length of six vehicles.

<u>Concept 1 – 3</u>

Peak-hour demands for all scenarios are similar between Concept 0 and Concepts 1, 2, and 3. As such, no VISSIM modeling was conducted for Concepts 1, 2, and 3.

Off-Site Traffic Analysis Results

The analysis includes an evaluation of intersection operations at four intersections. The study intersections (see **Figure 8**) and the jurisdictions include:

1. I-5 Southbound Ramps / S 188th St (WSDOT)
2. I-5 Northbound Ramps / S 188th St (WSDOT)
3. Orillia Rd S / S 188th St (Tukwila)
4. Orillia Rd S / S 200th St (Tukwila)

These study intersections were evaluated during the weekday and Saturday peak hours at Bow Lake identified during the station observations in September 2014. The peak hours identified were 12:00 to 1:00 p.m. for both weekday and Saturday conditions.

Intersection LOS was calculated at the study intersections based on Highway Capacity Methodology as described previously. As noted, the study intersections are within two jurisdictions, the cities of SeaTac and Tukwila. Based on the City of Tukwila's Comprehensive Plan, Orillia Rd S is a principal arterial and the LOS standard for principal intersections is not to exceed LOS E. LOS D thresholds are applied to the WSDOT facilities, including the I-5 ramps.

Figure 8
Bow Lake Study Intersections

Existing Conditions

Existing intersection turning movements were collected at the off-station intersections in October 2014 for both weekday and Saturday periods. Detailed intersection turning movement traffic volumes are provided in **Attachment G (Off-Station Intersection Traffic Counts)**. The weekday and Saturday existing intersection traffic volumes are shown in **Figure 9**.

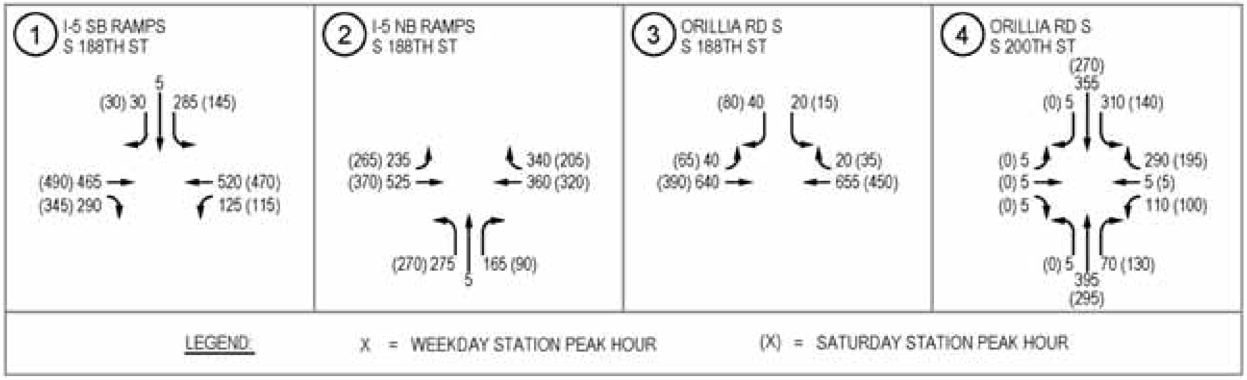

Figure 9
Bow Lake Existing Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 5 summarizes the existing weekday and Saturday station peak-hour LOS. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

Table 5
Bow Lake Existing Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Jurisdiction	Traffic Control	Weekday Station Peak-Hour (12 – 1 p.m.)				Saturday Station Peak-Hour (12 – 1 p.m.)		
			LOS[1]	Delay[2]	WM[3]		LOS	Delay	WM
1. I-5 Southbound Ramps / S 188th St	SeaTac	Signalized	B	13			A	8	
2. I-5 Northbound Ramps / S 188th St	SeaTac	Signalized	B	17			B	11	
3. Orillia Rd S / S 188th St	Tukwila	Two-Way Stop Controlled	D	35	SBL		C	20	SBL
4. Orillia Rd S / S 200th St	Tukwila	Signalized	B	16			A	9	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology.
2. Average delay in seconds per vehicle.
3. WM= Worst movement reported for unsignalized intersections where SBL = southbound left.

As shown in **Table 5**, under existing conditions all study intersections operate at LOS D or better during both weekday and Saturday study periods, meeting both WSDOT and Tukwila's LOS standards.

Future 2023 Without-Project Conditions

As the study intersections are located within two jurisdictions, both the City of SeaTac and the City of Tukwila's planned improvements were reviewed. Based on a review of the City of SeaTac's *(2015-2024) Transportation Improvement Program*, no planned improvements were identified that would impact the operations of the study intersections. Similarly, based on a review of the City of Tukwila's *(2015-2020) Capital Improvement Program*, no planned improvements were identified that would impact the operations of the study intersections.

The 2023 without-project traffic volumes were forecast by applying an annual growth rate to the existing 2014 traffic counts and adding traffic from approved, but not yet constructed (pipeline) development in the study area. Based on discussions with Tukwila staff, the pipeline project includes traffic volumes associated with the Tukwila South development and an annual growth rate of 1.5 percent. Without-project conditions represent a condition that assumes that the station continues to operate as-is. No changes in station volumes outside of normal background growth were assumed. This scenario is not consistent with Concept 0.

The 2023 without-project weekday and Saturday station peak-hour traffic volumes are shown in **Figure 10**. Comparing the existing traffic volumes to the without-project conditions, weekday peak-hour traffic volumes would increase by approximately 95 to 180 percent, and Saturday peak-hour traffic volumes would increase by 50 to 120 percent.

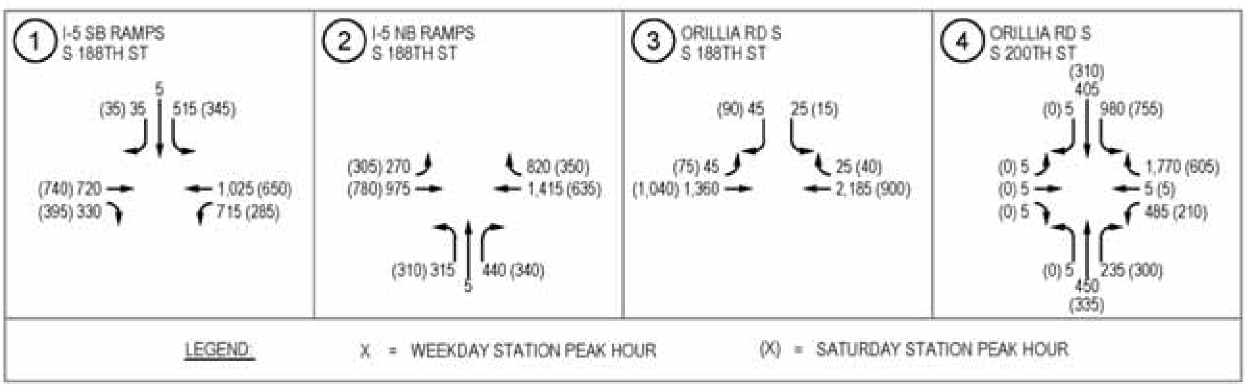

Figure 10
Bow Lake 2023 Without-Project Weekday and Saturday Station Peak-Hour Traffic Volumes

Signal timing was optimized for the 2023 analysis; optimizing the traffic signal timing takes into consideration the actuated nature of the signals and changes that would occur with growth in traffic volumes. **Table 6** summarizes the LOS results for the without-project weekday and Saturday peak hours.

Table 6
Bow Lake 2023 Without-Project Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Traffic Control	Existing				2023 Without-Project		
		LOS[1]	Delay[2]	WM[3]		LOS	Delay	WM
Weekday Station Peak-Hour (12 – 1 p.m.)								
1. I-5 Southbound Ramps / S 188th St	Signalized	B	13			D	45	
2. I-5 Northbound Ramps / S 188th St	Signalized	B	17			E	66	
3. Orillia Rd S / S 188th St	Two-Way Stop Controlled	D	35	SBL		F	>180	SBL
4. Orillia Rd S / S 200th St	Signalized	B	16			F	93	
Saturday Station Peak-Hour (12 – 1 p.m.)								
1. I-5 Southbound Ramps / S 188th St	Signalized	A	8			B	12	
2. I-5 Northbound Ramps / S 188th St	Signalized	B	11			B	16	
3. Orillia Rd S / S 188th St	Two-Way Stop Controlled	C	20	SBL		F	79	SBL
4. Orillia Rd S / S 200th St	Signalized	A	9			B	17	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology.
2. Average delay in seconds per vehicle.
3. WM= Worst movement reported for unsignalized intersections where SBL = southbound left.

Table 6 shows that with the addition of background growth and pipeline projects, many study intersections LOS would degrade under without-project conditions compared to existing conditions. During the weekday peak-hour, the I-5 ramp / S 188th Street intersections would degrade from LOS B to LOS D and E for the southbound and northbound ramps, respectively, the northbound ramp falling below WSDOT's LOS D standard. Similarly, the Orillia Rd intersections both degrade to LOS F under without-project conditions compared to LOS C and LOS D under existing conditions, exceeding the LOS E standard for the City of Tukwila. During the Saturday peak-hour, the study intersections would operate at LOS C or better, with the exception of the Orillia Road S / S 188th Street intersection, which degrades to LOS F for the southbound left movement under without-project conditions compared to LOS under existing conditions. This is the station access intersection, which is an unsignalized three-leg intersection, where S 188th Street changes to Orillia Road S as it transitions from east/west to north/south.

2023 Concept 0 Conditions

As discussed above, the station peak-hour traffic volumes are similar for each concept (see **Figure 7**) and as such the Concept 0 forecasts were utilized for the off-station intersection analysis. As this is an existing station, the net new trips were calculated and assigned to the off-station study intersections. To calculate the net new trips the station transactions (the inbound trips) were provided by King County for the same day the off-station traffic volumes were collected in order to ensure the data was consistent. The net-new trips under 2023 Concept 0 conditions were then calculated by subtracting the existing transactions, which were doubled to account for in and outbound trips from the station, from the 2023 Concept 0 forecast number of trips. This is shown in the Trip Generation **Tables 7** and **8** for with- and without-Renton conditions, respectively.

Table 7
Bow Lake Concept 0 With-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	**Outbound**	**Total**		**Inbound**	**Outbound**	**Total**
Existing Total[1]	*39*	*39*	78		78	78	156
Concept 0							
Commercial-haul	21	21	42		5	5	10
Self Haul	66	66	132		106	106	212
Total	87	87	174		111	111	222
Net New Project Trips (2023 Concept 0 – Existing)	48	48	96		33	33	66

1. Existing total based on station transactions during the peak hours on the day the off-station intersection traffic volumes were collected, October 4 and 7, 2014

As shown in **Table 7**, during the weekday peak-hour 96 net new trips are estimated, and during the Saturday peak-hour 66 net new trips are estimated relative to the existing traffic counts.

Table 8
Bow Lake Concept 0 Without-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	Outbound	Total		Inbound	Outbound	Total
Existing Total[1]	*39*	*39*	78		78	78	156
Concept 0							
Commercial-haul	25	25	50		5	5	10
Self-haul	85	85	170		135	135	270
Total	110	110	220		140	140	280
Net New Project Trips (2023 Concept 0 – Existing)	71	71	142		62	62	124

1. Existing total based on station transactions during the peak hours on the day the off-station intersection traffic volumes were collected October 4 and 7, 2014.

The weekday and Saturday peak-hour trips are 1.5 to 2 times greater under without-Renton conditions compared to with-Renton conditions. As shown in **Table 8**, during the weekday peak-hour 142 net new trips are estimated, and during the Saturday peak-hour 124 net new trips are estimated relative to the existing traffic counts.

The trip distribution pattern for the self-haul vehicles was developed based on the data received from the weekday and Saturday customer origin/destination surveys. As noted above, the survey respondents were asked the closest intersection and zip code they were coming from. Each respondents answer was plotted so the trip distribution could be estimated. Under with-Renton conditions the Bow Lake respondents were used to calculate the trip distribution. Under Bow Lake without-Renton conditions, approximately 2/3 of the Renton users are anticipated to use Bow Lake and as such, the Bow Lake without-Renton trip distribution was adjusted by adding 2/3 of the Renton respondents. The trip distributions for Bow Lake on the weekday and Saturday under both with- and without-Renton conditions are shown in **Figures 11** and **12**.

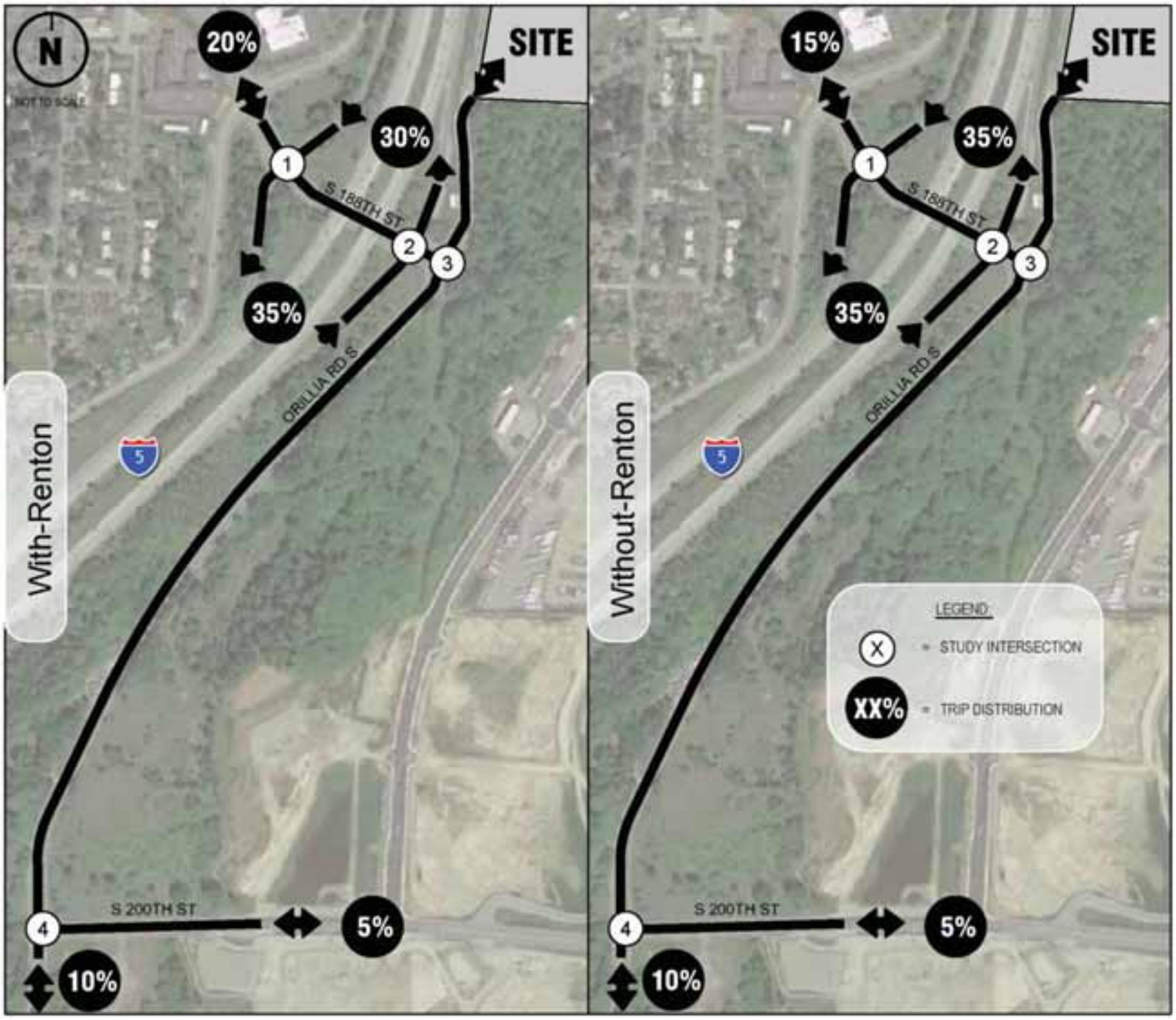

Figure 11
Bow Lake Weekday Trip Distribution (With and Without-Renton)

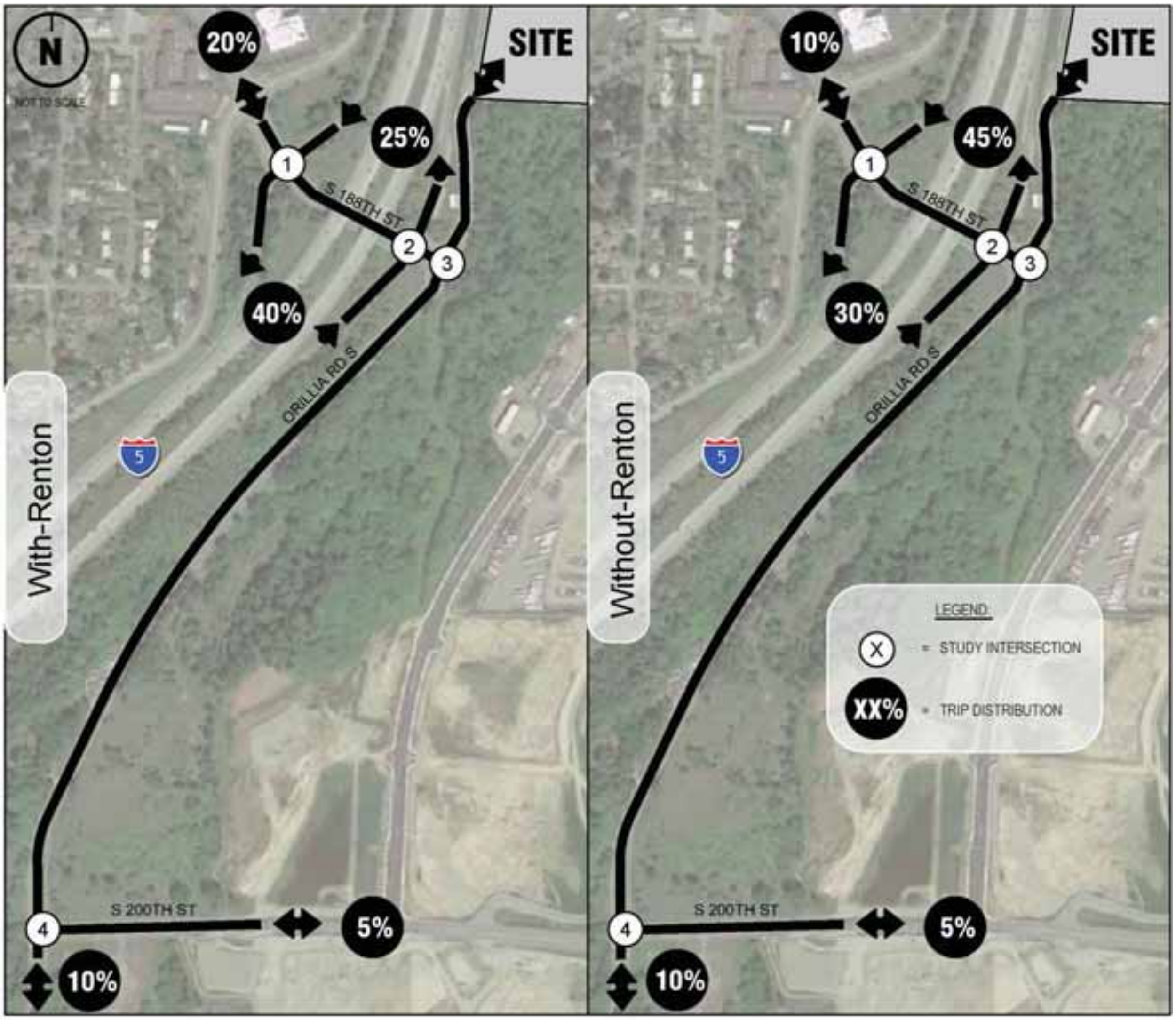

Figure 12
Bow Lake Saturday Trip Distribution (With and Without-Renton)

The net-new trips associated with each scenario was assigned to the study intersections based on the trip distributions. The net new project trip assignment for weekday and Saturday under both with- and without-Renton conditions are shown in **Figure 13**.

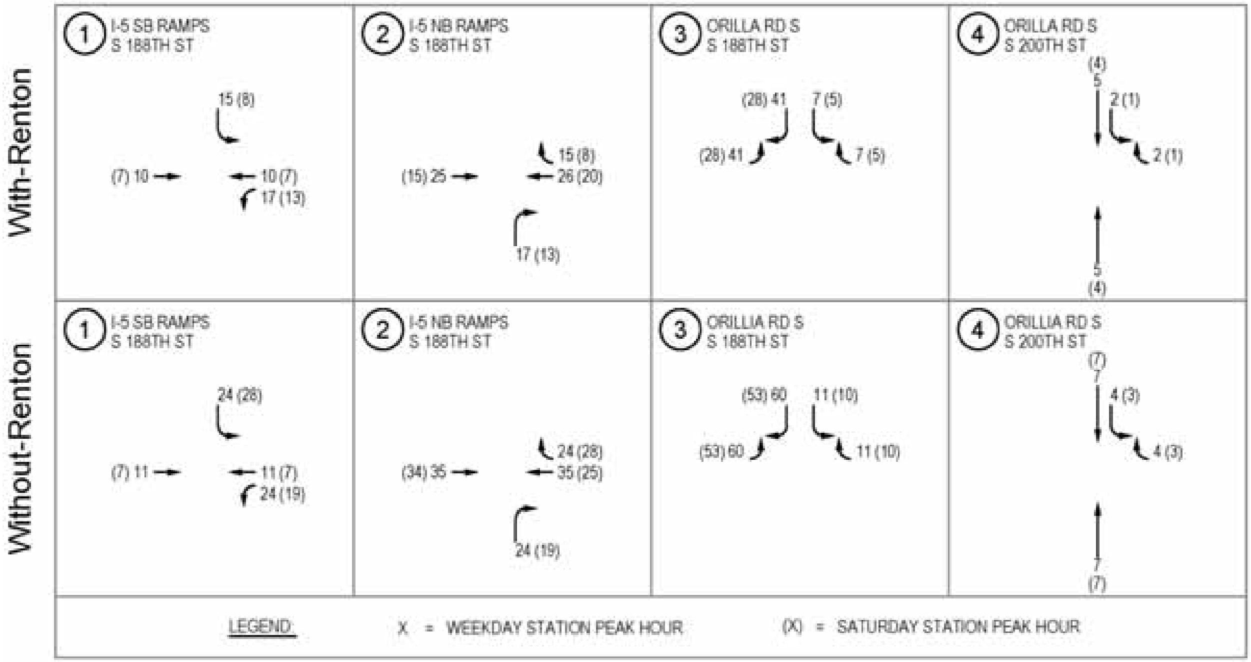

Figure 13
Bow Lake Concept 0 With and Without-Renton Net-New Trip Assignment

The with-project 2023 Concept 0 weekday and Saturday peak-hour traffic volumes both with- and without-Renton are shown in **Figure 14**.

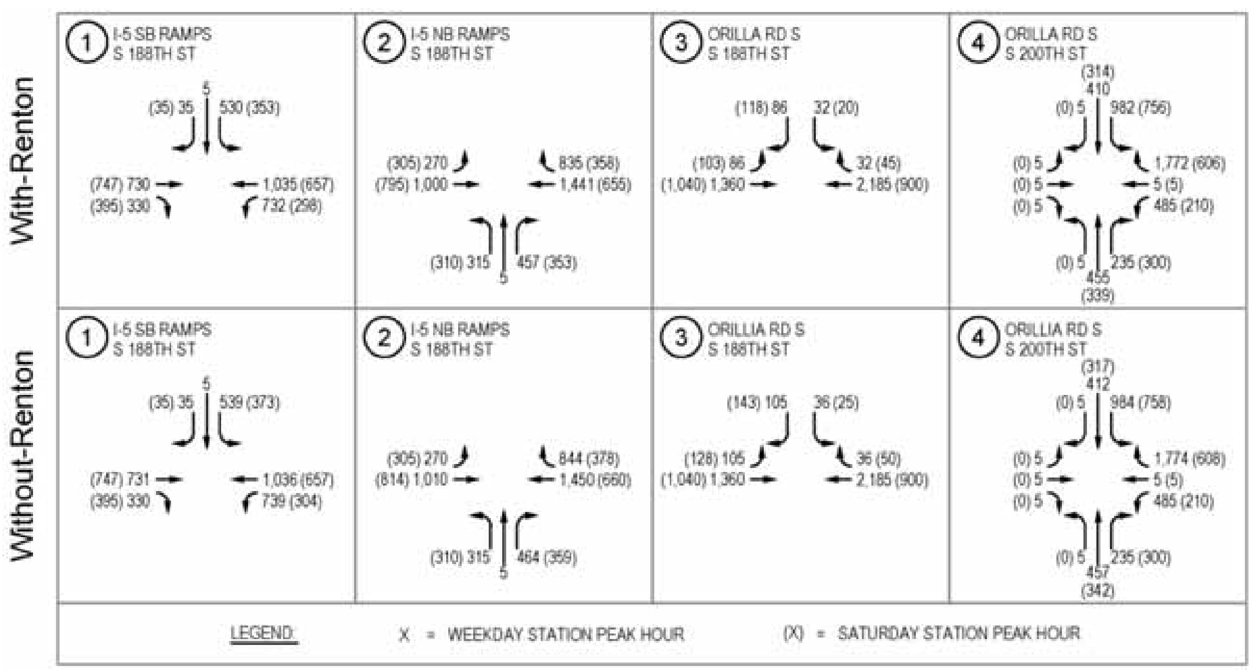

Figure 14
Bow Lake Concept 0 Weekday and Saturday Station Peak-Hour Traffic Volumes

The largest percent impact of the Concept 0 traffic volumes relative to the without-project conditions was at the station access intersection, the S 188th Street / Orillia Road S intersection, under all Concept 0 scenarios. During the weekday station peak-hour percent increases under Concept 0 compared to without-project conditions range from 3 percent to 4 percent under with- and without-Renton conditions, respectively. Similarly, during the Saturday station peak-hour percent increases under Concept 0 compared to without-project conditions range from 3 percent to 6 percent during with- and without-Renton conditions, respectively.

Table 9 provides a comparison between the 2023 Concept 0 and without-project conditions both with- and without-Renton conditions. The detailed LOS worksheets are included **in Attachment H (LOS Worksheets)**.

Table 9
Bow Lake Concept 0 Weekday and Saturday Station Peak Hours LOS Summary

	2023 Without-Project				**Concept 0 – With-Renton**				**Concept 0 – Without-Renton**		
Intersection	LOS[1]	Delay[2]	WM[3]		LOS	Delay	WM		LOS	Delay	WM
Weekday Station Peak-Hour (12 – 1 p.m.)											
1. I-5 Southbound Ramps / S 188th St	D	45			D	49			D	50	
2. I-5 Northbound Ramps / S 188th St	E	66			E	71			E	73	
3. Orillia Rd S / S 188th St	F	>180	SBL		F	>180	SBL		F	>180	SBL
4. Orillia Rd S / S 200th St	F	93			F	94			F	95	
Saturday Station Peak-Hour (12 – 1 p.m.)											
1. I-5 Southbound Ramps / S 188th St	B	12			B	12			B	12	
2. I-5 Northbound Ramps / S 188th St	B	16			B	17			B	17	
3. Orillia Rd S / S 188th St	F	79	SBL		F	108	SBL		F	156	SBL
4. Orillia Rd S / S 200th St	B	17			B	17			B	17	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology.
2. Average delay in seconds per vehicle.
3. WM= Worst movement reported for unsignalized intersections where SBL = southbound left.

As shown in **Table 9,** all study intersections continue to operate at the same LOS under Concept 0, both with- and without-Renton, compared to the without-project conditions.

Bow Lake Station Summary

- Increases in station traffic range from 85 to 88 between the different concepts during the weekday peak period under with-Renton conditions and range from 110 to 118 during the weekday peak period under the without-Renton conditions. During the Saturday peak period, peak demand volumes range from 110 to 111 under with-Renton conditions and range from 140 to 152 under without-Renton conditions.
- Analysis of on-site operations showed operational issues at the inbound scales, resulting in queues extending beyond the defined inbound queue thresholds.
  - Three combinations were analyzed to improve on-site operations under Concept 0 without-Renton conditions, both during the weekday and Saturday peak periods. Combination B2 (an additional inbound and outbound scale and outbound queue storage pocket) meets the Saturday adopted service times and queue thresholds as well as being near the adopted service times and meeting the queue thresholds on the weekdays. The other combinations under the without-Renton conditions exceed either the adopted service times or the queue thresholds.
- Evaluation of off-station intersections showed minimal increases in off-station intersections for Concept 0 relative to without-project conditions. Concept 0 represented the highest peak demand, and thus represents a more conservative analysis when considering the impacts to the other concepts and the greatest impact to the off-station intersections.

Renton

Station Description – Access and Circulation

Primary vehicle access to the Renton station is provided via Jefferson Avenue NE. Both the general public and County trucks utilize Jefferson Avenue NE. The transfer station site vicinity is shown in **Figure 15**.

Figure 15
Renton Site Vicinity

The tipping floor is laid out such that the commercial-haulers and self-haulers dump their garbage directly into the County trailers. The County vehicles are in the center of the floor set below the level of the haulers, dividing the floor into two sides, an east and west side. Both the east and west tipping floors are set up for entry on the north side and exit on the south side of the building (see **Figure 16** for vehicle circulation). The east tipping floor is set up consistently on the weekdays and Saturdays, serving the commercial-haul and self-haul vehicles with tipping trailers as well as some self-haul vehicles without tipping trailers. The east tipping floor has two stalls available to the commercial vehicles and self-haul vehicles with tipping trailers, and four stalls available to the general self-haul vehicles. The west tipping floor is for the general self-haul vehicles with four stalls on the weekdays, and eight stalls on Saturdays. This station also includes areas a recycling area which is located outside of the scales, northwest of the station.

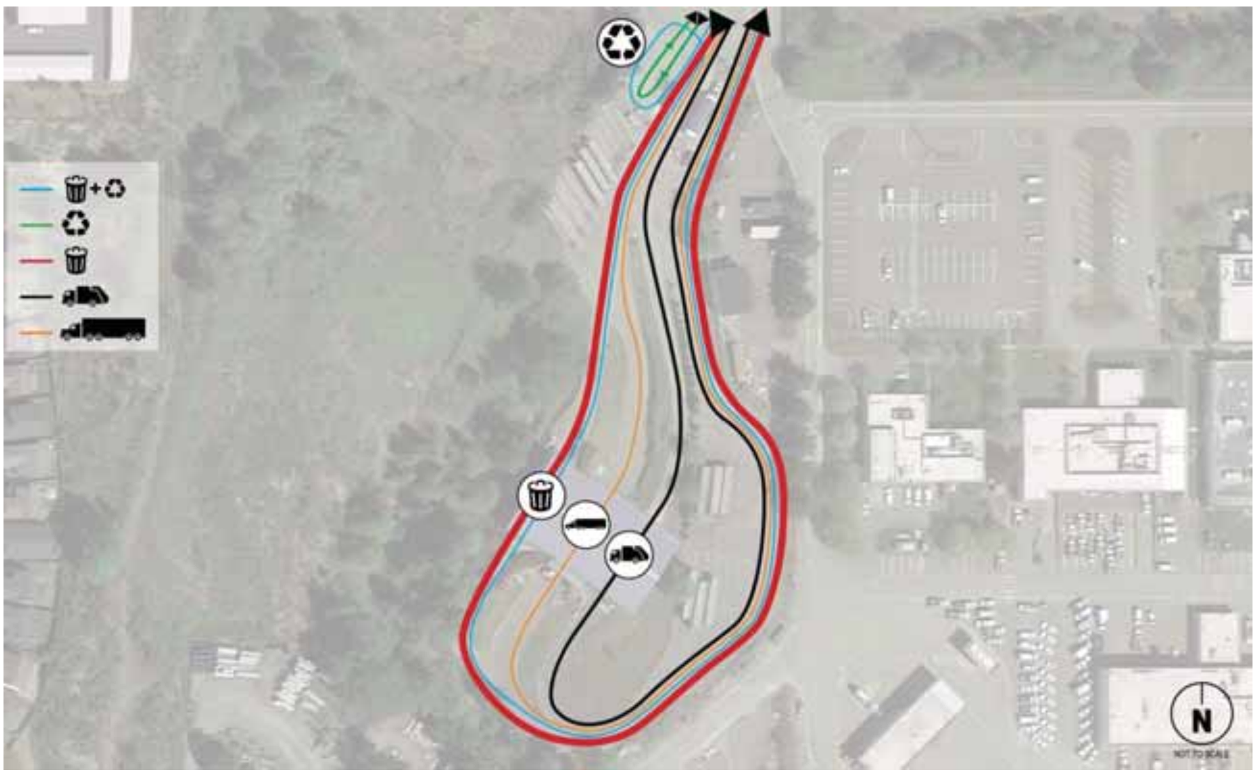

Figure 16
Renton On-Site Future Building Configuration and Circulation Patterns

Station Traffic Volumes

Data Collection. As noted previously, extensive data collection was conducted to support the development of the VISSIM model and establish the existing conditions on the station. While this information was largely used to calibrate the VISSIM model, it also assists in providing the existing context against which the future conditions can be compared. A general outline of the data collected as well as a map of the specific locations for video collection, traffic counts, and service time studies is included in **Attachment C (Data Collection Summary)**.

Customer Origin/Destination Surveys. In addition to the traffic volume, queuing, and service time data, customer origin/destination data was collected to identify the general distribution of customer traffic utilizing this station during the days the surveys were conducted. The survey was conducted during the 3-hour period. The following questions were asked of customers as they exited the facility:

- Where are you coming from (zip code and closest intersection)?
- Are you coming from a home or business?

Not all customers participated in the survey so the information shown in **Table 10** represents a sample of the customers that utilized the station during the observation period. The response rate on the weekday was approximately 70 percent, whereas the response rate on Saturday was approximately 100 percent, missing less than 5 customers. It is important to note that the lower response rate on the weekday is primarily due to not asking commercial vehicles to participate in the survey.

Reponses from customers were mapped to the nearest major intersection using GIS. This information is shown in **Attachment D (Customer Origin/Destination Data)**. The responses from the surveys indicated the following distribution of customers are utilizing the Renton station. Information is presented for the weekday and Saturday time periods, although (as shown) the general distribution of customers is not that different.

Table 10
Renton Customer Trip Origin Summary

Trip Origin	Survey Respondents - Weekday		Survey Respondents - Saturday	
	Number	Percentage	Survey Origin	Percentage
Renton	17	30%	72	45%
Seattle	0	0%	5	3%
King County (excluding Seattle/Renton)	38	68%	83	52%
Pierce County	1	2%	0	0%
Total	56	100%	160	100%

Existing Traffic Volumes. Based on the data collected for the station, the weekday peak period (3 hours) was defined to be 11:15 a.m. to 2:15 p.m. and the Saturday period was 10:45 a.m. to 1:45 p.m. **Figure 17** shows the weekday and Saturday daily station traffic volumes.

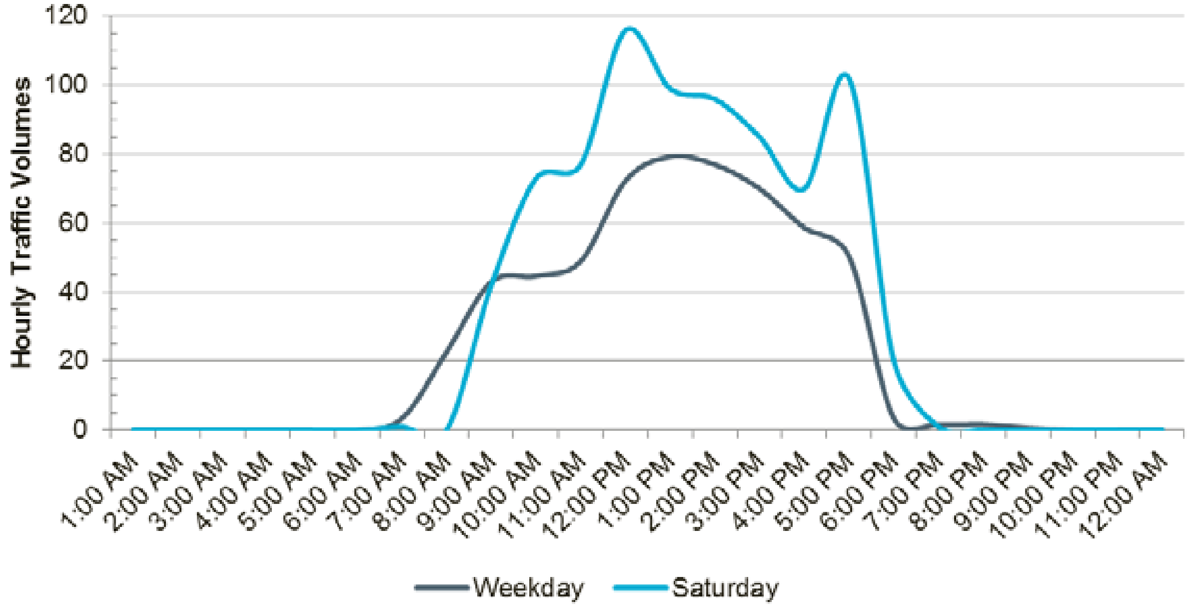

Figure 17
Renton Existing Typical Weekday and Saturday Traffic Volume Patterns

Future Traffic Volumes. Similar to previous station assessments, future conditions for 2023 were evaluated. Future traffic volumes at the station were forecast based on the methodologies described previously. Three (3)-hour peak volumes were developed based on annual tonnage forecasts developed for the station, distribution of weekday and Saturday activity, tonnage per vehicle, seasonal factors, and hourly trip generation patterns for the station. The detailed calculations showing all the key assumptions are included in **Attachment E (Trip Generation Forecasts)**.

Station forecasts were developed for Concept 0, Concept 1, Concept 2, and Concept 3. All concepts assumed that the Houghton station was closed. **Figure 18** summarizes the peak-hour volumes for each of the concepts (self-haul and commercial-haul) traffic for weekday and Saturday conditions. This comparison helps to understand the station traffic forecasts for the different concepts. Although only the peak-hour is shown in this Figure, the peak-hour volumes are generally anticipated to occur for multiple hours as shown in the **Figure 17** hourly profile.

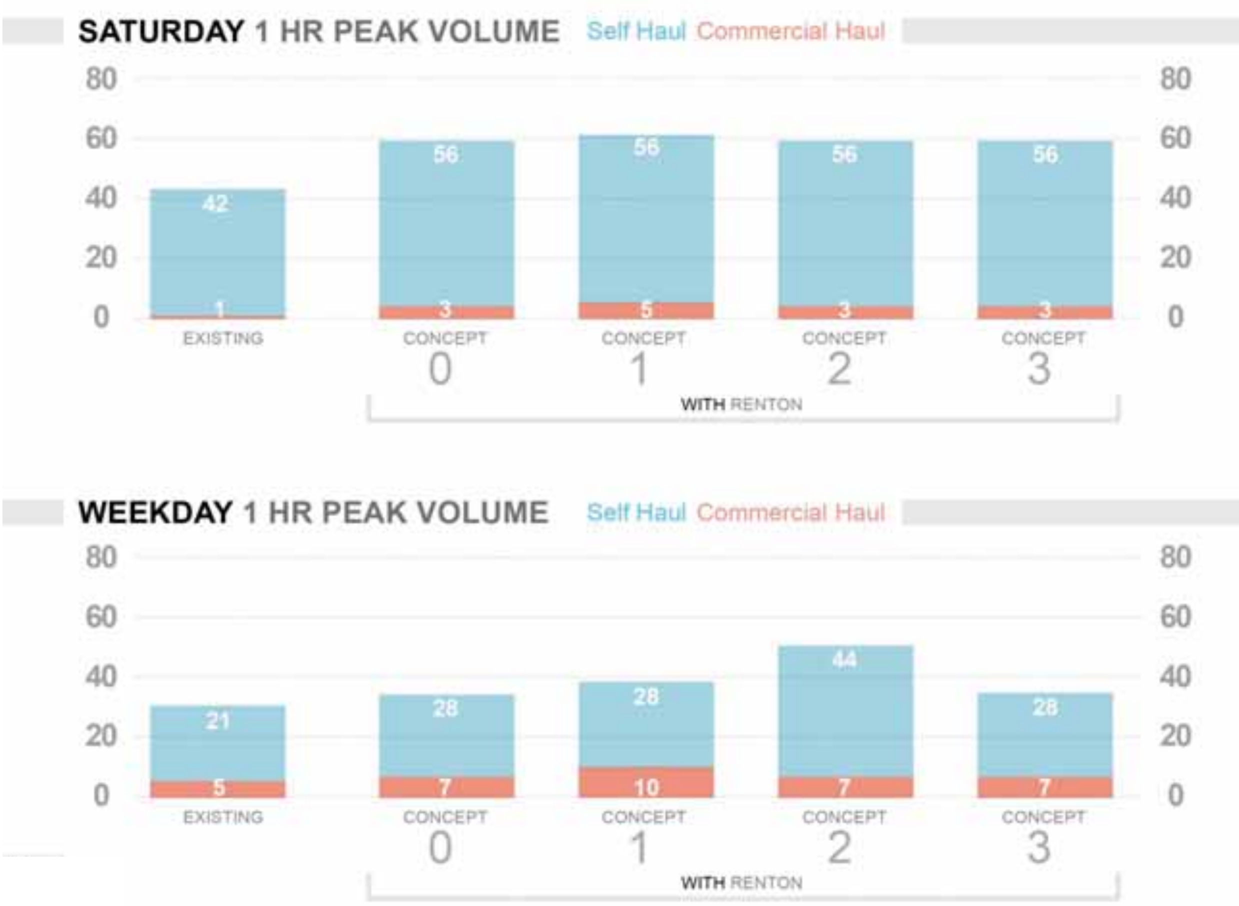

Figure 18
Renton Existing and Concepts 0-3 Peak-Hour Volumes

As shown in **Figure 18**, relative to the existing volumes, the Concept 0 peak-hour traffic volumes are anticipated to increase by approximately 35 percent during both the weekday and Saturday peak hours. During the Saturday peak-hour, the traffic volumes between the concepts are anticipated to be similar with up to two vehicle differences between Concepts 0 to 3. During the weekday peak-hour, traffic volumes for Concepts 0, 1, and 3 are similar, only Concept 2 has a notable change in traffic volumes. An increase in the peak-hour volumes is anticipated with Concept 2 during the weekday due to the restriction of self-haul vehicles at Factoria.

On-Site Analysis Results

The on-site service times and inbound vehicle queues were calculated using the methodology described previously. The service time and queue results are shown in **Table 11** for existing, and Concepts 0, 1, 2, and 3 conditions.

Table 11
Renton Existing and Concepts 0-3 Peak-Hour Service Times and Queuing Summary

Scenario	Service Times					Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)			
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*		*40*	*40*
Existing[6]	00:10	00:17	00:11	00:19		0	0
Concept 0	00:10	00:18	00:11	00:21		0	1
Concept 1	00:10	00:18	00:11	00:21		0	1
Concept 2	00:10	00:28	00:11	00:21		4	1
Concept 3	00:10	00:18	00:11	00:21		0	1

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet.
4. Adopted standards as defined in King County Transfer plan (December 2007)
5. Threshold - Threshold of 40 vehicle queue is approximate distance to adjacent intersection along Jefferson Ave NE (NE 3rd St / Jefferson Ave NE)
6. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 11**, service times for all concepts meet the adopted service times. Inbound queues for the commercial and self-haul vehicles is minimal and within the defined threshold. The longest service time and queues are under Concept 2 weekday conditions, with an anticipated 28-minute self-haul service time and an inbound queue of 4 vehicles.

Summary of Constraints

As noted above, all service travel times and queues are below the adopted standards or thresholds; therefore, no constraints were identified.

Analysis of Improvements Strategies

All service times and inbound queues are below the adopted standards or thresholds; therefore, no improvement strategies were identified and evaluated.

Off-Site Traffic Analysis Results

The analysis includes an evaluation of intersection operations at five intersections. The study intersections identified for this analysis include (see **Figure 19**):

1. I-405 Northbound Ramps / Maple Valley Hwy / SR 169
2. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169
3. SR 900 / NE 3rd St
4. Jefferson Ave NE / NE 3rd St
5. Duvall Ave NE / NE 4th St

These study intersections were evaluated during the weekday and Saturday station peak hours. Based on the station observations conducted in September 2014, the peak hours identified were 1:00 to 2:00 p.m. and 12:00 to 1:00 p.m. for the weekday and Saturday, respectively.

Figure 19
Renton Study Intersections

Intersection LOS was calculated at the study intersections using the LOS methodology described previously.

Existing Conditions

Existing intersection turning movements were collected at the off-station intersections in October 2014 during the weekday and Saturday peak hours defined for the station. Detailed intersection turning movement traffic volumes are provided in **Attachment G (Off-Station Intersection Traffic Counts)**. The weekday and Saturday existing intersection traffic volumes are shown in **Figure 20**. **Table 12** summarizes the existing weekday and Saturday station peak-hour LOS. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

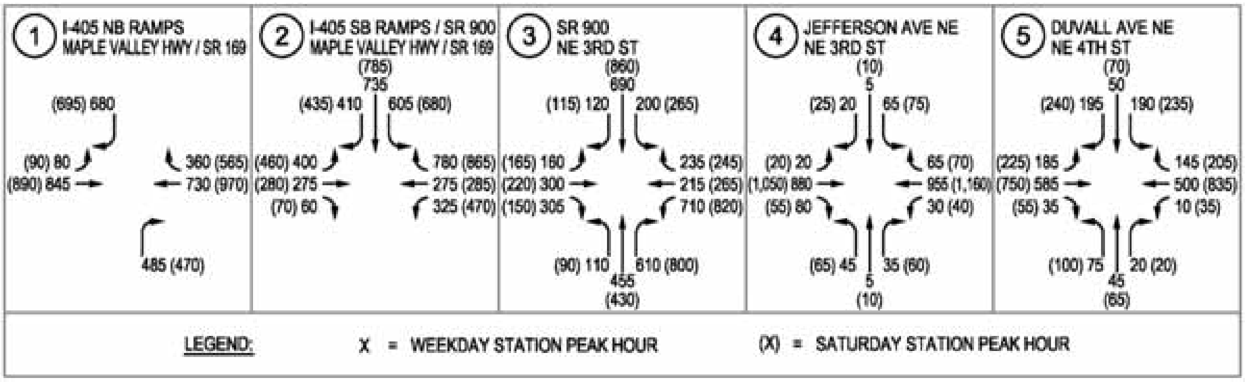

Figure 20
Renton Existing Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 12
Renton Existing Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Weekday Station Peak-Hour (1 – 2 p.m.)				Saturday Station Peak-Hour (12 – 1 p.m.)		
	LOS[1]	Delay[2]	V/C[3]		LOS	Delay	V/C
1. I-405 Northbound Ramps / Maple Valley Hwy / SR 169	B	16	0.4		B	15	0.39
2. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169	C	35	0.78		D	42	0.85
3. SR 900 / NE 3rd St	D	47	0.74		D	44	0.81
4. Jefferson Ave NE / NE 3rd St	A	9	0.45		B	11	0.51
5. Duvall Ave NE / NE 4th St	C	26	0.55		C	30	0.71

1. Level of service (LOS), based on 2000 Highway Capacity Manual methodology. The Renton study intersections were unable to be modeled using the HCM 2010 methodology.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections.

As shown in **Table 12**, under existing conditions all study intersections operate at LOS D or better during both weekday and Saturday station peak hours.

Future 2023 Without-Project Conditions

Based on a review of the City of Renton's *Six-Year (2015-2020) Transportation Improvement Program*, the NE 3rd / NE 4th Street corridor is planned to provide improved traffic operations including re-channelization and improved signal timing, transit priority at signalized intersections, queue jumps, and non-motorized improvements for pedestrians, bicyclists, and transit users. This improvement is planned to begin in 2017; however, no specific improvements that would affect the operations at the study intersections have been identified at this time.

The 2023 without-project weekday and Saturday peak-hour traffic volumes were estimated by growing existing traffic volumes by 2 percent per year to 2023 conditions. This growth rate was determined in coordination with the City of Renton. No pipeline projects were identified within the study area. The 2023 without-project weekday and Saturday peak-hour traffic volumes are shown in **Figure 21**. Without-project conditions represents a scenario that assumes the station continues to operate as-is. No changes in volumes outside of normal background growth was assumed. <u>This scenario is not consistent with Concept 0</u>.

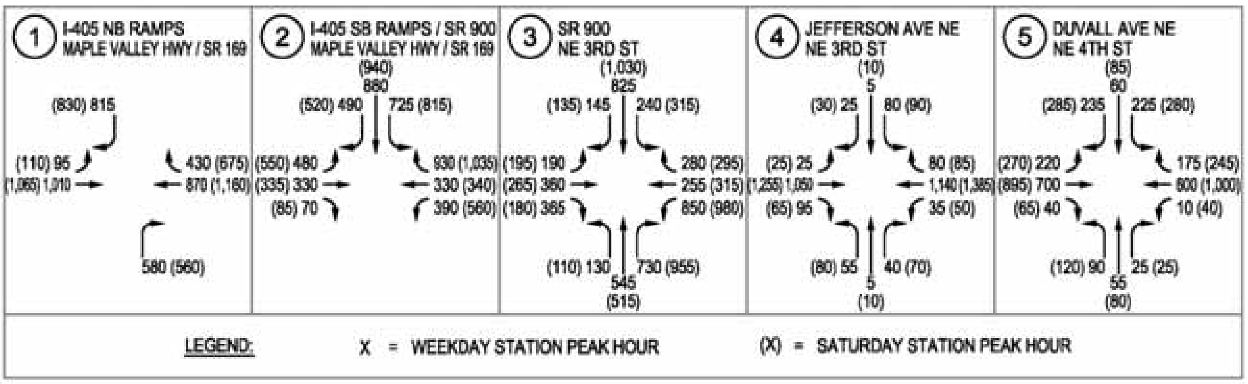

Figure 21
Renton Without-Project Weekday and Saturday Station Peak-Hour Traffic Volumes

Signal timing was optimized for the 2023 analysis; optimizing the traffic signal timing takes into consideration the actuated nature of the signals and changes that would occur with growth in traffic volumes. **Table 13** summarizes the LOS results for the without-project weekday and Saturday peak hours.

Table 13
Renton 2023 Without-Project Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Existing				2023 Without-Project		
	LOS[1]	Delay[2]	V/C[3]		LOS	Delay	V/C
Weekday Station Peak-Hour (1 – 2 p.m.)							
1. I-405 Northbound Ramps / Maple Valley Hwy / SR 169	B	16	0.4		C	31	0.85
2. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169	C	35	0.78		D	42	0.95
3. SR 900 / NE 3rd St	D	47	0.74		D	45	0.9
4. Jefferson Ave NE / NE 3rd St	A	9	0.45		B	12	0.54
5. Duvall Ave NE / NE 4th St	C	26	0.55		C	31	0.66
Saturday Station Peak-Hour (12 – 1 p.m.)							
1. I-405 Northbound Ramps / Maple Valley Hwy / SR 169	B	15	0.39		C	29	0.77
2. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169	D	42	0.85		D	53	1.01
3. SR 900 / NE 3rd St	D	44	0.81		D	39	0.89
4. Jefferson Ave NE / NE 3rd St	B	11	0.51		B	14	0.61
5. Duvall Ave NE / NE 4th St	C	30	0.71		D	50	0.86

1. Level of service (LOS), based on 2000 Highway Capacity Manual methodology. The Renton study intersections were unable to be modeled using the HCM 2010 methodology.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections.

As shown in **Table 13,** all study intersections operate at LOS D or better under both weekday and Saturday peak-hour conditions.

2023 Concept 2 Conditions

As discussed above, the station peak-hour traffic volumes are similar for each concept with the exception of the higher peak-hour traffic volumes under Concept 2 weekday conditions (see **Figure 18**) and as such the Concept 2 forecasts were utilized for the off-station intersection analysis. As this is an existing station, the net new trips were calculated and assigned to the off-station study intersections. To calculate the net new trips, the station transactions (inbound trips) were provided by King County for the same day the off-station traffic volumes were collected in order to ensure the data was consistent. The net-new trips under 2023 Concept 2 conditions were then calculated by subtracting the existing transactions, which were doubled to account for in- and outbound trips from the station from the 2023 Concept 2 forecast number of trips. This is shown in the Trip Generation **Table 14**.

Table 14
Renton Concept 2 Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	Outbound	Total		Inbound	Outbound	Total
Existing Total[1]	*35*	*35*	70		51	51	102
Concept 2							
Commercial-haul[2]	11	11	22		3	3	6
Self-haul	44	44	88		56	56	112
Total	55	55	110		59	59	118
Net New Project Trips (2023 Concept 0 – Existing)	20	20	40		8	8	16

1. Existing total based on station transactions during the peak hours on the day the off-station intersection traffic volumes were collected.
2. Actual weekday forecast inbound and outbound commercial vehicles is 7 vehicles. For a conservative analysis, no decrease in commercial vehicles taken into account.

As shown in **Table 14**, during the weekday peak-hour 40 net new trips are estimated, and during the Saturday peak-hour 16 net new trips are estimated, relative to the existing traffic counts.

The trip distribution pattern for the self-haul vehicles was developed based on the survey respondents at Renton on the weekday and Saturday. As noted above, the survey respondents reported the closest intersection and zip code they were coming from. Each respondents answer was plotted so the trip distribution could be estimated. The trip distributions for Renton on the weekday and Saturday are shown in **Figure 22**.

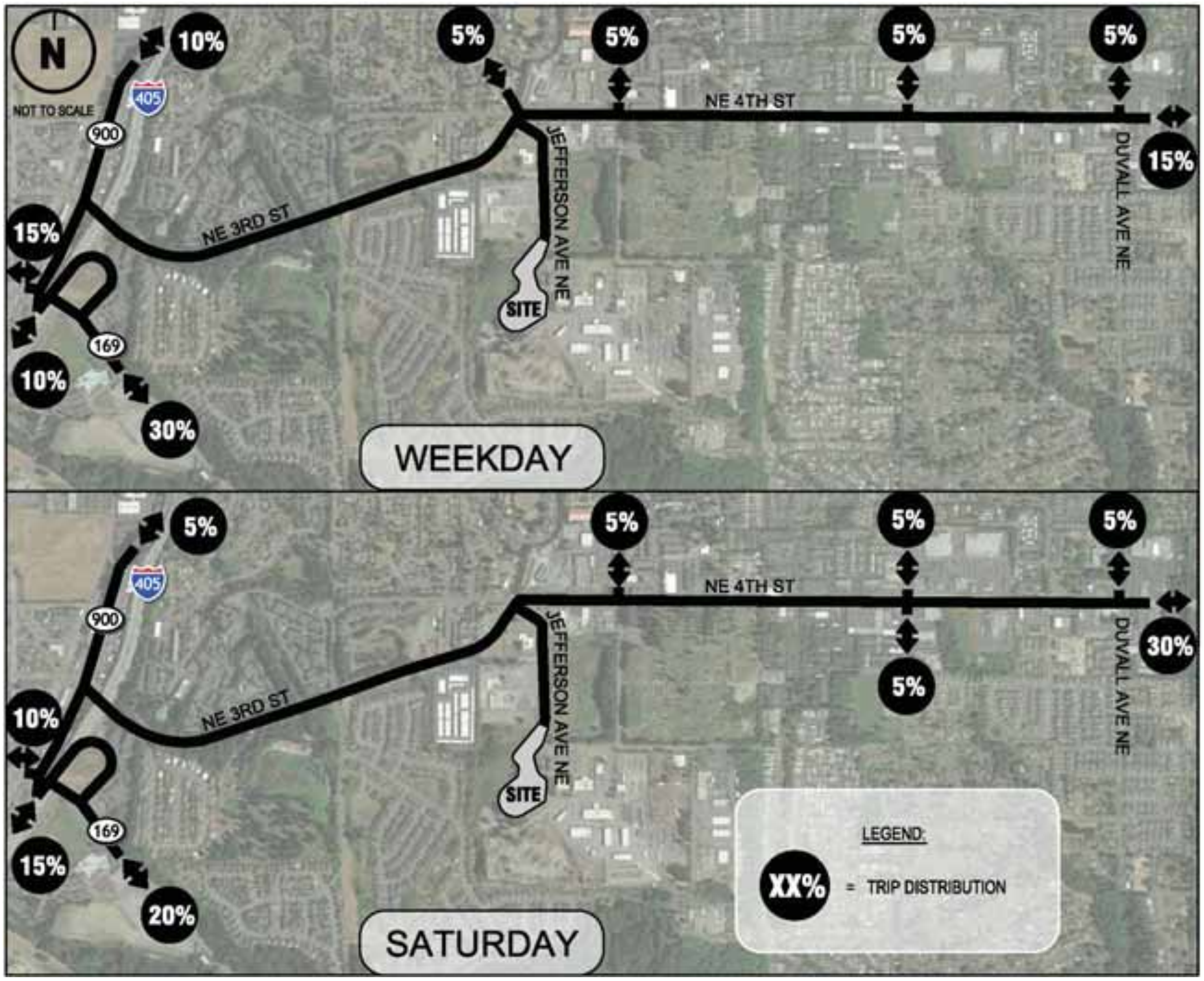

Figure 22
Renton Weekday and Saturday Trip Distribution

The net new project trip assignment for weekday and Saturday are shown in **Figure 23**.

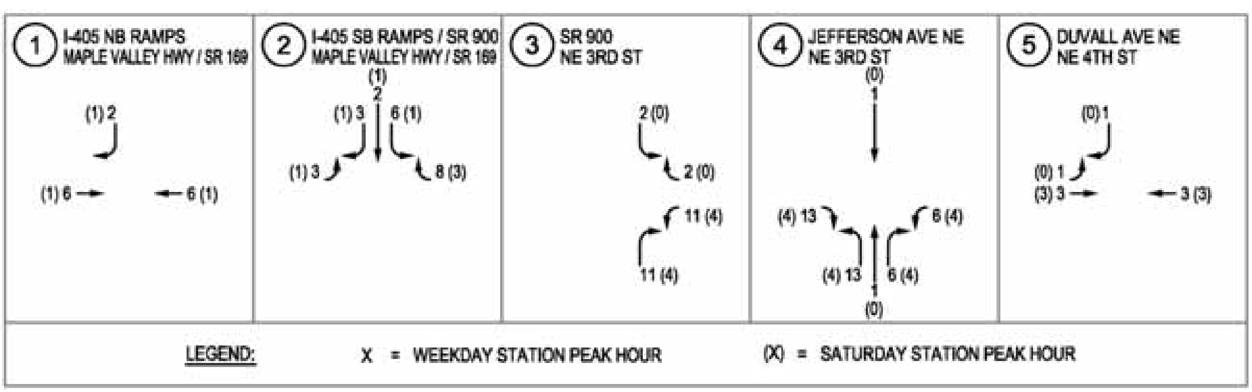

Figure 23
Renton Weekday and Saturday Net-New Trip Assignment

The with-project 2023 Concept 2 weekday and Saturday peak-hour traffic volumes are shown in **Figure 24**. Based on the anticipated increase in station trip generation, the largest percent impact of the Concept 2 traffic volumes relative to the without-project conditions was at the station access intersection, and the Jefferson Avenue NE / NE 3rd Street intersection, during both the weekday and Saturday station peak hours. The percent increase at this intersection is less than 2 percent during both the weekday and Saturday station peak hours under Concept 2, compared with without-project conditions, showing that Concept 2 has little impact on the off-station study intersections.

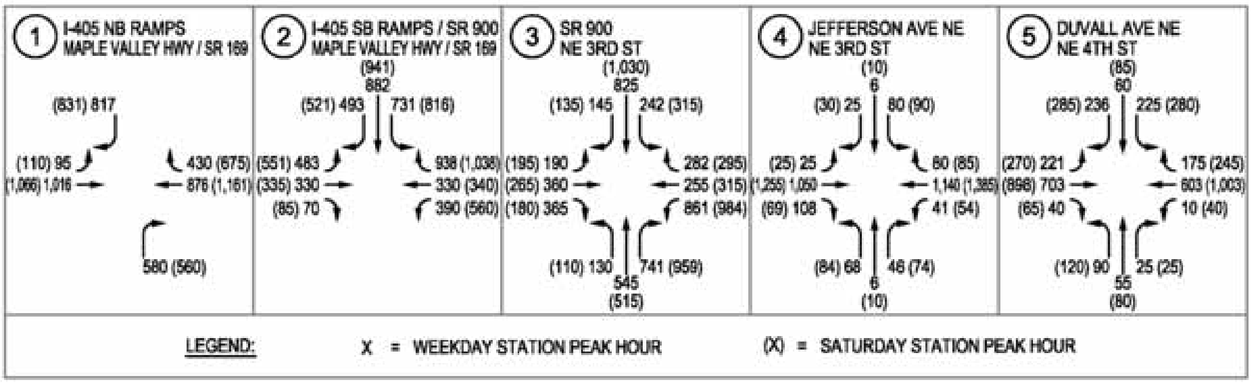

Figure 24
Renton Concept 2 Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 15 provides a comparison between the 2023 Concept 2 and without-project conditions. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

Table 15
Renton Concept 2 Weekday and Saturday Station Peak Hours LOS Summary

Intersection	2023 Without-Project				Concept 2		
	LOS[1]	Delay[2]	V/C[3]		LOS	Delay	V/C
Weekday Station Peak-Hour (1 – 2 p.m.)							
6. I-405 Northbound Ramps / Maple Valley Hwy / SR 169	C	31	0.85		C	32	0.86
7. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169	D	42	0.95		D	43	0.96
8. SR 900 / NE 3rd St	D	45	0.9		D	45	0.9
9. Jefferson Ave NE / NE 3rd St	B	12	0.54		B	13	0.55
10. Duvall Ave NE / NE 4th St	C	31	0.66		C	31	0.66
Saturday Station Peak-Hour (12 – 1 p.m.)							
6. I-405 Northbound Ramps / Maple Valley Hwy / SR 169	C	29	0.77		C	29	0.77
7. I-405 Southbound Ramps / SR 900 / Maple Valley Hwy / SR 169	D	53	1.01		D	53	1.01
8. SR 900 / NE 3rd St	D	39	0.89		D	39	0.9
9. Jefferson Ave NE / NE 3rd St	B	14	0.61		B	14	0.61
10. Duvall Ave NE / NE 4th St	D	50	0.86		D	50	0.87

1. Level of service (LOS), based on 2000 Highway Capacity Manual methodology. The Renton study intersections were unable to be modeled using the HCM 2010 methodology.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections.

As shown in **Table 15**, all study intersections would continue to operate at the same LOS under Concept 2 compared to 2023 without-project conditions. All intersections are projected to operate at LOS D or better under all conditions during the station peak hours.

Renton Station Summary

- Increases in station traffic ranges from 35 to 51 between the different concepts during the weekday peak period. During the Saturday peak period, peak demand volumes range from 59 to 61 vehicles per hour, with the highest traffic volumes occurring under Concept 2.
- Analysis of on-site operations showed no operational issues with respect to on-site service times or vehicle queueing.
- Evaluation of off-station intersections showed minimal increases in delay under volumes for Concept 2. Concept 2 represented the highest peak demand, and thus represents a more conservative analysis when considering the impacts to the other concepts and the greatest impact to the off-station intersections.

Factoria

Station Description – Access and Circulation

Primary vehicle access to the Factoria station is currently provided via SE 32nd Street. The transfer station site vicinity is shown in **Figure 25**.

Figure 25
Factoria Site Vicinity

Currently County trucks and the general public utilize SE 32nd Street. In the future (anticipated by late 2016), with the new transfer station building, County truck access the station via SE 30th Street. Access for the self-haul and commercial-haul vehicles will continue to be provided via SE 32nd Street. The station assessment for Factoria was conducted based on the future building configuration that is currently under construction. **Figure 26** shows the future building configuration.

Like the other facilities previously described, the tipping floor is divided into two main sections, commercial and self-haul areas. The self-haul area is located in the eastern portion of the building and is accessed via the north side during weekday and Saturday periods. During the weekday period, self-haul vehicles will exit the building at the southeast corner. Commercial vehicles will access the building from the south, circulate internally, and exit to the south. During the Saturday periods, when commercial traffic is less, self-haul traffic will also utilize the commercial tipping floor, exiting from the southwest corner of the building consistent with the commercial traffic.

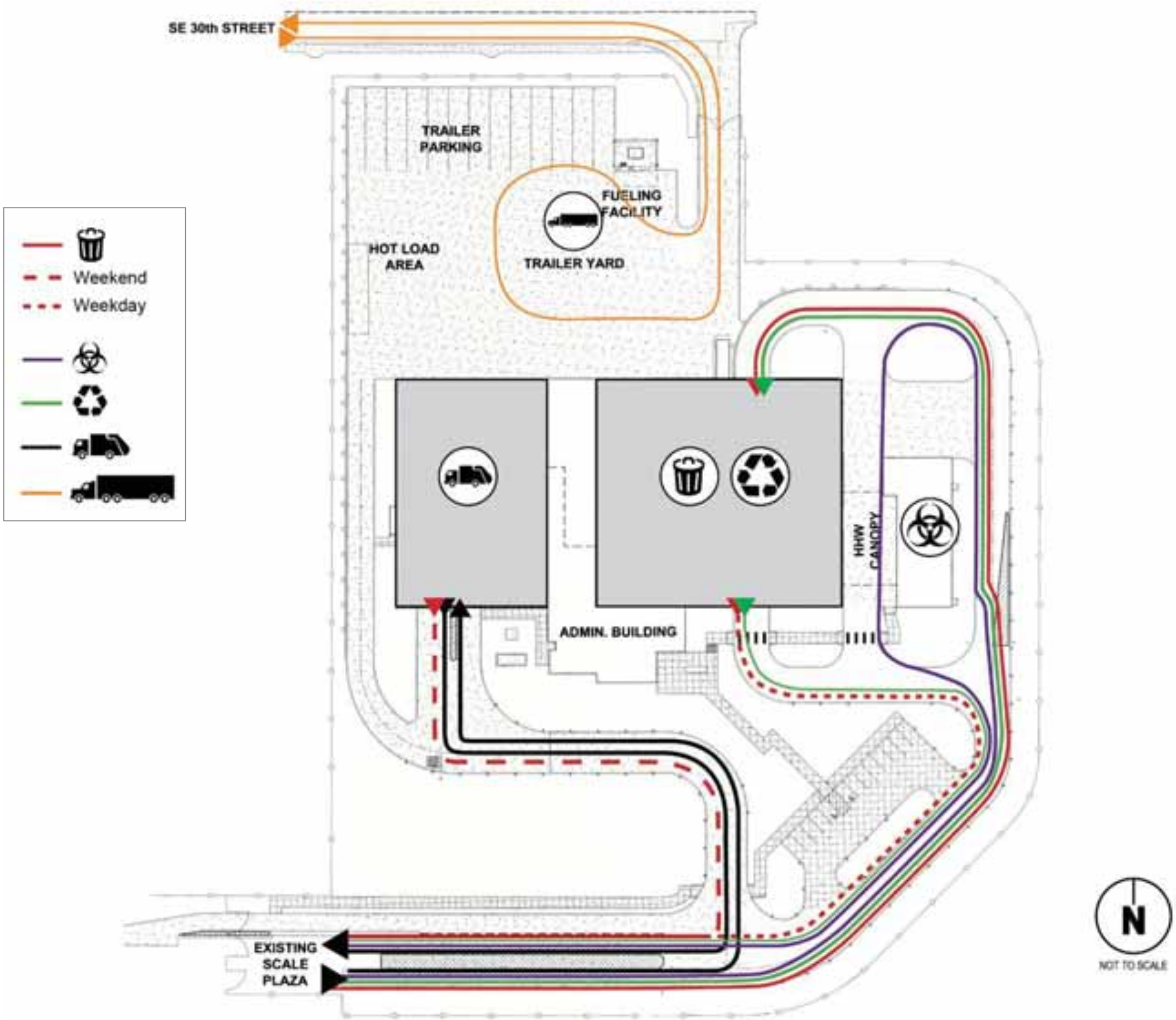

Figure 26
Factoria On-Site Future Building Configuration and Circulation Patterns

The tipping floor is an open floor concept with general areas identified for self-haul and commercial-haul activity. In the self-haul area there is anticipated to be a total of 10 and 14 stalls used for garbage on the weekday and Saturdays, respectively. There is also a total of six stalls on the commercial side of the floor. Because of the flat floor configuration, a total of 30 percent of all stalls were assumed to be closed at any one time in order to clear the area of garbage.

This station includes areas for yard waste and recycling, both of which are accommodated in the main tipping floor building. The HHW area is accessed via a separate vehicle loop. Vehicles utilizing the HHW and the tipping floor areas have to circulate an extra time through the station to deposit both types of material.

Station Traffic Volumes

Data Collection. As noted previously, extensive data collection was conducted to support the development of the VISSIM model and establish the existing conditions on the station. While this information was largely used to calibrate the VISSIM model, it also assists in providing the existing context against which the future conditions can be compared. A general outline of the data collected as well as a map of the specific locations for video collection, traffic counts, and service time studies is included in **Attachment C (Data Collection Summary)**.

Customer Origin/Destination Surveys. In addition to the traffic volume, queuing, and service time data, customer origin/destination data was collected to identify the general distribution of customer traffic utilizing this station during the days the surveys were conducted. The survey was conducted during the 3-hour period. The following questions were asked of customers as they exited the facility:

- Where are you coming from (zip code and closest intersection)?
- Are you coming from a home or business?

Not all customers participated in the survey so the information shown in **Table 16** represents a sample of the customers that utilized the station during the observation period. The response rate on the weekday was approximately 90 percent, whereas the response rate on Saturday was approximately 95 percent.

Reponses from customers were mapped to the nearest major intersection using GIS. This information is shown in **Attachment D (Customer Origin/Destination Data)**. The survey responses indicated the following distribution of customers are utilizing the Factoria station. Information is presented for the weekday and Saturday time periods, although (as shown) the general distribution of customers is not that different.

Table 16
Factoria Customer Trip Origin Summary

Trip Origin	Survey Respondents - Weekday		Survey Respondents - Saturday	
	Number	Percentage	Survey Origin	Percentage
Bellevue	41	40%	65	45%
Seattle	2	2%	4	3%
King County (excluding Seattle/Bellevue)	57	55%	75	51%
Snohomish County	3	3%	1	1%
Total	103	100%	145	100%

Existing Traffic Volumes. During the weekday period, traffic on the adjacent arterials adjacent to the station have two primary peaking periods, both corresponding to the a.m. and p.m. commute periods. This is unlike the station traffic during the weekday and Saturday periods which has a more sustained and consistent level of activity without the elevated peak periods. Based on the data collected for the station, the weekday peak period (3 hours) was defined to be 11:45 a.m. to 2:45 p.m., and the Saturday period was 1:15 to 4:15 p.m. **Figure 27** shows the weekday and Saturday daily station traffic volumes.

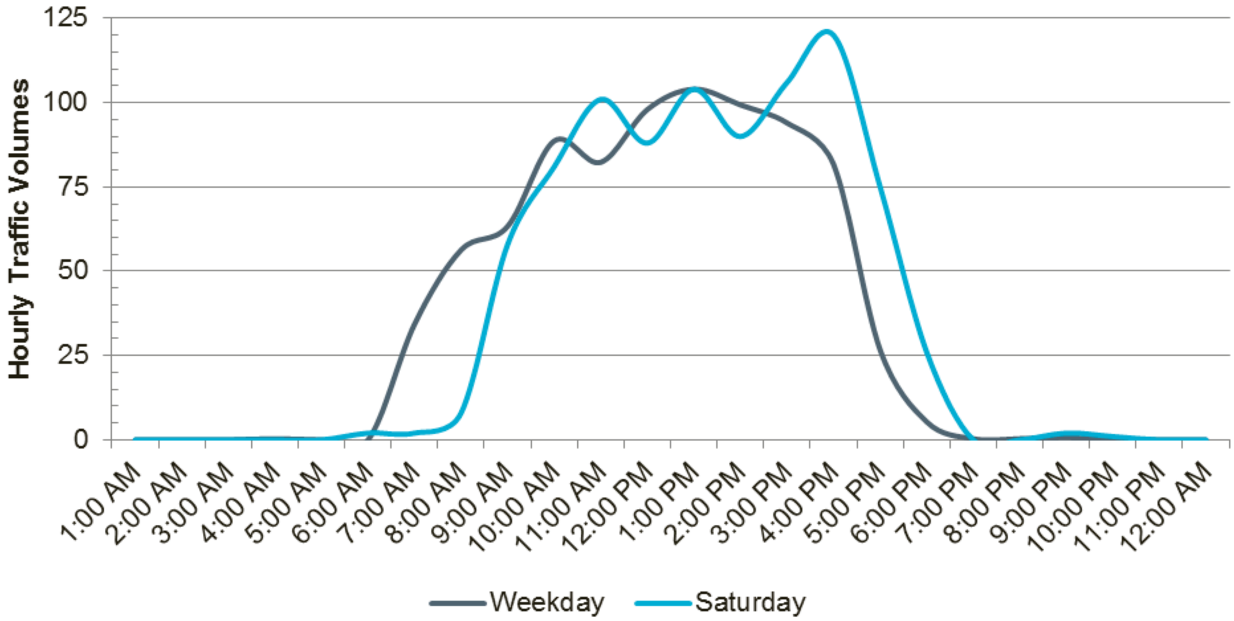

Figure 27
Factoria Existing Typical Weekday and Saturday Traffic Volume Patterns

Future Traffic Volumes. Future traffic volumes at the station were forecast based on the methodologies described previously. Three (3)-hour peak volumes were developed based on annual tonnage forecasts developed for the station, distribution of weekday and Saturday activity, tonnage per vehicle, seasonal factors, and hourly trip generation patterns for the station. The detailed calculations showing all the key assumptions are included in **Attachment E (Trip Generation Forecasts).**

Station forecasts were developed for Concept 0, Concept 1, Concept 2, and Concept 3; both with and without the Renton station operational. All concepts assumed that the Houghton station was closed. **Figure 28** summarizes the peak-hour volumes for each of the concepts (self-haul and commercial-haul) traffic for weekday and Saturday conditions, and with- and without-Renton. This comparison helps to understand the relationship and potential impacts of the different concepts at the station level. Although only the peak-hour is shown in this figure, the peak-hour volumes are generally anticipated to occur for multiple hours as shown in the **Figure 27** hourly profile.

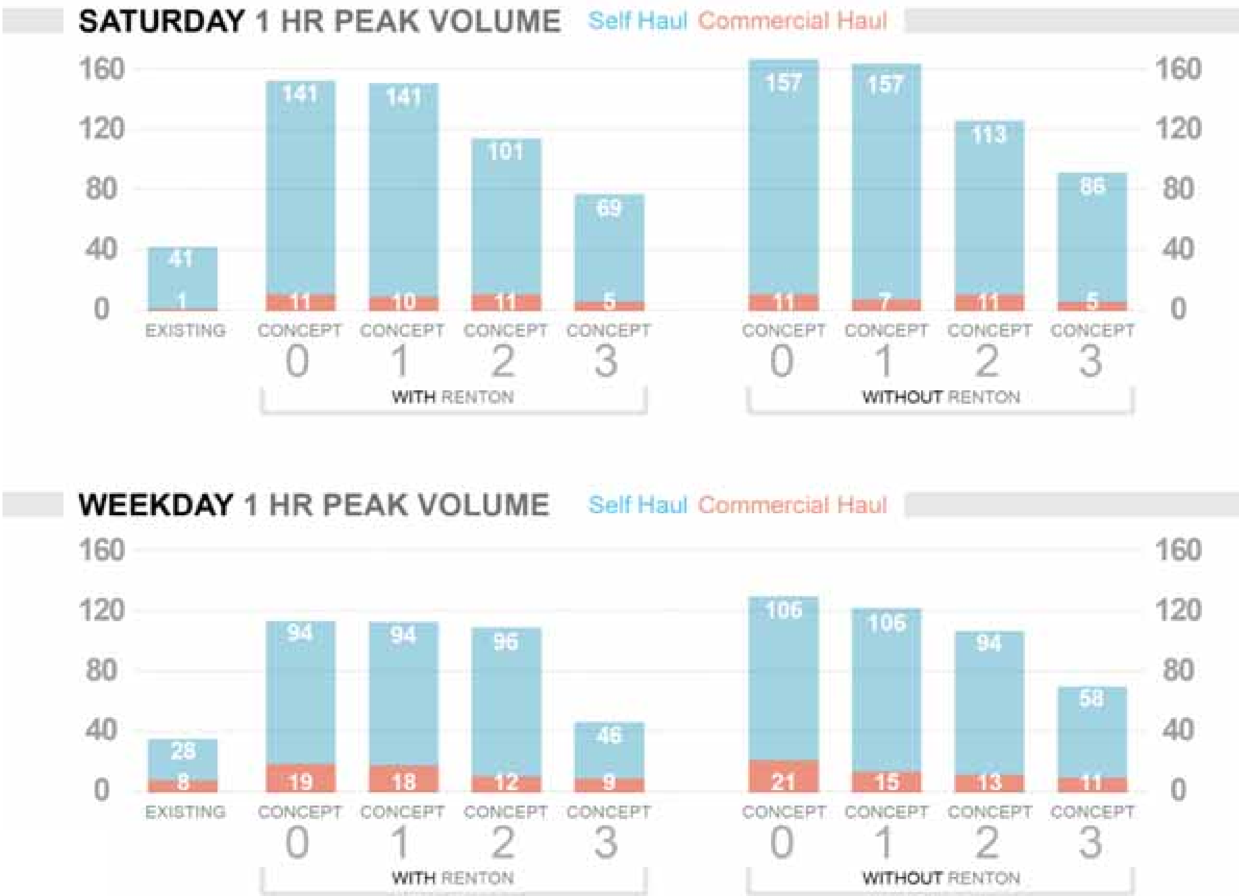

Figure 28
Factoria Existing and Concepts 0-3 Peak-Hour Volumes

As shown in **Figure 28**, during the Saturday period with-Renton, the peak-hour volumes forecast for Concept 0 and Concept 1 are similar. In both scenarios, with Concept 2, the peak-hour volumes are anticipated to decrease due to the extended hours assumed for Saturday. The hourly patterns anticipated under Concept 2, with extended hours, are based on information received from King County and generally follows the observed patterns at the Bow Lake station. The biggest decrease in peak-hour activity is anticipated under Concept 3, due to the construction of the Northeast Recycling and Transfer Station (NERTS). During this same period, without-Renton, the peak-hour volumes are slightly higher due to the closure of Renton, but the general relationships between the concepts stay the same.

The assumed hourly distribution is one characteristic that is different on the weekday versus Saturday for Concept 2. Since Concept 2 includes restriction of self-haul activity until 3:00 p.m., the peak-hour demand is anticipated to occur later in the day. This revised hourly distribution was based on discussions with King County staff. **Figure 29** shows the relationship between the Concept 0 hourly assumptions and Concept 2 hourly assumptions for the weekday period. With the extended hours assumed for the Saturday period, the magnitude of the peak-hour traffic is anticipated to decrease slightly as well, but not have the change as forecasted for the weekday period.

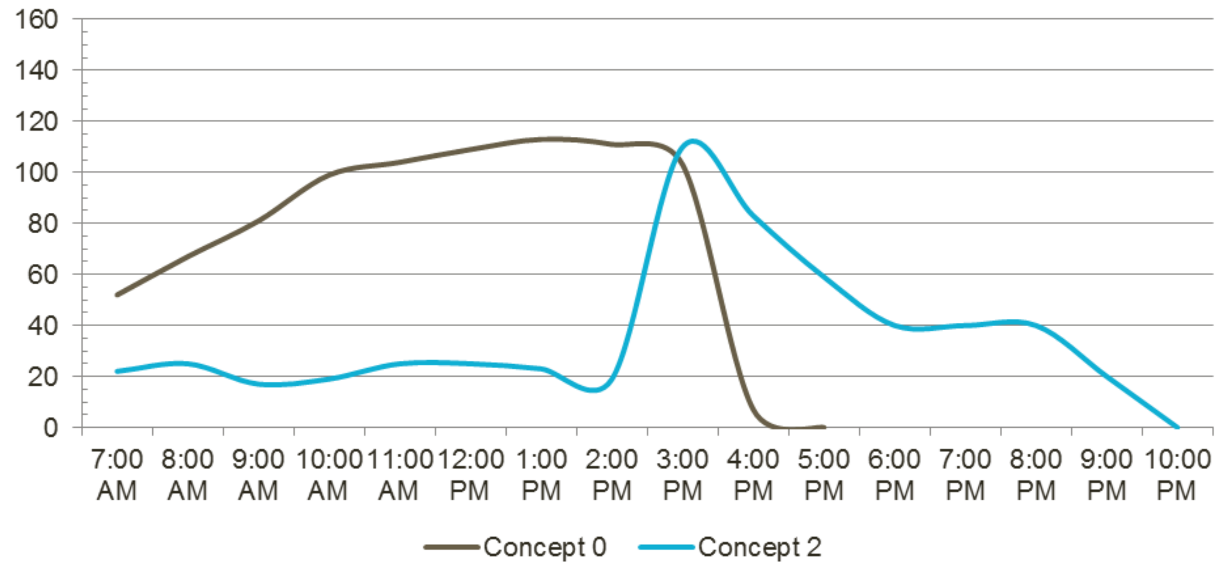

Figure 29
Total Factoria Weekday 2023 Transactions for Concepts 0 and 2

On-Site Analysis Results

The on-site service times and inbound vehicle queues were calculated using the methodology described previously. The service time and queue results are shown in **Tables 17** and **18**, respectively, for existing and Concepts 0 to 3.

Table 17
Factoria Existing and Concepts 0-3 Peak-Hour Service Times Summary

Scenario	**With-Renton Station**					**Without-Renton Station**			
	Weekday Peak-Hour		**Saturday Peak-Hour**			**Weekday Peak-Hour**		**Saturday Peak-Hour**	
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)		CH (h:mm)	SH (h:mm)	CH (h:mm)	SH (h:mm)
Standard[3]	*16:00*	*30:00*	*16:00*	*30:00*		*16:00*	*30:00*	*16:00*	*30:00*
Existing[4]	11:00	23:00	15:00	22:00					
Concept 0 (2023)	22:00	1:06:00	24:00	52:00		22:00	1:06:00	23:00	54:00
Concept 1 (2023)	22:00	1:07:00	24:00	52:00		21:00	1:09:00	23:00	54:00
Concept 2 (2023)	13:00	30:00	20:00	45:00		13:00	28:00	23:00	49:00
Concept 3 (2023)	12:00	24:00	15:00	22:00		12:00	38:00	15:00	25:00

1. CH = Commercial-haul
2. SH = Self-haul
3. Adopted standards as defined in King County Transfer plan (December 2007)
4. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 17**, all concepts exceed the adopted service times for both commercial and self-haul vehicles with the following exceptions:

- Concept 2 weekday with- and without-Renton
- Concept 3 weekday with-Renton
- Concept 3 Saturday with- and without-Renton

The service time results are discussed by concept, below.

Concept 0 - The Concept 0 service times under with-Renton condition have increased compared to the exiting service times. The weekday service time increase from existing to Concept 0 on Saturday showed increases of 11 minutes for commercial-haul service times and 43 minutes for self-haul service times. As shown in **Figure 28**, the Concept 0 peak-hour on-site volumes have more than tripled relative to the existing peak-hour volumes.

The Concept 0 service times under the without-Renton condition are the same during the weekday and have 1- to 2-minute changes during Saturday compared to the without-Renton condition. This is likely due to the station operating at capacity and no additional vehicles able accommodated on-site.

Concept 1 - Concept 1 has similar service times to Concept 0, with the largest change being 3 minutes. Concept 1 redirects commercial haulers, reducing the number of commercial vehicles at the Factoria station. This reduction in commercial-haul volume is greater under the without-Renton condition and a reduction of 1-minute of service time for the commercial haulers is anticipated under Concept 1 compared with Concept 0. The self-haul service times actually increase under Concept 1 compared to Concept 0, an increase of 1-minute and 3 minutes under the with- and without-Renton conditions, respectively. This increase in service time for the self-haul vehicles is likely due to more self-haul vehicles accommodated on-site due to the reduction in the number of commercial vehicles.

Concept 2 - As stated above, Concept 2 meets the adopted service times for the weekdays under both with- and without-Renton conditions. Concept 2 restricts the self-haul vehicles at Factoria on the weekdays, changing the self-haul operating hours to 3:00 p.m. to 10:00 p.m. and the commercial-haul operating hours to 6:00 a.m. to 10:00 p.m. The Factoria station opens to self-haul customers once the majority of commercial-haul volumes have completed the activity for the day. This allows for the Factoria station to be operated as it is on Saturday, increasing the number of stalls on the tipping floor from 10 to 14 for the self-haul customers. This increase in stalls on the tipping floor on the weekday and the variation in volumes with the shift in the peak volumes at the station resulted in at- or below-adopted service times for the weekday both with- and without-Renton conditions for Concept 2.

The Saturday service times for Concept 2 are reduced compared to Concept 0. Although the daily on-site volumes are the same on the Saturday for both Concepts 0 and 2, Concept 2 operates with extended hours on Saturday. The station operates from 8:00 a.m. to 8:00 p.m. for Concept 2, an extension of 2 hours from Concept 0. This allows for lower volumes per hour, resulting in the lower service times for Concept 2 compared to Concept 0.

Concept 3 - All service times are below the adopted standards with the exception of the self-haul weekday service time under without-Renton conditions which exceeds the standard by approximately 8 minutes. Concept 3 constructs the NERTS resulting in a decrease in peak-hour demand when compared to the other concepts. Despite the increase in volume due to the different analysis years, Concept 3 under with-Renton conditions increases in service time by only 1-minute during the weekday and is the same on Saturday.

Table 18
Factoria Existing and Concepts 0-3 Inbound Queues Summary

Scenario	With-Renton Station			Without-Renton Station	
	Weekday (Vehicles)[1]	Saturday (Vehicles)		Weekday (Vehicles)	Saturday (Vehicles)
Threshold[2]	*10*	*10*		*10*	*10*
Existing[3]	1	1			
Concept 0 (2023)	99	121		131	184
Concept 1 (2023)	93	119		126	177
Concept 2 (2023)	3	22		4	58
Concept 3 (2023)	1	2		2	3

1. Vehicle length assumed to be 32 feet
2. Threshold - Threshold of 10 vehicle queue is approximate distance to adjacent driveway along SE 32nd Street (station access)
3. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 18**, Concepts 0, 1, and Concept 2 exceed the threshold queue lengths during the peak period on Saturday. Concept 3 and Concept 2 on weekdays are within the queue threshold. The results of the queueing analysis are discussed by concept, below.

Concept 0 - The anticipated queues under the with-Renton condition are projected to increase compared to the existing queues. The increase from existing to Concept 0 is forecast to be 98 and 120 vehicles for weekday and Saturday, respectively. As shown in **Figure 28**, the Concept 0 peak-hour on-station volumes have more than tripled relative to the existing peak-hour volumes. Due to the increase in peak-hour demand anticipated with the closure of Renton, vehicle queueing is anticipated to increase as shown in the table.

Concept 1 - Concept 1 has similar queues compared to Concept 0, with minor reductions in the inbound queue length, with the largest reduction of seven vehicles occurring under without-Renton conditions during the Saturday peak period.

Concept 2 – Forecasted queue lengths are within the defined thresholds for the weekdays under both with- and without-Renton conditions. Thresholds are exceeded during the Saturday peak period.

Concept 3 – With the construction of the NERTS, peak-hour demands are reduced. Queues under Concept 3 are within 1 to 2 vehicle lengths of existing conditions. As such forecast queue lengths are anticipated to operate within the defined threshold.

Summary of Constraints

As shown by the high service times and long queues for all concepts with the exception of Concept 3, the Factoria station has several constraints. The main constraints at the Factoria station were found to be the self-haul tipping floor capacity, the outbound scale capacity, and the available on-station queue storage. These constraints were identified with the modeling of the station in VISSIM and are discussed below.

Self-Haul Tipping Floor - The primary constraint at the Factoria station was found to be the self-haul tipping floor. The self-haul tipping floor is constrained by the number of stalls and the service time of vehicles on the tipping floor itself. The self-haul tipping floor cannot accommodate all of the self-haul vehicles within the peak-hour.

Outbound Scale - Another constraint of the station is the outbound scale. Although not an issue at the current rate vehicles are processed on the commercial and self-haul tipping floors; if the tipping floor were to increase their capacity (decreasing on-floor dwell times or increasing stalls) the outbound scale would become a constraint.

On-station Queue Storage - As shown by the long queues under Concepts 0 and 1 relative to the adopted service times, the on-station storage length is unable to accommodate the high volumes anticipated during the peak hours. This results in queues that extend off-station, blocking adjacent businesses along SE 32nd Street.

The Tier 1 screening primarily focused on the overall reduction in station traffic anticipated under the particular strategy. The strategies analyzed are listed above in **Tier 1/Tier 2 Screening Methodology**. The anticipated peak-hour demand reduction in station traffic under both the with- and without-Renton scenarios during the weekday and Saturday peak hours are summarized in **Attachment F (Demand Management Strategy Trip Reductions)**. The percent reductions shown in the table are based on modeling conducted by the division. Reductions from strategies range from 0 to 34 percent of the peak-hour demand. Specific strategies examined at the Factoria station and the reductions assumed include:

- Extend Operating Hours (4%)
- Lower Cost Curbside Bulky Waste Collection (3.4%)
- Mandatory Curbside Garbage Collection (4%)
- Incentive / Peak Pricing (15%)
- Higher Minimum Fee at Factoria Only (20%)
- Banned Materials
  - HHW (3%)
  - Yard/Wood Waste (34%)

The percentage reductions were provided to Transpo from the division for use in the traffic volume forecasts and modeling. It is important to note that not all improvement strategies are as effective if combined. Thus, the identification of the improvement combinations accounts for the relationship to one another. In addition to the transportation demand strategies noted above, potential physical station improvements were identified to address the operational constraints. These improvements considered the addition of increased staffing, the addition of an outbound scale, and added internal vehicle queueing.

Strategy combinations were identified based on the results of the Tier 1 screening process. The Tier 2 screening process included the testing of the strategy combinations using VISSIM. The effectiveness of the strategies were tested for the without-Renton scenario as that time period represents the period with the highest peak-hour demand for the stations. Various strategy combinations were applied for Concept 0 and Concept 2. Modeling was not conducted for Concept 1 as the demand is similar to Concept 0. No modeling was necessary for Concept 3 based on the results of the modeling. The following combinations were identified for detailed evaluation:

Combination A – extended hours and incentive/peak pricing

Combination B –

B1. Increase staffing (decrease dwell time) and higher minimum fee

B2. Increase staffing (decrease dwell time), higher minimum fee, and additional outbound scale

Combination C –

C1. Banned Materials, mandatory curbside collection, and lower cost curbside bulky waste collection

C2. Banned Materials, mandatory curbside collection, lower cost curbside bulky waste collection, and additional outbound scale

Combination D – Added internal queuing (expanded entry lane and repurpose of HHW area), added external queue lane, and HHW banned

The results of the combinations tested on the Concepts are shown and discussed below.

Concept 0

Combinations A, B, and C were tested on Concept 0. The queue and service times of the combinations are shown in **Table 19**. Results are compared to the existing and Concept 0 conditions, with no additional mitigation.

Table 19
Factoria Combinations Peak-Hour Service Times and Queues (Concept 0 – 2023 Without-Renton)

Scenario	Service Times					Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)			
Standard[4]/ Threshold[5]	*16:00*	*30:00*	*16:00*	*30:00*		*10*	*10*
Existing[6]	11:00	23:00	15:00	22:00		1	1
Concept 0	22:00	1:06:00	23:00	54:00		131	184
Concept 0 + Combination A	12:00	38:00	20:00	41:00		3	6
Concept 0 + Combination B1	17:00	51:00	29:00	50:00		39	48
Concept 0 + Combination B2	16:00	52:00	16:00	29:00		35	11
Concept 0 + Combination C1	13:00	25:00	20:00	32:00		3	5
Concept 0 + Combination C2	11:00	23:00	15:00	23:00		2	4

1. CH = Commercial-haul
2. SH = Self-haul
3. 3. Vehicle length assumed to be 32 feet
4. Adopted standards as defined in King County Transfer Plan (December 2007)
5. Threshold – Threshold of 10 vehicle queue is approximate distance to adjacent driveway along SE 32nd Street (station access)
6. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 19**, Concept 0 with combination C2 is the only package that meets the adopted service times, and falls within the threshold of vehicle queues for both the weekdays and Saturday peak periods. While the improvements identified in Combination B reflect improvements in service times and queues relative to Concept 0, the resulting values do not meet the adopted standards or thresholds.

Concept 1

No strategy combinations were tested for Concept 1 as peak-hour demand are similar to forecasts for Concept 0. Future operations for Concept 1 under the scenarios tested would be similar to the operations shown in **Table 19**.

Concept 2

Strategy Combinations C and D were applied to the Concept 2 without-Renton traffic volumes. The resulting queue and service times of the strategy combinations are shown in **Table 20**.

Table 20
Factoria Combinations Service Times and Queues (Concept 2 – 2023 Without-Renton)

	Service Times				Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			
Scenario	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)	**Weekday (Vehicles)[3]**	**Saturday (Vehicles)**
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*	*10[2]*	*10*
Existing[6]	00:11	00:23	00:15	00:22	1	1
Concept 0	00:22	1:06	00:23	00:54	131	184
Concept 2	00:13	00:28	00:23	00:49	4	58
Concept 2 + Combination C	00:12	00:23	00:15	00:22	2	3
Concept 2 + Combination D	00:12	00:34	00:18	1:17	3	11

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet
4. Adopted standards as defined in King County Transfer Plan (December 2007)
5. Threshold – Threshold of 10 vehicle queue is approximate distance to adjacent driveway along SE 32nd Street (station access)
6. Existing conditions based on calibrated VISSIM model – September 2014

As shown in **Table 20**, Concept 2 with Combination C meets the adopted standards for travel time and thresholds for queues for both the weekdays and Saturday. Combination D exceeds the adopted self-haul service time, greatly increasing the service times compared to Concept 2. This is due to the additional on-site queue storage. As shown by the greatly reduced queues under Combination D compared with Concept 2, the queues that were previously off-site are now mostly accommodated on-site.

<u>Concept 3</u>

No combinations were modeled for Concept 3 as the service times and queues shown in **Tables 17** and **18** meet the queue thresholds and adopted service times under all scenarios with the exception of the self-haul service times exceeding the adopted service times under the weekday peak period. During this period, on-site service times are anticipated to exceed the standard by approximately 8 minutes. Based on the results from the Concept 0 evaluation, the application of the strategy combinations tested would likely result in decrease in service times, improving these conditions.

Off-Site Traffic Analysis Results

The analysis includes an evaluation of intersection operations at seven intersections. The study intersections include and are shown in **Figure 30**:

1. Richards Rd / Lake Hills Connector
2. Richards Rd / SE 26th St
3. Richards Rd / SE 32nd St
4. Richards Rd / SE Eastgate Way
5. Factoria Blvd SE / I-90 EB Ramp
6. Factoria Blvd SE / Coal Creek Pkwy SE
7. 148th Ave SE / Eastgate Way

These study intersections were evaluated during the weekday and Saturday peak hours at Factoria as identified during the station observations in September 2014. The peak hours identified were 1:00 to 2:00 p.m., and 2:00 to 3:00 p.m. for weekday and Saturday conditions, respectively. Intersection LOS was calculated at the study intersections using the LOS method described previously.

Figure 30
Factoria Study Intersections

Existing Conditions

Existing peak-hour intersection turning movements were collected at the off-site intersections in October 2014 for both weekday and Saturday periods. Detailed intersection turning movement traffic volumes are provided in **Attachment G (Off-Station Intersection Traffic Counts)**. The weekday and Saturday existing intersection traffic volumes are shown in **Figure 31**. **Table 21** summarizes the existing weekday and Saturday peak-hour LOS. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

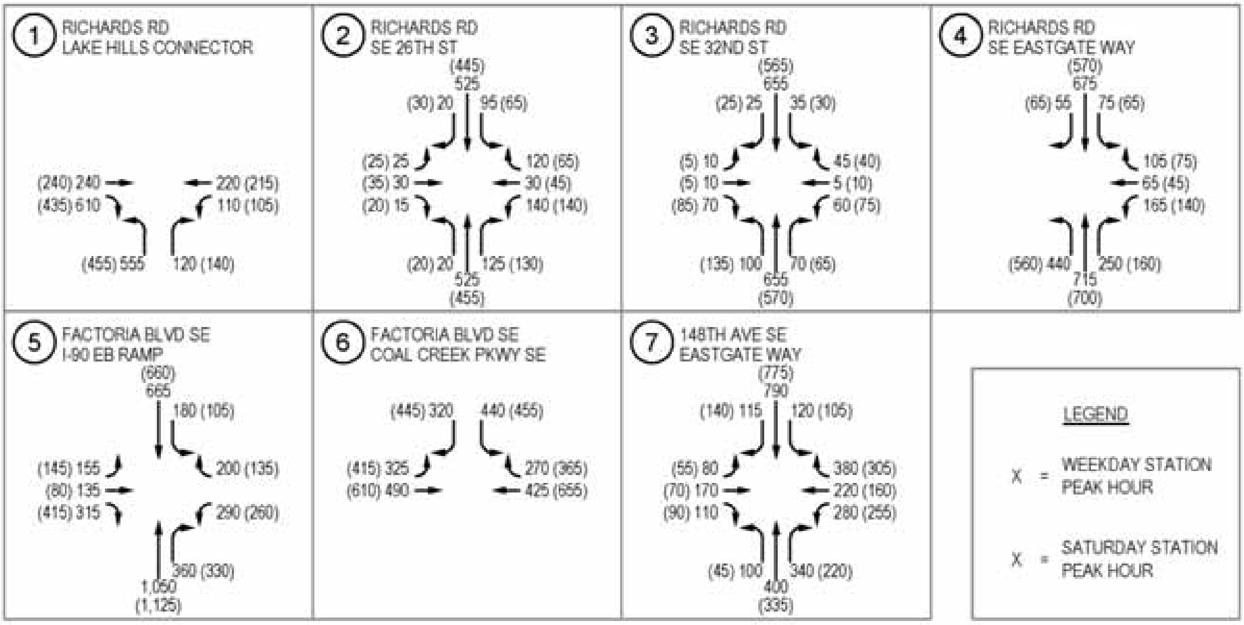

Figure 31
Factoria Existing Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 21
Factoria Existing Weekday and Saturday Station Peak Hours LOS Summary

	Weekday Station Peak-Hour (1 – 2 p.m.)				Saturday Station Peak-Hour (2 – 3 p.m.)		
Intersection	LOS[1]	Delay[2]	V/C[3]		LOS	Delay	V/C
1. Richards Rd / Lake Hills Connector[4]	B	16	0.52		B	15	0.41
2. Richards Rd / SE 26th St	B	11			B	13	
3. Richards Rd / SE 32nd St	A	4			A	4	
4. Richards Rd / SE Eastgate Way	B	14			B	18	
5. Factoria Blvd SE / I-90 EB Ramp	B	13			B	20	
6. Factoria Blvd SE / Coal Creek Pkwy SE	B	12			D	37	
7. 148th Ave SE / Eastgate Way	C	27			C	26	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. Evaluated using 2000 HCM methodology.

As shown in **Table 21**, under existing conditions all study intersections operate at LOS C or better during both weekday and Saturday.

Future 2023 Without-Project Conditions

Based on a review of the City of Bellevue's *(2015-2020) Transportation Improvement Program*, no planned improvements were identified that would impact the operations of the study intersections.

The 2023 without-project weekday and Saturday peak-hour traffic volumes were estimated by growing existing traffic volumes by 2 percent per year to 2023 conditions. This growth rate was determined in coordination with the City of Bellevue. No pipeline projects were identified within the study area. The 2023 without-project weekday and Saturday peak-hour traffic volumes are shown in **Figure 32**. Without-project conditions represent a condition that assumes that the station continues to operate as-is. No changes in volumes outside of normal background growth was assumed. This scenario is not consistent with Concept 0.

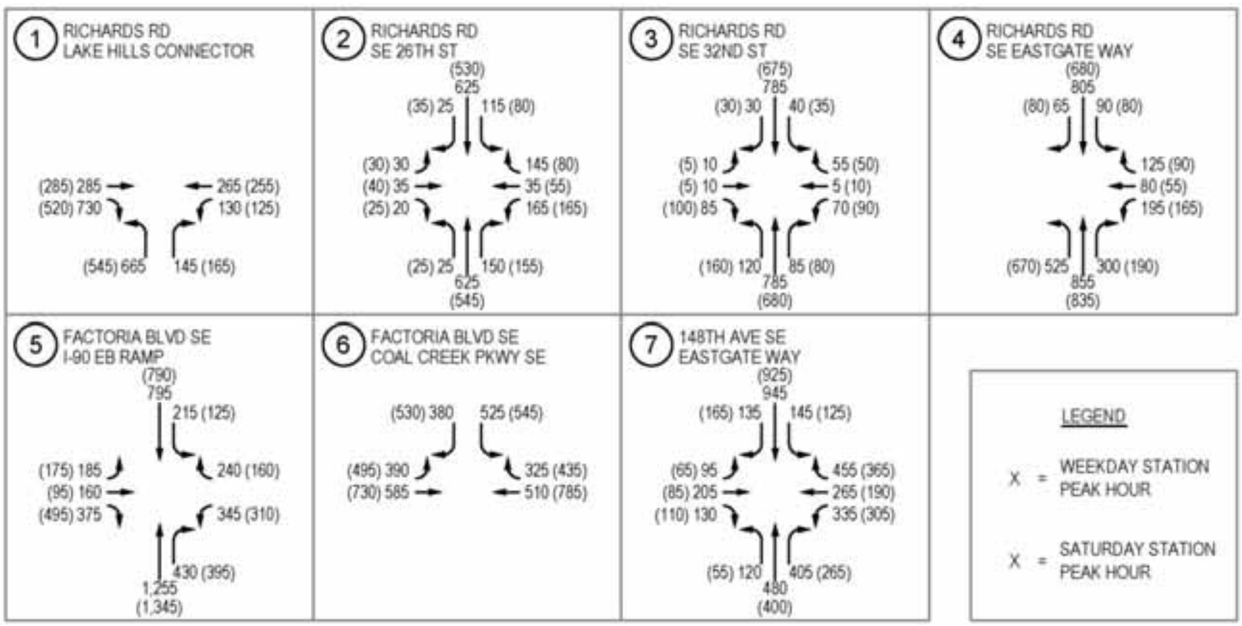

Figure 32
Factoria 2023 Without-Project Weekday and Saturday Station Peak-Hour Traffic Volumes

Signal timing was optimized for the 2023 analysis; optimizing the traffic signal timing takes into consideration the actuated nature of the signals and changes that would occur with growth in traffic volumes. **Table 22** summarizes the LOS results for the without-project weekday and Saturday peak hours.

Table 22
Factoria 2023 Without-Project Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Existing				2023 Without-Project		
	LOS[1]	Delay[2]	V/C[3]		LOS	Delay	V/C
Weekday Station Peak-Hour (1 – 2 p.m.)							
1. Richards Rd / Lake Hills Connector[4]	B	16	0.52		B	18	0.61
2. Richards Rd / SE 26th St	B	11			B	12	
3. Richards Rd / SE 32nd St	A	4			A	4	
4. Richards Rd / SE Eastgate Way	B	14			B	16	
5. Factoria Blvd SE / I-90 EB Ramp	B	13			B	17	
6. Factoria Blvd SE / Coal Creek Pkwy SE	B	12			B	14	
7. 148th Ave SE / Eastgate Way	C	27			C	33	
Saturday Station Peak-Hour (2 – 3 p.m.)							
1. Richards Rd / Lake Hills Connector	B	15	0.41		B	16	0.48
2. Richards Rd / SE 26th St	B	13			B	13	
3. Richards Rd / SE 32nd St	A	4			A	4	
4. Richards Rd / SE Eastgate Way	B	18			B	18	
5. Factoria Blvd SE / I-90 EB Ramp	B	20			B	20	
6. Factoria Blvd SE / Coal Creek Pkwy SE	D	37			D	37	
7. 148th Ave SE / Eastgate Way	C	26			C	26	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. Evaluated using 2000 HCM methodology.

As shown in **Table 22**, all study intersections continue to operate at LOS D or better under without-project conditions.

2023 Concept 0 Conditions

As previously discussed, the Concept 0 peak-hour traffic volumes are largest relative to the other concepts (see **Figure 28**) and as such the Concept 0 forecasts were utilized for the off-site intersection analysis. As this is an existing station, the net new trips were calculated and assigned to the off-site study intersections. To calculate the net new trips the station transactions (the inbound trips) were provided by King County for the same day the off-station traffic volumes were collected in order to ensure the data was consistent. The net-new trips under 2023 Concept 0 conditions were then calculated by subtracting the existing transactions, which were doubled to account for in- and outbound trips from the station, from the 2023 Concept 0 forecast number of trips. This is shown in the Trip Generation **Tables 23** and **24** for with- and without-Renton conditions, respectively.

Table 23
Factoria Concept 0 With-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	**Outbound**	**Total**		**Inbound**	**Outbound**	**Total**
Existing Total[1]	*38*	*38*	76		43	43	86
Concept 0							
Commercial-haul	19	19	38		141	141	282
Self-haul	94	94	188		11	11	22
Total	113	113	226		152	152	304
Net New Project Trips (2023 Concept 0 – Existing)	75	75	150		109	109	218

1. Existing total based on on-site transactions during the peak hours on the day the off-site intersection traffic volumes were collected.

As shown in **Table 23**, during the weekday peak-hour 150 net new trips are estimated, and during the Saturday peak-hour 218 net new trips are estimated.

Table 24
Factoria Concept 0 Without-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	**Outbound**	**Total**		**Inbound**	**Outbound**	**Total**
Existing Total[1]	*38*	*38*	76		43	43	86
Concept 0							
Commercial-haul	21	21	42		157	157	314
Self-haul	106	106	212		11	11	22
Total	127	127	254		168	168	336
Net New Project Trips (2023 Concept 0 – Existing)	89	89	178		125	125	250

1. Existing total based on on-site transactions during the peak hours on the day the off-site intersection traffic volumes were collected.

As shown in **Table 24**, during the weekday peak-hour 178 net new trips are estimated, and during the Saturday peak-hour 250 net new trips are estimated. The net new trips under the without-Renton conditions are larger than the with-Renton net new trips, an increase of approximately 15 to 20 percent during the weekday and Saturday peak hours, respectively.

The trip distribution pattern for the self-haul vehicles was developed based on the survey respondents on the weekday and Saturday. As noted above, the survey respondents told the closest intersection and zip code they were coming from. Each respondent's answer was plotted so the trip distribution could be estimated. Due to the closure of Houghton, the users that go to Houghton under existing conditions that would shift to Factoria were included. Under with-Renton conditions the Factoria and Houghton respondents were used to calculate the trip distribution. Under Factoria without-Renton conditions, approximately 1/3 of the Renton users are anticipated to use Factoria and as such, the Factoria without-Renton trip distribution was adjusted by adding 1/3 of the Renton respondents to the Factoria with-Renton conditions. The trip distributions for Bow Lake on the weekday and Saturday under both with- and without-Renton conditions are shown in **Figures 33** and **34**.

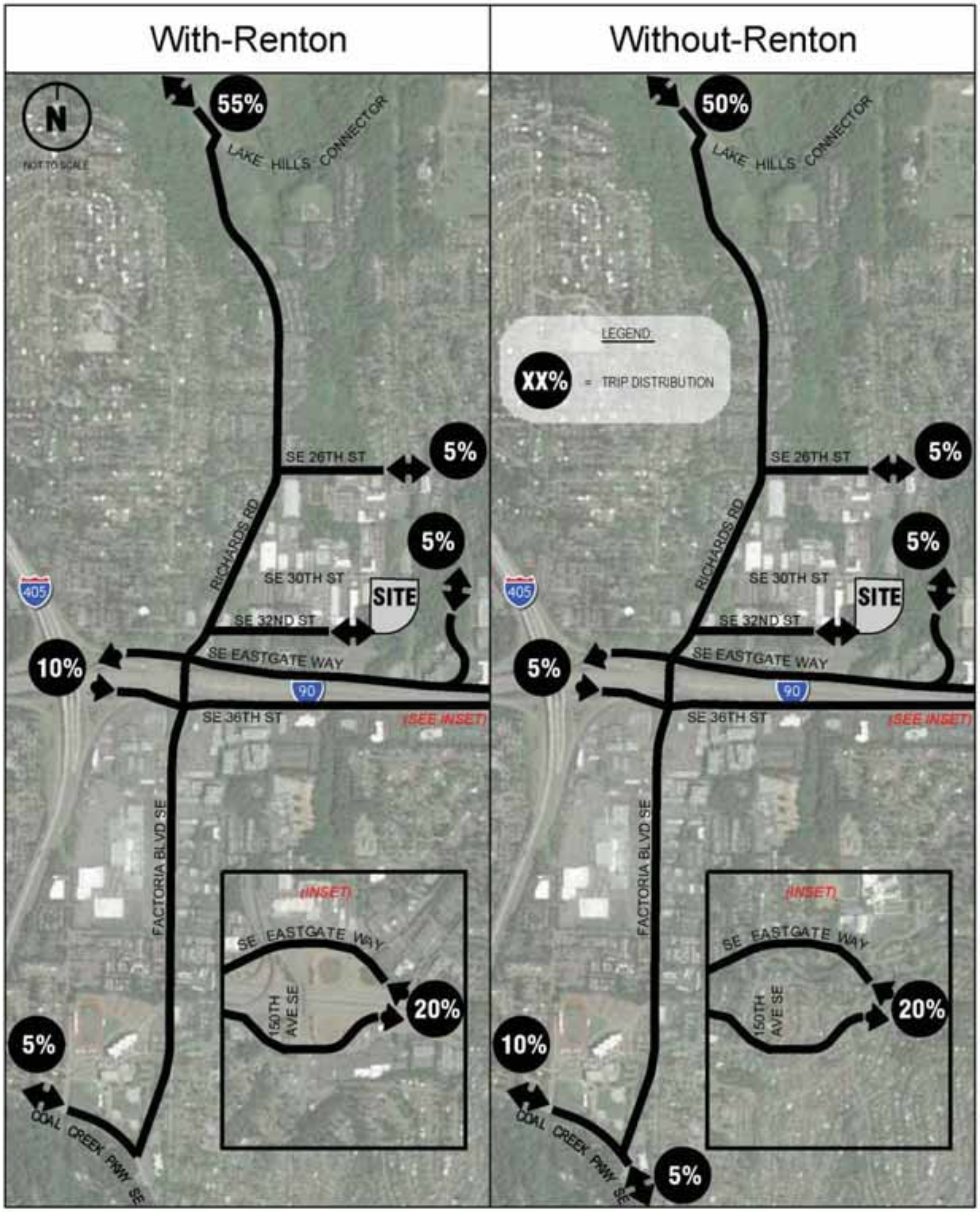

Figure 33
Factoria Weekday Trip Distribution (With and Without-Renton)

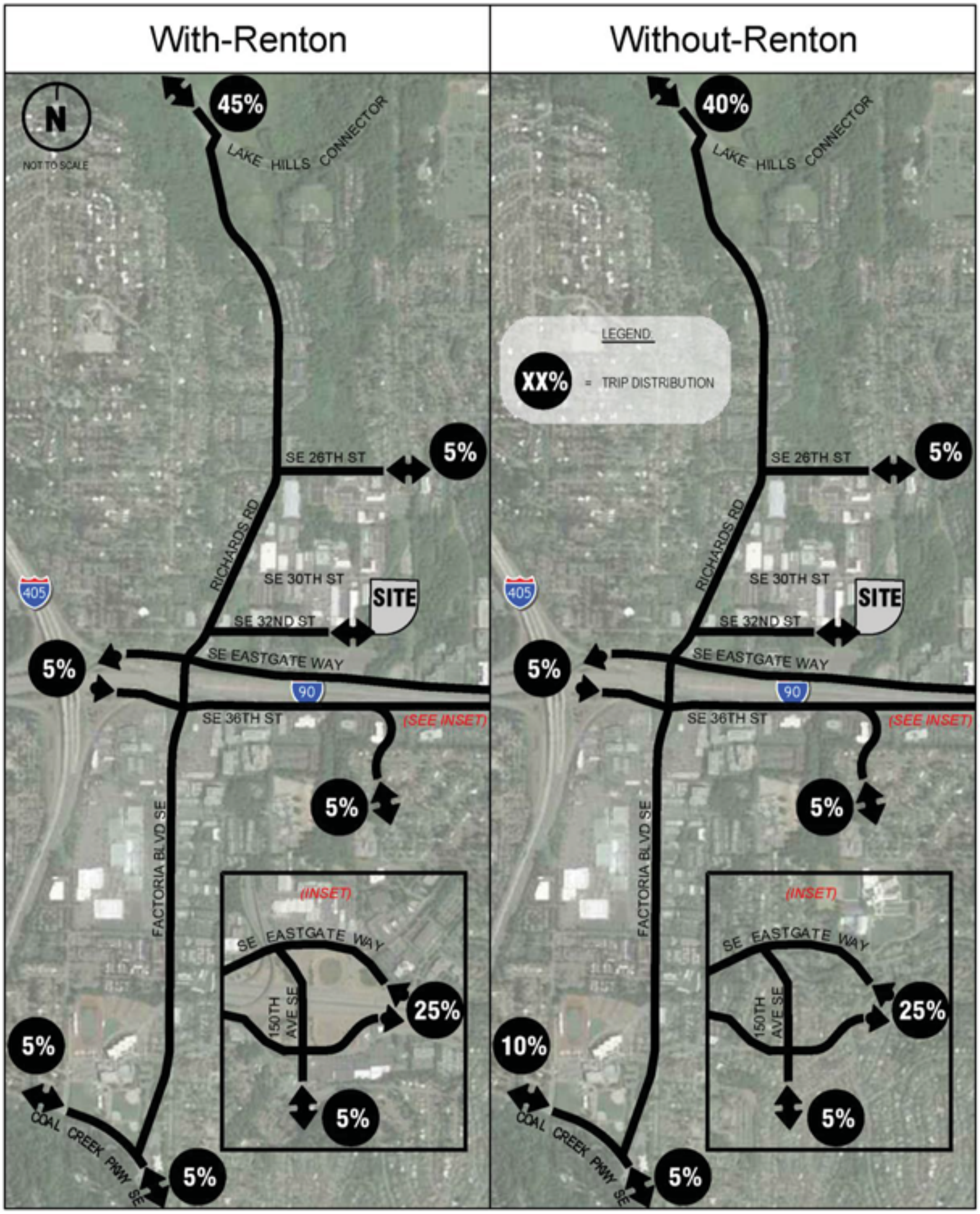

Figure 34
Factoria Saturday Trip Distribution (With and Without-Renton)

The net-new trips associated with each scenario assigned to the study intersections was based on the trip distributions. The net new project trip assignment for weekday and Saturday under both with- and without-Renton conditions are shown in **Figure 35**.

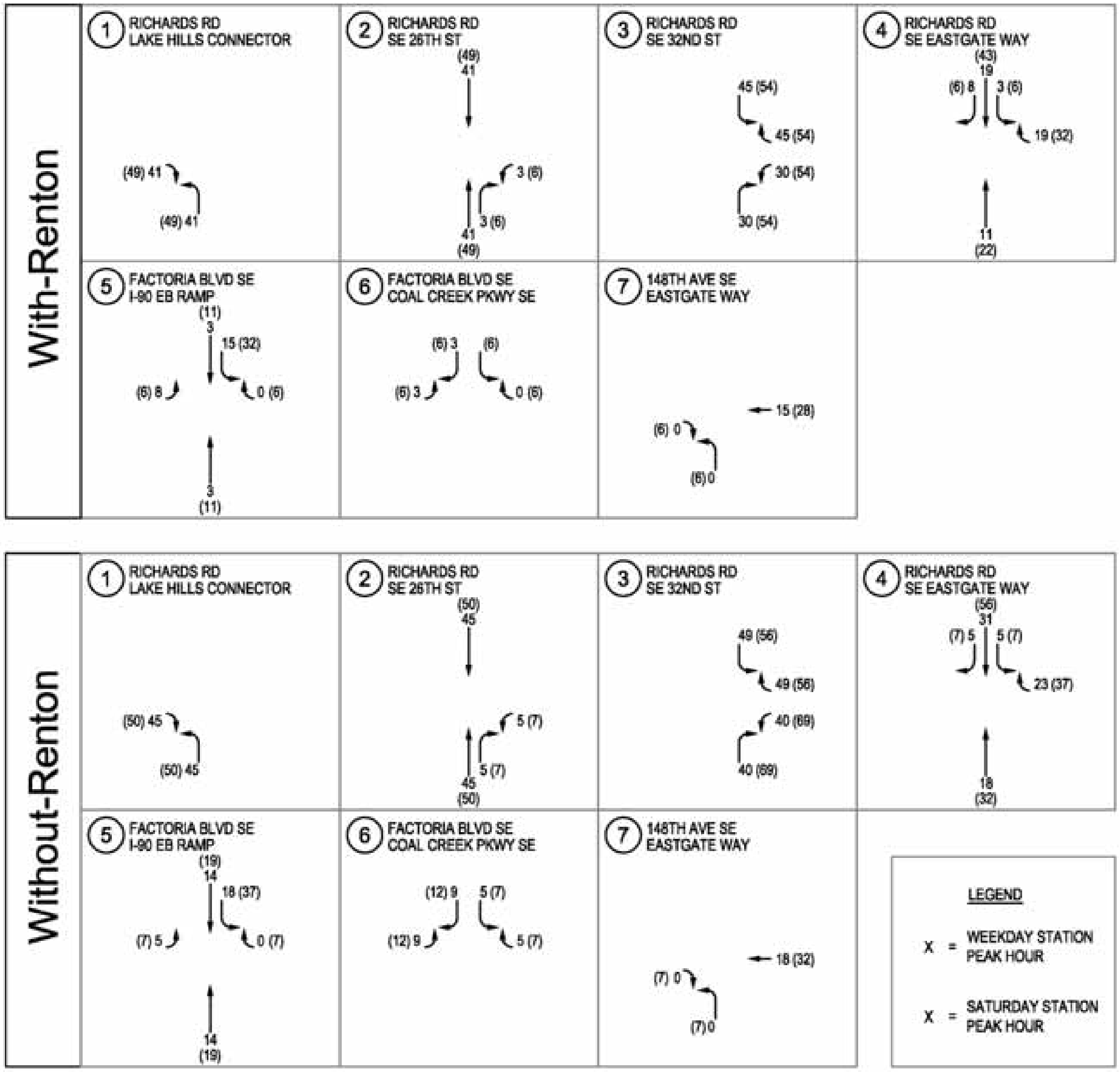

Figure 35
Factoria Concept 0 With and Without-Renton Net-New Trip Assignment

The with-project 2023 Concept 0 weekday and Saturday peak-hour traffic volumes both with- and without-Renton are shown in **Figure 36**. The largest percent impact of the Concept 0 traffic volumes relative to the without-project conditions was at the station access intersection, the Richards Road / SE 32nd Street intersection, under all Concept 0 scenarios. During the weekday station peak-hour percent increases under Concept 0 compared to without-project conditions range from 7 to 9 percent under with- and without-Renton conditions, respectively. Similarly, during the Saturday station peak-hour percent increases under Concept 0 compared to without-project conditions range from 11 to 13 percent during with- and without-Renton conditions, respectively.

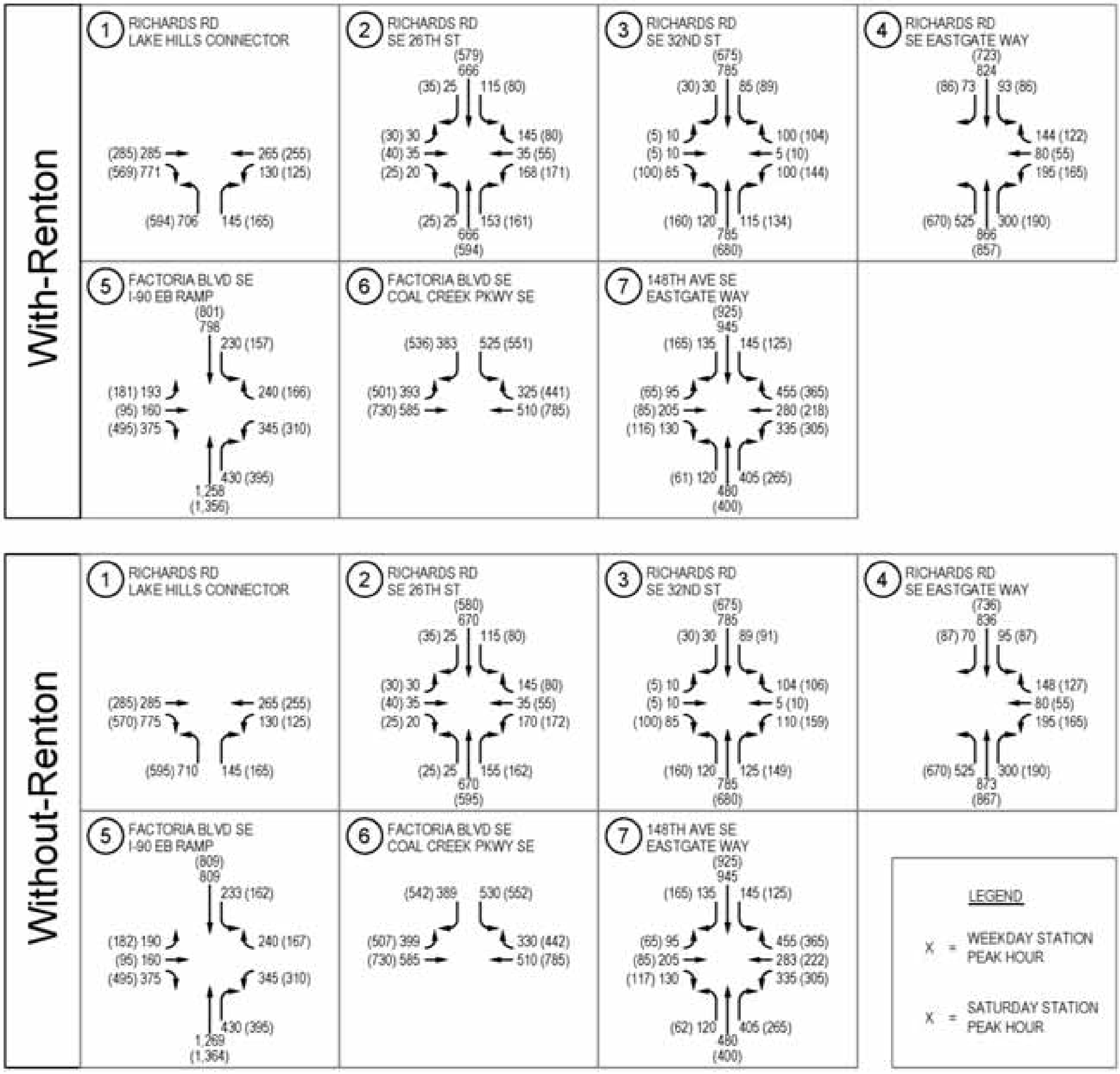

Figure 36
Factoria Concept 0 Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 25 provides a comparison between the 2023 Concept 0, both with- and without-Renton conditions and without-project conditions. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

Table 25
Factoria Concept 0 Weekday and Saturday Station Peak Hours LOS Summary

Intersection	2023 Without-Project			Concept 0 – With-Renton			Concept 0 – Without-Renton		
	LOS[1]	Delay[2]	V/C[3]	LOS	Delay	V/C	LOS	Delay	V/C
Weekday Station Peak-Hour (1 – 2 p.m.)									
1. Richards Rd / Lake Hills Connector[4]	B	18	0.61	B	19	0.63	B	19	0.64
2. Richards Rd / SE 26th St	B	12		B	12		B	12	
3. Richards Rd / SE 32nd St	A	4		A	5		A	5	
4. Richards Rd / SE Eastgate Way	B	16		B	16		B	16	
5. Factoria Blvd SE / I-90 EB Ramp	B	17		B	17		B	17	
6. Factoria Blvd SE / Coal Creek Pkwy SE	B	14		B	14		B	14	
7. 148th Ave SE / Eastgate Way	C	33		C	33		C	33	
Saturday Station Peak-Hour (2 – 3 p.m.)									
1. Richards Rd / Lake Hills Connector	B	16	0.48	B	17	0.51	B	17	0.51
2. Richards Rd / SE 26th St	B	13		B	13		B	13	
3. Richards Rd / SE 32nd St	A	4		A	5		A	6	
4. Richards Rd / SE Eastgate Way	B	18		B	19		B	19	
5. Factoria Blvd SE / I-90 EB Ramp	B	20		C	20		C	20	
6. Factoria Blvd SE / Coal Creek Pkwy SE	D	37		D	39		D	41	
7. 148th Ave SE / Eastgate Way	C	26		C	26		C	26	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. Evaluated using 2000 HCM methodology.

Table 25 shows that all study intersections would continue to operate at LOS D or better with the addition of the Concept 0 net new traffic during the weekday and Saturday peak hours under both with- and without-Renton conditions.

Factoria Station Summary

- Increases in station traffic range from 55 to 113 between the different concepts during the weekday peak period under with-Renton conditions, and range from 69 to 127 during the weekday peak period under the without-Renton conditions. During the Saturday peak period, peak demand volumes range from 74 to 152 under with-Renton conditions, and range from 91 to 168 under without-Renton conditions.

- Analysis of on-site operations showed operational issues at the self-haul tipping floor, resulting in queues extending off-site, beyond the queue thresholds, as well as service times exceeding the adopted standards under Concepts 0 to 2 for the weekday and/or Saturday peak conditions.
    - Seven combinations were analyzed to improve on-site operations under Concepts 0 and 2 without-Renton conditions, both during the weekday and Saturday peak periods. Combinations C1 and C2 (banned materials, mandatory curbside collection, lower cost curbside bulky waste collection, and as part of Combination C2 only, an additional outbound scale) under Concepts 0 and 2, respectively, meet both the weekday and Saturday adopted service time and queue thresholds. The other combinations under the without-Renton conditions exceed either the adopted service times or the queue thresholds.
- Evaluation of off-station intersections showed minimal increases in off-station intersections for Concept 0. Concept 0 represented the highest peak demand and represents a more conservative analysis when considering the impacts to the other concepts and the greatest impact to the off-station intersections.

Shoreline

Station Description – Access and Circulation

Primary vehicle access to the Shoreline station is provided via N 165th Street. The general public utilize N 165th Street to access the station, whereas the County truck access is provided to the south via a shared transit access to I-5. The transfer station site vicinity is shown in **Figure 37**.

The tipping floor is divided into two main sections, commercial and self-haul areas. The self-haul area is located in the eastern portion of the building and is accessed via the southeast side, and exits the building via the northeast corner. Commercial vehicles access the building from the southwest corner and exit the building through the west side of the building.

In the self-haul area there is a total of 10 stalls used for garbage. There are also two stalls on the commercial side of the floor. This station also includes areas a recycling area which is located north of the tipping floor. **Figure 38** shows the building configuration and vehicle access.

Figure 37
Shoreline Station Vicinity

Station Traffic Volumes

Data Collection. As noted previously, extensive data collection was conducted to support the development of the VISSIM model and establish the existing conditions on the station. While this information was largely used to calibrate the VISSIM model it also assists in providing the existing context against which the future conditions can be compared. A general outline of the data collected as well as a map of the specific locations for video collection, traffic counts, and service time studies is included in **Attachment C (Data Collection Summary)**.

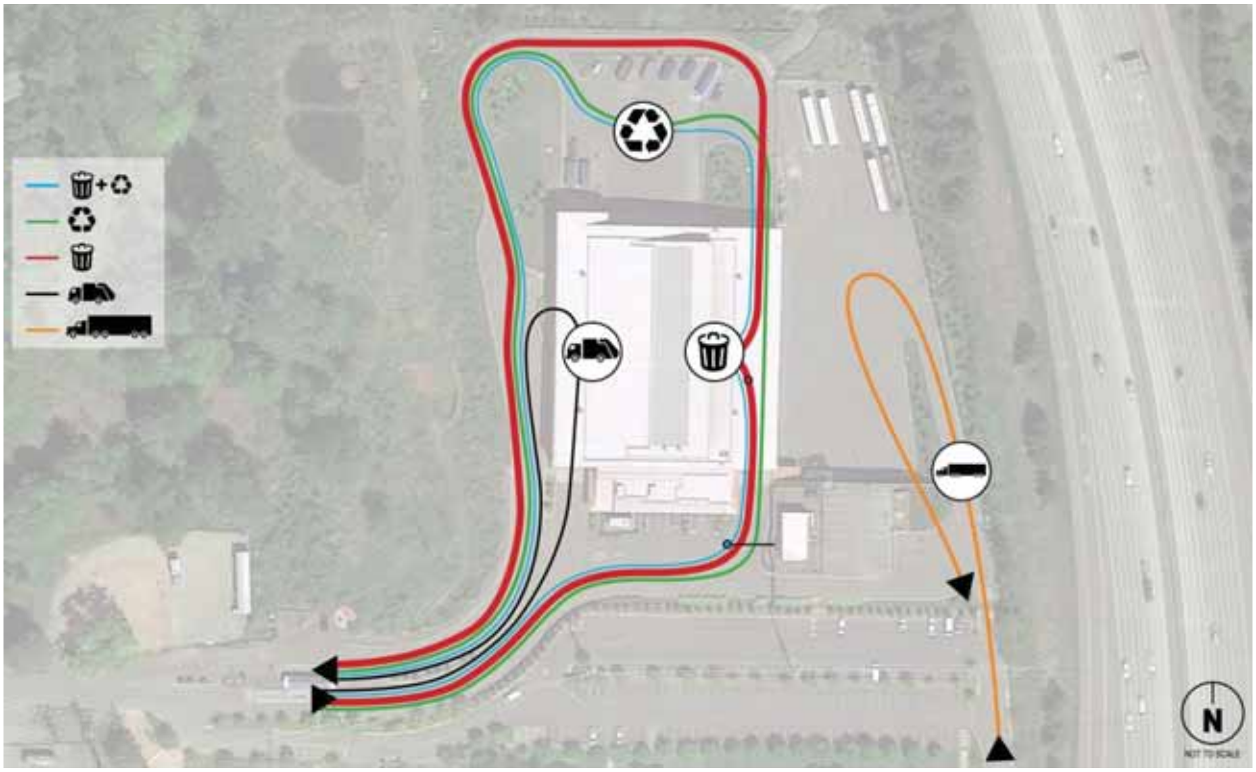

Figure 38
Shoreline On-Site Future Building Configuration and Circulation Patterns

Customer Origin/Destination Surveys. In addition to the traffic volume, queuing, and service time data, customer origin/destination data was collected to identify the general distribution of customer traffic utilizing this station during the days the surveys were conducted. The survey was conducted during the 3-hour period. The following questions were asked of customers as they exited the facility:

- Where are you coming from (zip code and closest intersection)?
- Are you coming from a home or business?

Not all customers participated in the survey so the information shown in **Table 26** represents a sample of the customers that utilized the station during the observation period. The response rate on the weekday was approximately 90 percent whereas the response rate on Saturday was approximately 95 percent.

Reponses from customers were mapped to the nearest major intersection using GIS. This information is shown in **Attachment D (Customer Origin/Destination Data)**. The responses from the surveys indicated the following distribution of customers are utilizing the Factoria station. Information is presented for the weekday and Saturday time periods; although as shown, the general distribution of customers is not that different.

Table 26
Shoreline Customer Trip Origin Summary

Trip Origin	Survey Respondents - Weekday		Survey Respondents - Saturday	
	Number	Percentage	Survey Origin	Percentage
Shoreline	32	22%	65	34%
Seattle[1]	89	61%	94	50%
King County (excluding Seattle/Shoreline)	11	8%	19	10%
Snohomish County	13	9%	12	6%
Total	145	100%	190	100%

1. The North Transfer Station in Seattle was closed at the time of observation increasing the percentage of Seattle customers.

Existing Traffic Volumes. Based on the data collected for the station, the weekday peak period (3 hours) was defined to be 11:45 a.m. to 2:45 p.m., and the Saturday period was 1:15 to 4:15 p.m. **Figure 39** shows the weekday and Saturday daily station traffic volumes.

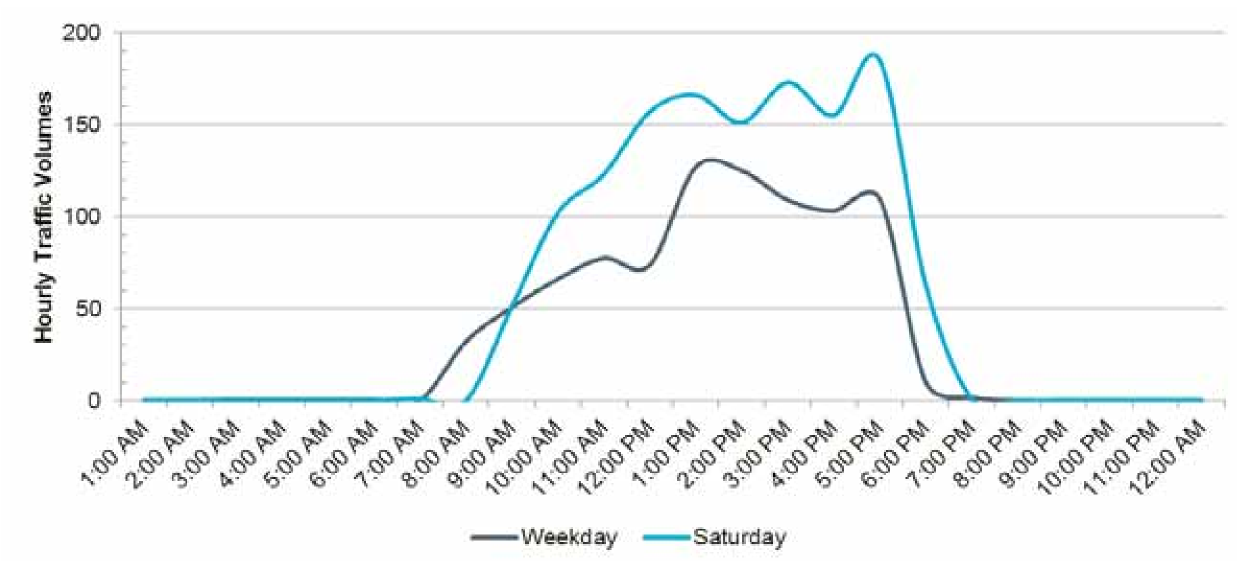

Figure 39
Shoreline Existing Typical Weekday and Saturday Traffic Volume Patterns

Future Traffic Volumes. Future traffic volumes at the station were forecast based on the methodologies described previously. Three (3)-hour peak volumes were developed based on annual tonnage forecasts developed for the station, distribution of weekday and Saturday activity, tonnage per vehicle, seasonal factors, and hourly trip generation patterns for the station. The detailed calculations showing all the key assumptions are included in **Attachment E (Trip Generation Forecasts)**.

Station forecasts were developed for Concepts 0, 1, 2, and 3, both with and without the Renton station operational. All concepts assumed that the Houghton station was closed. **Figure 40** summarizes the peak-hour volumes for each of the concepts (self-haul and commercial-haul) traffic for weekday and

Saturday conditions, with- and without-Renton to help understand the comparison of the station traffic forecasts for the different concepts. Although only the peak-hour is shown in this Figure, the peak-hour volumes are generally anticipated to occur for multiple hours as shown in the **Figure 39** hourly profile.

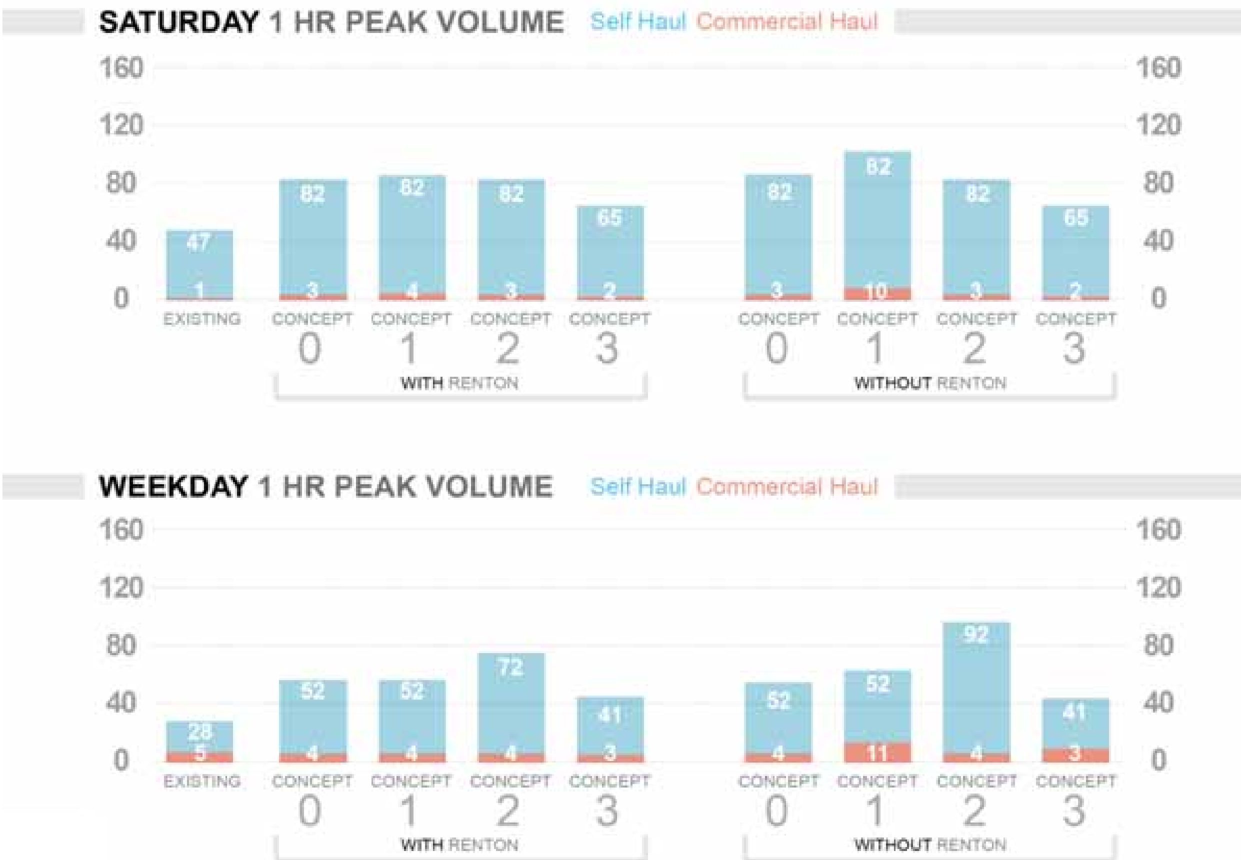

Figure 40
Shoreline Existing and Concepts 0-3 Peak-Hour Volumes

As shown in **Figure 40**, Concepts 0 and 1 are generally similar with commercial-haul volumes increasing up to seven vehicles under Concept 1, compared with Concept 0 under without-Renton conditions due to the redistribution of commercial vehicles. During the weekday peak hours, Concept 2 is consistently largest due to the restriction of self-haul vehicles at the Factoria station on the weekdays. In all scenarios, Concept 3 has the smallest peak-hour volumes due to the construction of NERTS.

On-Site Analysis Results

The on-site service times and inbound vehicle queues were calculated using the methodology described previously. The service time and queue results are shown in **Tables 27** and **28**, respectively, for existing and Concepts 0 to 3.

Table 27
Shoreline Existing and Concepts 0-3 Service Times Summary

Scenario	With-Renton Station					Without-Renton Station			
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday Peak-Hour		Saturday Peak-Hour	
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)		CH (h:mm)	SH (h:mm)	CH (h:mm)	SH (h:mm)
Standard[3]	*00:16*	*00:30*	*00:16*	*00:30*		*00:16*	*00:30*	*00:16*	*00:30*
Existing[4]	00:13	00:17	00:12	00:18					
Concept 0 (2023)	00:13	00:18	00:23	00:29		00:13	00:18	00:23	00:29
Concept 1 (2023)	00:13	00:18	00:24	00:29		00:18	00:20	00:26	00:35
Concept 2 (2023)	00:19	00:22	00:23	00:29		00:25	00:38	00:23	00:29
Concept 3 (2023)	00:13	00:18	00:14	00:19		00:13	00:18	00:14	00:19

1. CH = Commercial-haul
2. SH = Self-haul
3. Adopted standards as defined in King County Transfer plan (December 2007)
4. "Existing" is based on reduced volumes than observed due to the additional vehicles from North Transfer Station in Seattle.

As shown in **Table 27**, with Renton station, self-haul travel times for the weekday and Saturday conditions are anticipated to meet adopted service times. Commercial-haul service times are anticipated to exceed adopted standards with Concept 2 on weekdays and Concepts 0, 1, and 2 on Saturday.

Results without Renton station show overall increases in service times for several scenarios. When compared to the with-Renton scenario, the same concepts exceed the adopted service times during the same time periods with the exception of two additional cases of Concept 1 on the weekday (commercial-haul) and Concept 2 on the weekday (self-haul).

The travel time results are discussed by concept, below:

Concept 0 – The Concept 0 service times are the same under Concept 0 with- and without-Renton. The Concept 0 travel times are similar during the weekday peak-hour but have increased by 11 minutes for both commercial and self-haul travel times during the Saturday peak-hour, exceeding the commercial-haul adopted service time standards.

Concept 1 – The Concept 1 service times under with-Renton conditions, during both weekday and Saturday peak periods, are the same as the Concept 0 service times with only the commercial-haul during the Saturday peak period exceeding the adopted service times. Under without-Renton conditions, all service times exceed the standards with the exception of the self-haul service time during the weekday peak period.

Concept 2 - Self-haul service times are within adopted standards for all scenarios with the exception of the weekday peak-hour under without-Renton conditions; however, the commercial-haul service times exceed the standard under all scenarios. Concept 2 restricts the self-haul vehicles at Factoria on the weekdays, which is why the weekday peak hours are effected and the Saturday peak hours under Concept 2 are the same as Concept 0.

Concept 3 - All travel times are below the adopted standards. Concept 3 constructs the NERTS making conditions similar to existing.

Table 28
Shoreline Existing and Concepts 0-3 Inbound Queues Summary

Scenario	With-Renton Station			Without-Renton Station	
	Weekday (Vehicles)[1]	Saturday (Vehicles)		Weekday (Vehicles)	Saturday (Vehicles)
Threshold[2]	*15*	*15*		*15*	*15*
Existing[3]	1	2			
Concept 0 (2023)	3	6		3	6
Concept 1 (2023)	3	6		3	46
Concept 2 (2023)	4	6		11	6
Concept 3 (2023)	2	3		2	3

1. Vehicle length assumed to be 32 feet.
2. Threshold - Threshold of 15 vehicle queue is approximate distance to adjacent intersection along N 165th Street (Meridian Avenue N / N 165th Street)
3. "Existing" is based on reduced volumes than observed due to the additional vehicles from North Transfer Station in Seattle.

As shown in **Table 28**, queues are within the queue length threshold under all scenarios with the exception of Concept 1 during the Saturday peak-hour under without-Renton conditions. The queue results are discussed by concept, below:

Concept 0 – The with- and without-Renton queues are the same under Concept 0. The queues have tripled under Concept 0 compared to existing conditions but the queues are well within the threshold of 15 vehicles.

Concept 1 - Concept 1 has similar queues to Concept 0 under all scenarios with the exception of during the Saturday peak-hour under without-Renton conditions. The Concept 1 during the Saturday peak-hour under without-Renton conditions exceeds the threshold queues. Concept 1 redirects commercial-haulers, increasing the number of commercial vehicles at Shoreline. Although both weekday and

Saturday peak hours increase the commercial-haul vehicles by seven vehicles under the without-Renton conditions, the Shoreline station is less able to accommodate the additional vehicles on Saturday. On Saturday, there are a greater number of self-haul vehicles and the number of self-haul vehicles that have lift trailers proportionally increase compared with the weekday. The lift-trailers are allowed on the commercial-haul tipping floor, and as they are the general public, they generally take longer on the tipping floor than the commercial vehicles. As stated above, the commercial-haul tipping floor is assumed to have two stalls on Saturday, and a greater percentage of the time if taken up by the self-haul vehicles. The greater volumes through the commercial-haul tipping floor cannot be accommodated which creates a queue from the commercial-haul tipping floor which blocks the internal circulation of the station, resulting in the long inbound queue.

Concept 2 - Concept 2 is within the queue thresholds under all scenarios.

Concept 3 - All queues are within the threshold queue lengths. Concept 3 constructs the NERTS making conditions similar to existing.

Summary of Constraints

The primary constraints at the Shoreline station were found to be the commercial-haul tipping floor and the outbound scale. These constraints were identified with the modeling of the station in VISSIM.

Commercial-Haul Tipping Floor - The primary constraint identified at the Shoreline station was found to be the commercial-haul tipping floor. The commercial-haul tipping floor is constrained by the number of stalls and the dwell time of vehicles on the tipping floor itself.

Outbound Scale - Another constraint at the station is the outbound scale. Queues at the outbound scale extend back to the commercial tipping floor during the Saturday peak-hour resulting in larger commercial-haul service times. If the capacity of the commercial tipping floor were to increase their capacity by decreasing on-floor dwell times or increasing stalls the outbound scale would become a more notable constraint.

The Tier 1 screening primarily focused on the overall reduction in station traffic anticipated under the particular strategy. The strategies analyzed are listed above in **Tier 1/Tier 2 Screening Methodology**. The anticipated peak-hour demand reduction in station traffic under both the with- and without-Renton scenarios during the weekday and Saturday peak hours are summarized in **Attachment F (Demand Management Strategy Trip Reductions)**. The percent reductions shown in the table are based on modeling conducted by the division. Reductions from strategies range from 0 to 34 percent of the peak-hour demand. Mandatory curbside garbage collection was considered has a possible strategy at Shoreline and had a 13.7 percent reduction in traffic. The percentage reductions were provided to Transpo for use in the traffic volume forecasts and modeling.

It is important to note that not all improvement strategies are as effective if combined. Thus, the identification of the improvement combinations accounts for the relationship to one another. In addition to the transportation demand strategies noted above, potential physical station improvements were identified to address the operational constraints. These improvements considered the addition of a TSO staff member on the commercial floor and the addition of an outbound scale.

Strategy combinations were identified based on the results of the Tier 1 screening process. The Tier 2 screening process included the testing of the strategy combinations using VISSIM. The effectiveness of the strategies were tested for the without-Renton scenario as that time period represents the period with the highest peak-hour demand for the stations. Various strategy combinations were applied for Concepts 0 to 2. No modeling was necessary for Concept 3 based on the results of the modeling. The following combinations were identified for detailed evaluation:

Combination A –

A1. Add a TSO/person on commercial floor

A2. Add a TSO/person on commercial floor and additional outbound scale

Combination B – Add a TSO/person on commercial floor and mandatory curbside collection

The results of the combinations tested on the Concepts are shown and discussed below:

Concept 0

Combinations A and B were tested on the Concept 0 without-Renton traffic volumes as the without-Renton traffic volumes are higher, modeling the worst-case scenarios. Only the Saturday peak hours were evaluated under Concept 0 as the weekday peak hours under Concept 0 already met the adopted standards for service times and thresholds for queues. The queue and service times of the combinations are shown in **Table 29**.

Table 29
Shoreline Combinations Service Times and Queues (Concept 0 – 2023 Without-Renton)

Scenario	Service Times				Queues	
	Weekday Peak-Hour		Saturday Peak-Hour		Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)		
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*	*15[3]*	*15*
Existing[6]	00:13	00:17	00:12	00:18	1	2
Concept 0	00:13	00:18	00:23	00:29	3	6
Concept 0 + Combination A1	-[7]	-	00:20	00:29	-	4
Concept 0 + Combination A2	-	-	00:12	00:17	-	4
Concept 0 + Combination B	-	-	00:15	00:22	-	4

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet.
4. Adopted standards as defined in King County Transfer plan (December 2007)
5. Threshold - Threshold of 15 vehicle queue is approximate distance to adjacent intersection along N 165th Street (Meridian Avenue N / N 165th Street).
6. "Existing" is based on reduced volumes than observed due to the additional vehicles from North Transfer Station in Seattle.
7. Weekday Concept 0 combinations not modeled because Concept 0 meets adopted service times and inbound queue thresholds.

As shown in **Table 29**, Concept 0 with the addition of Combinations A2 or B, meet the adopted standards for service times and thresholds for queues. Concept 0, with Combination A1, exceeds the adopted commercial-haul travel time standards by approximately 4 minutes.

Concept 1

Concept 1 with Combinations A and B were evaluated with Concept 1 for the without-Renton conditions. **Table 30** shows that Concept 1 along with any strategy combination meets the weekday adopted service times and queue thresholds, but only Concept 1 with Combination A2 meet the Saturday adopted service times.

Table 30
Shoreline Combinations Service Times and Queues (Concept 1 – 2023 Without-Renton)

Scenario	Service Times					Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)			
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*		*15[3]*	*15*
Existing[6]	00:13	00:17	00:12	00:18		1	2
Concept 0	00:13	00:18	00:23	00:29		3	6
Concept 1	00:18	00:20	00:26	00:35		3	46
Concept 1 + Combination A1	00:15	00:20	00:22	00:37		3	7
Concept 1 + Combination A2	00:13	00:17	00:12	00:17		3	6
Concept 1 + Combination B	00:15	00:19	00:20	00:27		3	5

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet
4. Adopted standards as defined in King County Transfer plan (December 2007)
5. Threshold - Threshold of 10 vehicle queue is approximate distance to adjacent driveway along SE 32nd Street (station access)
6. Existing conditions based on calibrated VISSIM model – September 2014

Concept 2

The queue and service times of the Combinations A and B were tested with Concept 2 are shown in **Table 31** under the without-Renton conditions.

Table 31
Shoreline Combinations Service Times and Queues (Concept 2 – 2023 Without-Renton)

Scenario	Service Times					Queues	
	Weekday Peak-Hour		Saturday Peak-Hour			Weekday (Vehicles)[3]	Saturday (Vehicles)
	CH[1] (h:mm)	SH[2] (h:mm)	CH (h:mm)	SH (h:mm)			
Standard[4]/ Threshold[5]	*00:16*	*00:30*	*00:16*	*00:30*		*15[3]*	*15*
Existing[6]	00:13	00:17	00:12	00:18		1	2
Concept 0	00:13	00:18	00:23	00:29		3	6
Concept 2	00:25	00:38	00:23	00:29		11	6
Concept 2 + Combination A1	00:23	00:38	00:20	00:29		11	4
Concept 2 + Combination A2	00:13	00:19	00:12	00:17		8	4
Concept 2 + Combination B	00:21	00:28	00:15	00:22		5	4

1. CH = Commercial-haul
2. SH = Self-haul
3. Vehicle length assumed to be 32 feet
4. Adopted standards as defined in King County Transfer plan (December 2007)
5. Threshold - Threshold of 10 vehicle queue is approximate distance to adjacent driveway along SE 32nd Street (station access)
6. Existing conditions based on calibrated VISSIM model – September 2014

Table 31 shows that only Concept 2 along with Combination A2 meets the adopted service times and queue thresholds for both weekday and Saturday. Concept 2 with Combination B meets the adopted service times and queues during the Saturday peak conditions. Concept 2 with Combination A1 does not meet the adopted service times for either the weekday or Saturday peak periods.

Concept 3

Tables 27 and **28** show that Concept 3 is within the adopted travel times and threshold inbound queues, and as such, no combinations were modeled.

Off-station Traffic Analysis Results

The analysis includes an evaluation of intersection operations at seven intersections. The study intersections include and are shown in **Figure 41**:

1. Meridian Ave N / N 175th St
2. I-5 SB Ramps / N 175th St
3. I-5 NB Ramps / N 175th St
4. Meridian Ave N / N 165th St
5. Meridian Ave N / N 145th St
6. Southbound Ramps / N 145th St
7. 5th Ave NE / NE 145th St

These study intersections were evaluated during the weekday and Saturday peak hours at Shoreline, and identified during the station observations in September 2014. The peak hours identified were 12:00 to 1:00 p.m., and 2:00 to 3:00 p.m. for the weekday and Saturday conditions, respectively.

Figure 41
Shoreline Study Intersections

Intersection LOS was calculated at the study intersections using the LOS method described previously. Based on the City of Shoreline's Comprehensive Plan, the adopted standard LOS is LOS D.

Existing Conditions

Existing peak-hour intersection turning movements were collected at the off-station intersections in October 2014 for both weekday and Saturday periods. Detailed intersection turning movement traffic volumes are provided in **Attachment G (Off-Station Intersection Traffic Counts)**. The weekday and Saturday existing intersection traffic volumes are shown in **Figure 42**.

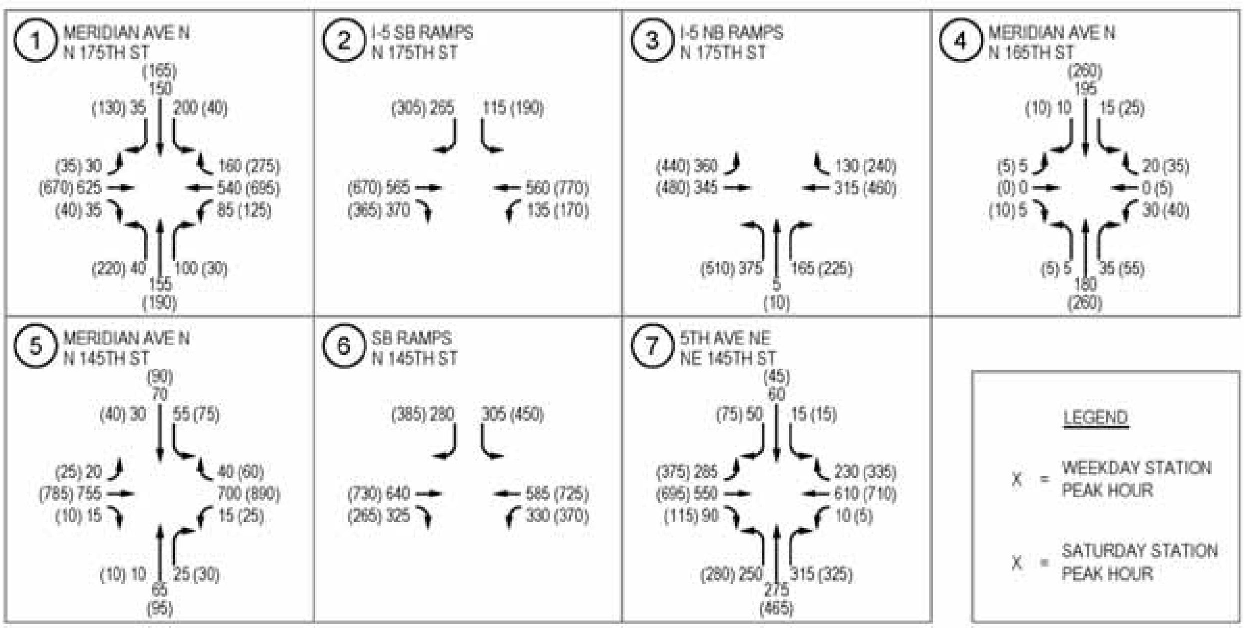

Figure 42
Shoreline Existing Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 32 summarizes the existing weekday and Saturday peak-hour LOS. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

Table 32
Shoreline Existing Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Traffic Control	Weekday Station Peak-Hour (12 – 1 p.m.)				Saturday Station Peak-Hour (2 – 3 p.m.)		
		LOS[1]	Delay[2]	V/C[3] or WM[4]		LOS	Delay	V/C or WM
1. Meridian Ave N / N 175th St	Signalized	C	22			C	28	
2. I-5 SB Ramps / N 175th St[5]	Signalized	B	19	0.54		B	19	0.57
3. I-5 NB Ramps / N 175th St[5]	Signalized	B	16	0.56		D	48	0.87
4. Meridian Ave N / N 165th St	Two-Way Stop Controlled	B	13	WB		C	15	WB
5. Meridian Ave N / N 145th St	Signalized	A	8			A	10	
6. I-5 SB Ramps / N 145th St	Signalized	C	28			B	14	
7. 5th Ave NE / NE 145th St	Signalized	D	36			D	46	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. WM= Worst movement reported for unsignalized intersections where WB = westbound.
5. N 175th Street and the I-5 Ramp intersections were evaluated using 2000 HCM methodology.

As shown in **Table 32**, under existing conditions all study intersections operate at LOS D or better during both weekday and Saturday, meeting the City of Shoreline's LOS standard.

Future 2023 Without-Project Conditions

Based on a review of the City of Shoreline's *(2015-2020) Transportation Improvement Program*, the following improvements were identified:

- **Meridian Avenue N / N 175th Street intersection** – A northbound through lane along Meridian Avenue N is planned which will include widening of the northbound approach and re-channelization of the southbound approach to a single southbound left turn lane as well as extending the length of the westbound left turn pocket.
- **N 175th Street / I-5 Ramps** – Extend the left-turn pockets along NE 175th Street and improve the interchanges through coordination with WSDOT.
- **Re-channelization along Meridian Avenue N** – Re-channelize Meridian Avenue N to provide a two-way center left-turn lane and bicycle lanes by removing on-street parking.
- **145th Street Corridor Improvement** – The corridor is planned to be studied to help identify the specific improvements. Some that have been identified at this point include improvements to accommodate the future light rail station, and multiple non-motorized improvements along the

corridor. This project is anticipated to continue past 2020, and due to no specific operational improvements identified no changes to the future network were included.

The 2023 without-project weekday and Saturday peak-hour traffic volumes were estimated by growing existing traffic volumes by 0.25 percent per year to 2023 conditions. This growth rate was determined in coordination with the City of Shoreline. No pipeline projects were identified within the study area. The 2023 without-project weekday and Saturday peak-hour traffic volumes are shown in **Figure 43**. Without-project conditions represent a condition that assumes that the station continues to operate as-is. No changes in station volumes outside of normal background growth was assumed. <u>This scenario is not consistent with Concept 0</u>.

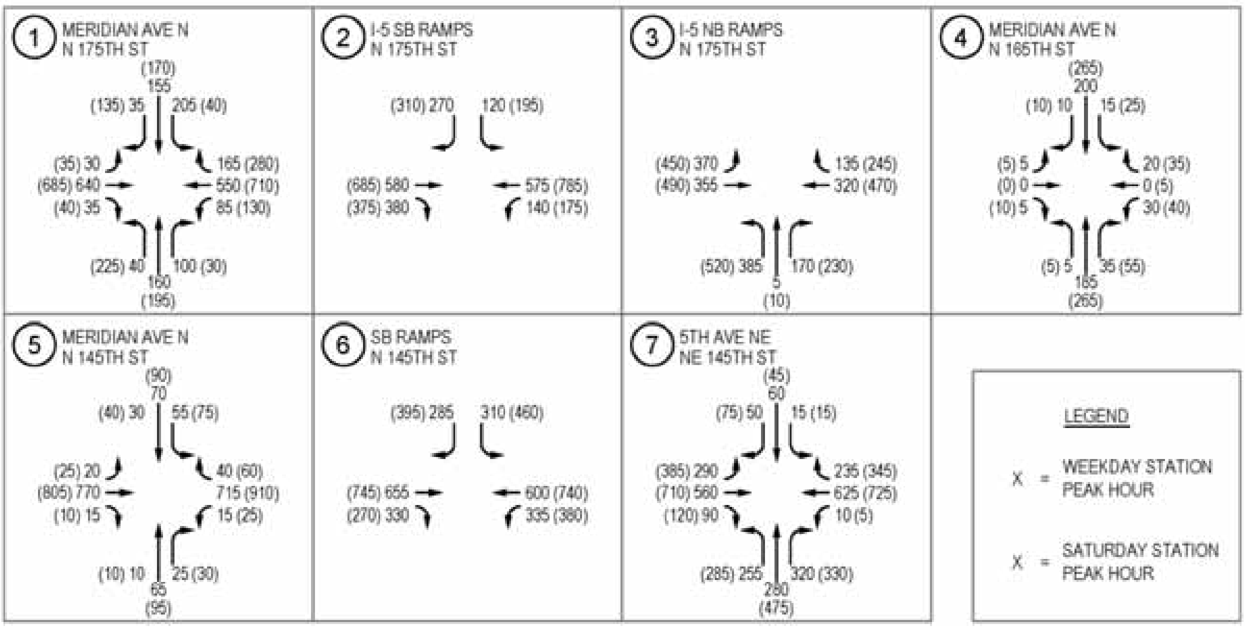

Figure 43
Shoreline 2023 Without-Project Weekday and Saturday Station Peak-Hour Traffic Volumes

For all study intersections, lane geometrics and traffic control remained consistent with existing conditions for 2023 without-project conditions except for the inclusion of the transportation improvement projects noted above. Signal timing was optimized for the 2023 analysis; optimizing the traffic signal timing takes into consideration the actuated nature of the signals and changes that would occur with growth in traffic volumes. **Table 33** summarizes the LOS results for the without-project weekday and Saturday peak hours.

Table 33
Shoreline 2023 Without-Project Weekday and Saturday Station Peak Hours LOS Summary

Intersection	Traffic Control	Existing				2023 Without-Project		
		LOS[1]	Delay[2]	V/C[3] or WM[4]		LOS	Delay	V/C or WM
Weekday Station Peak-Hour (12 – 1 p.m.)								
1. Meridian Ave N / N 175th St	Signalized	C	22			C	23	
2. I-5 SB Ramps / N 175th St[5]	Signalized	B	19	0.54		B	20	0.55
3. I-5 NB Ramps / N 175th St[5]	Signalized	B	16	0.56		B	16	0.58
4. Meridian Ave N / N 165th St	Two-Way Stop Controlled	B	13	WB		B	13	WB
5. Meridian Ave N / N 145th St	Signalized	A	8			A	8	
6. I-5 SB Ramps / N 145th St	Signalized	C	28			C	27	
7. 5th Ave NE / NE 145th St	Signalized	D	36			D	38	
Saturday Station Peak-Hour (2 – 3 p.m.)								
1. Meridian Ave N / N 175th St	Signalized	C	28			C	30	
2. I-5 SB Ramps / N 175th St	Signalized	B	19	0.57		C	21	0.69
3. I-5 NB Ramps / N 175th St	Signalized	D	48	0.87		D	52	0.89
4. Meridian Ave N / N 165th St	Two-Way Stop Controlled	C	15	WB		C	16	WB
5. Meridian Ave N / N 145th St	Signalized	A	10			A	10	
6. I-5 SB Ramps / N 145th St	Signalized	B	14			C	30	
7. 5th Ave NE / NE 145th St	Signalized	D	46			D	48	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. WM= Worst movement reported for unsignalized intersections where WB = westbound.
5. N 175th Street and the I-5 Ramp intersections were evaluated using 2000 HCM methodology.

Table 33 shows, under 2023 without-project conditions, all study intersections continue to operate within City of Shoreline standards; operating at LOS D or better with the greatest increase in delay of 16 seconds occurring at the I-5 Southbound Ramps / N 145th Street intersection during the Saturday station peak-hour under without-project conditions compared to existing conditions.

2023 Concept 2 Conditions

As previously discussed, the Concept 2 peak-hour traffic volumes are largest relative to the other concepts (see **Figure 40**) and as such the Concept 2 forecasts were utilized for the off-site intersection analysis. As this is an existing station, the net new trips were calculated and assigned to the off-site study intersections. To calculate the net new trips the station transactions (inbound trips) were provided by King County for the same day the off-station traffic volumes were collected in order to ensure the data was consistent. The net-new trips under 2023 Concept 2 conditions were then calculated by subtracting the existing transactions, which were doubled to account for in- and outbound trips from the station, from the 2023 Concept 2 forecast number of trips. This is shown in the Trip Generation **Tables 34** and **35** for with- and without-Renton conditions, respectively.

Table 34
Shoreline Concept 2 With-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	**Outbound**	**Total**		**Inbound**	**Outbound**	**Total**
Existing Total[1]	*45*	*45*	90		68	68	136
Concept 2							
Commercial-haul	4	4	8		3	3	6
Self-haul	72	72	144		82	82	164
Total	76	76	152		85	85	170
Net New Project Trips (2023 Concept 2 – Existing)	31	31	62		17	17	34

1. Existing total based on on-site transactions during the peak hours on the day the off-site intersection traffic volumes were collected.

As shown in **Table 34**, with Concept 2, 62 net new weekday station peak-hour trips and 34 net new Saturday station peak-hour trips are forecast to impact off-site intersections.

Table 35
Shoreline Concept 2 Without-Renton Trip Generation Summary

	Weekday Station Peak-Hour				Saturday Station Peak-Hour		
	Inbound	**Outbound**	**Total**		**Inbound**	**Outbound**	**Total**
Existing Total[1]	*45*	*45*	90		68	68	136
Concept 2							
Commercial-haul	4	4	8		3	3	6
Self-haul	92	92	184		82	82	164
Total	96	96	192		85	85	170
Net New Project Trips (2023 Concept 2 – Existing)	51	51	102		17	17	34

1. Existing total based on on-site transactions during the peak hours on the day the off-site intersection traffic volumes were collected.

The weekday peak-hour trips are approximately 60 percent larger under without-Renton conditions compared to with-Renton conditions. The Saturday peak-hour trips are the same under with- and without-Renton conditions. This is because under Concept 2 conditions, only the weekday is affected due to the restriction of vehicles at Factoria. As shown in **Table 35**, during the weekday peak-hour 102 net new trips are estimated, and during the Saturday peak-hour 34 net new trips are estimated.

The trip distribution pattern for the self-haul vehicles was developed based on the survey respondents on the weekday and Saturday. As noted above, the survey respondents told the closest intersection and zip code they were coming from. Each respondents answer was plotted so the trip distribution could be estimated. Due to the closure of Houghton, the users that go to Houghton under existing conditions that would shift to Shoreline were included. The closure of Renton does not affect the Shoreline distribution, resulting in the same distribution for with- and without-Renton. The trip distributions for Shoreline on the weekday and Saturday under both with- and without-Renton conditions are shown in **Figure 44**.

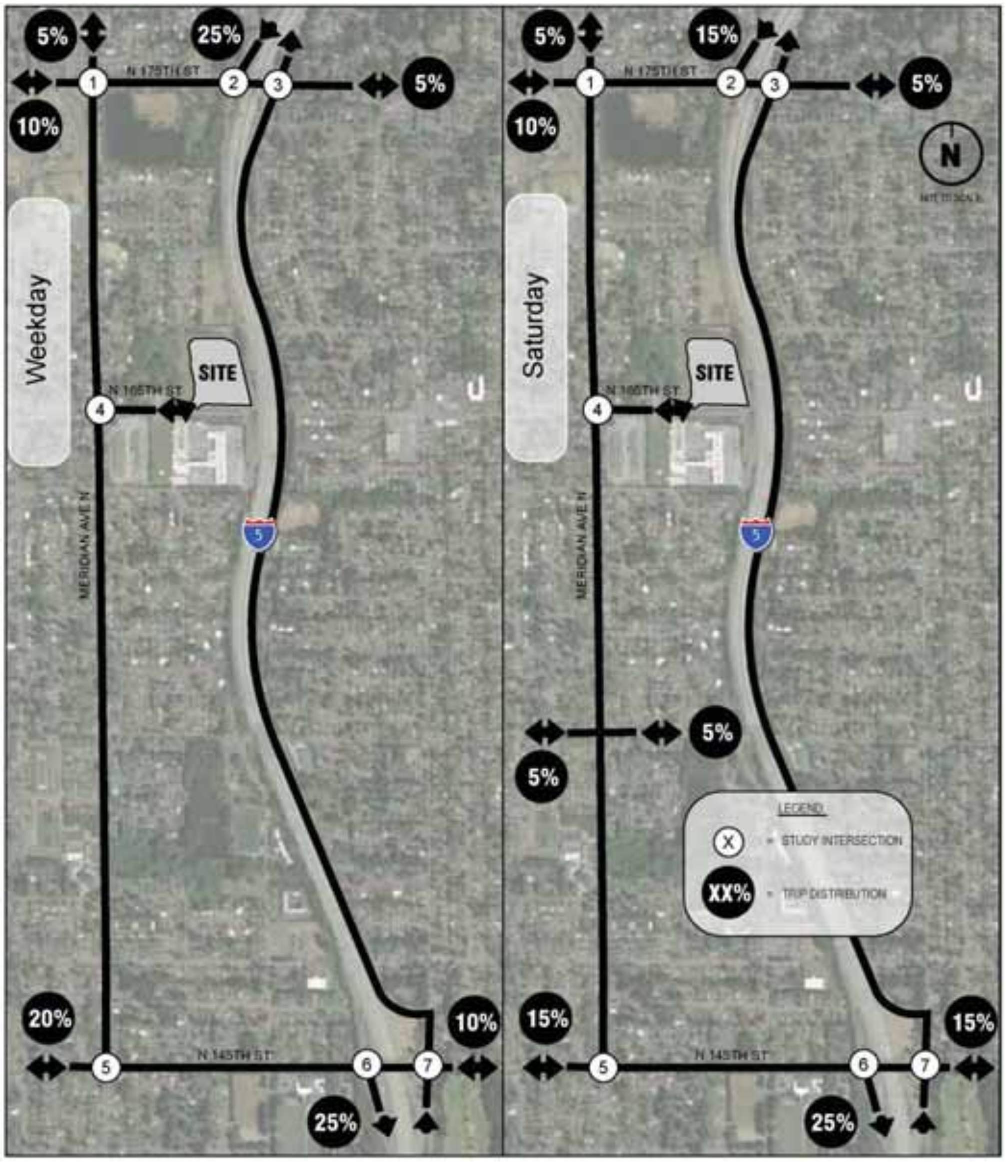

Figure 44
Shoreline Weekday and Saturday Trip Distribution (With and Without-Renton)

The net-new trips associated with each scenario was assigned to the study intersections based on the trip distributions. The net-new project trip assignment for weekday and Saturday under both with- and without-Renton conditions are shown in **Figure 45**.

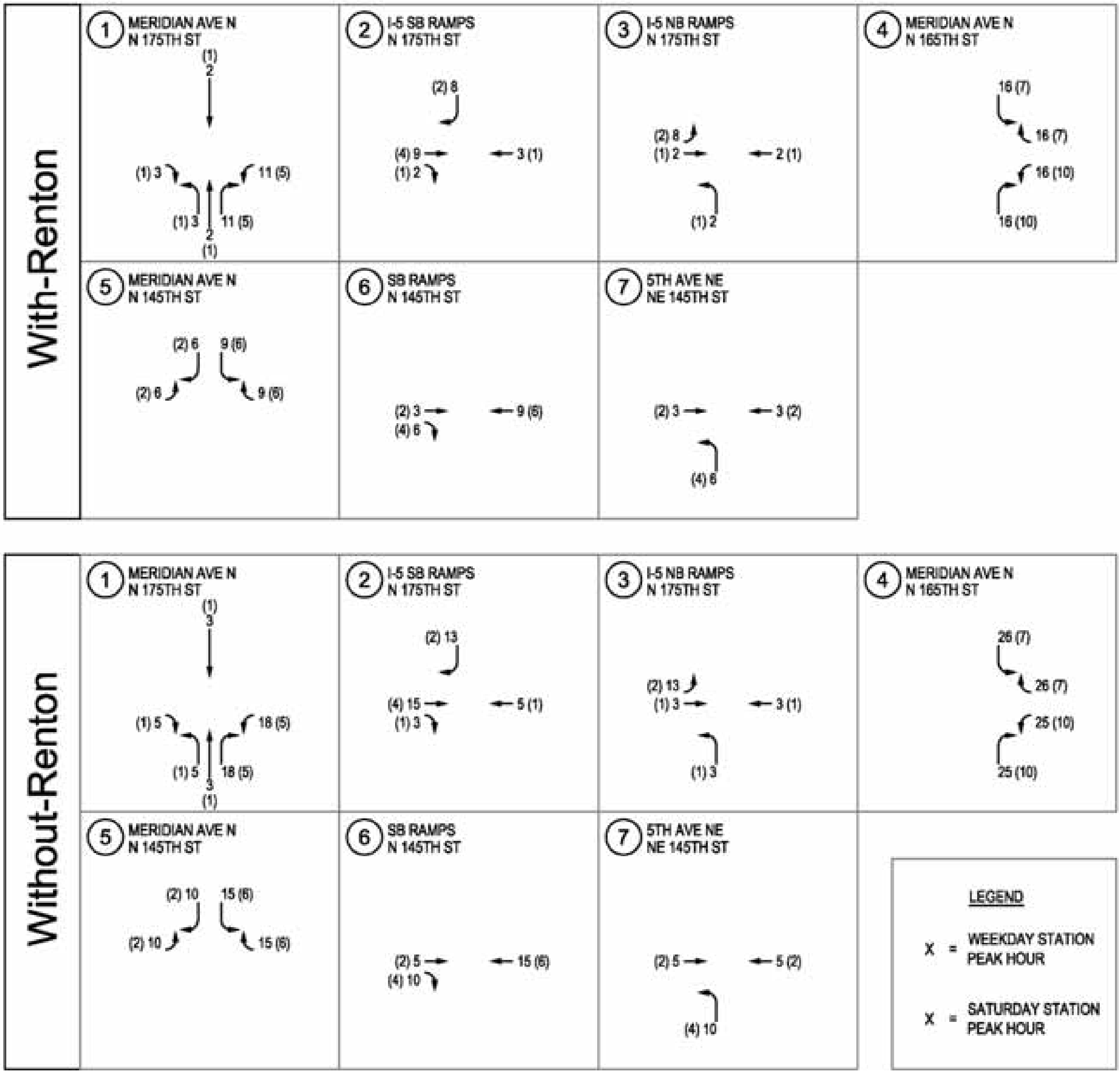

Figure 45
Shoreline Concept 2 With and Without-Renton Net-New Trip Assignment

The with-project 2023 Concept 2 weekday and Saturday peak-hour traffic volumes both with- and without-Renton are shown in **Figure 46**. The largest percent impact of the Concept 2 traffic volumes relative to the without-project conditions was at the station access intersection, the Meridian Avenue N / N 165th Street intersection, under all Concept 2 scenarios. During the weekday station peak-hour percent increases under Concept 2 compared to without-project conditions range from 13 percent to 20 percent under with- and without-Renton conditions, respectively. Similarly, during the Saturday station peak-hour percent increases under Concept 2 compared to without-project conditions are 5 percent during both with- and without-Renton conditions.

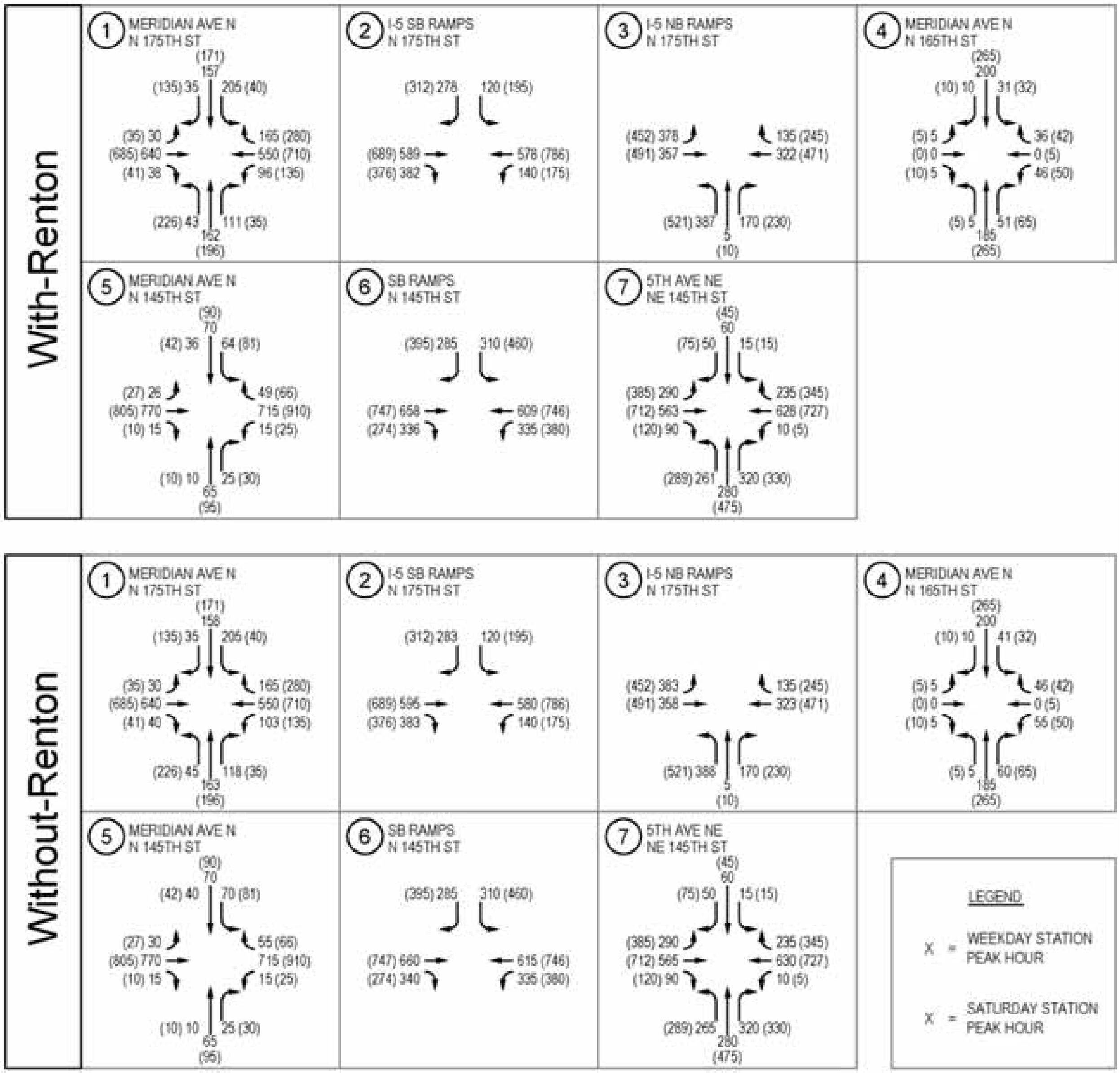

Figure 46
Shoreline Concept 2 Weekday and Saturday Station Peak-Hour Traffic Volumes

Table 36 provides a comparison between the 2023 Concept 2 and without-project conditions both with- and without-Renton conditions. The detailed LOS worksheets are included in **Attachment H (LOS Worksheets)**.

Table 36
Shoreline Concept 2 Weekday and Saturday Station Peak Hours LOS Summary

	2023 Without-Project			Concept 2 – With-Renton			Concept 2 – Without-Renton		
Intersection	LOS[1]	Delay[2]	V/C[3] or WM[4]	LOS	Delay	V/C or WM	LOS	Delay	V/C or WM
Weekday Station Peak-Hour (12 – 1 p.m.)									
1. Meridian Ave N / N 175th St	C	23		C	24		C	24	
2. I-5 SB Ramps / N 175th St[5]	B	20	0.55	B	20	0.56	B	20	0.57
3. I-5 NB Ramps / N 175th St[5]	B	16	0.58	B	16	0.59	B	17	0.59
4. Meridian Ave N / N 165th St	B	13	WB	B	14	WB	B	15	WB
5. Meridian Ave N / N 145th St	A	8		A	9		A	9	
6. I-5 SB Ramps / N 145th St	C	27		C	27		C	26	
7. 5th Ave NE / NE 145th St	D	38		D	38		D	38	
Saturday Station Peak-Hour (2 – 3 p.m.)									
1. Meridian Ave N / N 175th St	C	30		C	30		C	30	
2. I-5 SB Ramps / N 175th St	C	21	0.69	C	21	0.69	C	21	0.69
3. I-5 NB Ramps / N 175th St	D	52	0.89	D	54	0.89	D	54	0.89
4. Meridian Ave N / N 165th St	C	16	WB	C	17	WB	C	17	WB
5. Meridian Ave N / N 145th St	A	10		B	10		B	10	
6. I-5 SB Ramps / N 145th St	C	30		C	30		C	30	
7. 5th Ave NE / NE 145th St	D	48		D	48		D	48	

1. Level of service (LOS), based on 2010 Highway Capacity Manual methodology, 2000 methodology utilized where 2010 could not be applied.
2. Average delay in seconds per vehicle.
3. Volume-to-capacity ratio reported for signalized intersections. Only reported for HCM 2000 methodology.
4. WM= Worst movement reported for unsignalized intersections where WB = westbound.
5. N 175th Street and the I-5 Ramp intersections were evaluated using 2000 HCM methodology.

As shown in **Table 36**, all study intersections continue to operate at LOS D or better, meeting the City of Shoreline LOS standard, with the addition of Concept 2 traffic. Furthermore, no intersections change in LOS between 2023 without-project conditions and Concept 2 conditions with the exception of the Meridian Avenue N / N 145th Street intersection. This intersection degrades from LOS B to LOS C with the addition of Concept 2 traffic compared to without-project conditions.

Shoreline Station Summary

- Increases in station traffic range from 44 to 76 between the different concepts during the weekday peak period under with-Renton conditions and range from 44 to 96 during the weekday peak period under the without-Renton conditions. During the Saturday peak period, peak demand volumes range from 67 to 86 under with-Renton conditions and range from 67 to 92 under without-Renton conditions.
- Analysis of on-site operations showed operational issues at the commercial-haul tipping floor and the outbound scale resulting commercial-haul service times exceeding the adopted service times primarily during the Saturday peak periods.
    - Three improvement strategy combinations were analyzed to improve on-site operations under Concepts 0 to 2 without-Renton conditions, both during the weekday and Saturday peak periods. Combinations A2 (add a TSO/person on commercial floor and additional outbound scale) under Concepts 0 to 2 meet both the weekday and Saturday adopted service times and queue thresholds. The other combinations under the without-Renton conditions exceed either the adopted service times or the queue thresholds.
- Evaluation of off-station intersections showed minimal increases in off-station intersections for Concept 2. Concept 2 represented the highest peak demand thus represents a more conservative analysis when considering the impacts to the other concepts and the greatest impact to the off-station intersections.

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Noise

This study shows that the proposed concepts for handling increased system capacity in the King County Solid Waste system, if the Northeast Transfer and Recycling Station is not constructed, are not anticipated to be associated with significant noise effects. Minimal instances of anticipated exceedance of regulatory standards are identified, and potential mitigation measures are proposed to resolve these conditions. Only one analysis scenario (nighttime operations at Renton Transfer Station) increased existing conditions above common thresholds for adverse community reaction (5 decibels [dB]). While this 6 dB increase (1 dB above the 5 dB threshold) is minor and may be associated with conservative modeling assumptions, it may also identify Renton as having a potential sensitivity to increased nighttime operations. Aside from this result, no unmitigable noise impacts are anticipated. However, due to the breadth of this study, covering numerous potential traffic and operational scenarios, refinement of the environmental noise assessment is recommended once an action is proposed. The intent of this study is to inform the planning and preparation process for updating the King County Comprehensive Solid Waste Management Plan.

Terminology

General Principles

The auditory response to sound is a complex process that occurs over a wide range of levels. Decibel levels, or “dB,” are a form of shorthand that compress this broad range of levels with a convenient numerical scale. The decibel scale is logarithmic. For example, using the decibel scale, a doubling of energy causes the sound level to increase by 3 dB. Three (3) dB is generally considered to be the minimum increase perceptible to a human observer. However, a 3-dB increase does not double the perceived loudness. Six (6) to 10 times the energy is needed to result in a perceived doubling of loudness, which is an increase of 8 to 10 dB.

The human ear has a unique response to sound pressure. It is less sensitive to those sounds falling outside of the speech frequency range. Sound level meters and monitors utilize a filtering system to approximate human perception of sound. Measurements made using this filtering system are referred to as “A weighted” and are called “dBA.”

Noise is generally defined as “unwanted sound” and is a subjective response to a particular sound source or environment. “Noise impacts” identify an expectation that a particular sound source or group of sound sources may negatively impact noise-sensitive receptors within an existing environment. This is largely dependent on the existing sound environment and the acoustical characteristics of the new sound sources.

Metrics

The following mathematical descriptors correlate with human response to sound, and are used to assess sounds that vary over time:

- **Equivalent Sound Level (L_{eq})**

  L_{eq} is the average of a time-varying A-weighted sound level during a specified interval. The L_{eq} is used to characterize complex, fluctuating sound levels with a single number. This study utilizes an hourly L_{eq}.

- **Maximum Sound Level (L_{max})**

  L_{max} is the maximum recorded A-weighted sound level for a given time interval or event. This study utilizes an hourly L_{max} "fast" (125-millisecond averaging time) to correlate with the typical response time of the human ear.

- **Percent Sound Level (L_n)**

  L_n is the sound level that is exceeded 'n' percent of the time; for example, L_{08} is the level exceeded 8 percent of the time. L_{25} is the sound level exceeded 25 percent of the time. Percent sound levels isolate louder events of short duration in a given measurement period, the smaller the percentage, the more shorter-duration events influence the value.

- **Sound Power Level (L_w or PWL)**
  Sound power is the amount of energy per second generated by a source, measured in watts. The sound power level (PWL) is a decibel representation with a reference value of 1 pico-watt (pW). Sound power is independent of distance, path, or influence from any nearby surfaces and is the most prevalent method for describing the amount of sound radiating from a noise source.

- **Sound Pressure Level (L_p or SPL)**

  Sound pressure level (SPL) correlates the sound emissions from the noise source with what is heard by the human ear, based on the acoustic environment that bounds the noise source and receiver. SPL is a decibel representation with a reference value of 20 micro-pascals (µPa). Distance, path, barriers, directivity, etc… affect sound pressure.

The appropriate descriptor for a given situation will depend on the following sound source, receiver, and analysis conditions:

- Transient character of the sound (constant level, changes frequently over time, etc.)
- Jurisdictional criteria (descriptors defined by municipal code, interpretations of code requirements, existing sound levels, etc.)
- Source characterization (influence of each sound source)

Common sound levels are shown in **Table N-37**.

Table N-37
Common Sound Levels, dBA

Sound Source	Sound Level[1]	Approximate Relative Loudness[2]
Jet Plane @ 100 feet	130	128
Rock Music with Amplifier	120	64
Thunder, Danger of Permanent Hearing Loss	110	32
Boiler Shop, Power Mower	100	16
Orchestral Crescendo at 25 feet	90	8
Busy Street	80	4
Interior of Department Store	70	2
Ordinary Conversation @ 3 feet	60	1
Quiet Car at Low Speed	50	1/2
Average Office	40	1/4
City Residence, Interior	30	1/8
Quiet Country Residence, Interior	20	1/16
Rustle of Leaves	10	1/32
Threshold of Hearing	0	1/64

1. Sound pressure level, dBA re: 20 μPa
2. As compared to ordinary conversation at 3 feet.
Source: US Department of Housing and Urban Development, Aircraft Noise Impact Planning Guidelines for Local Agencies, November 1972.

Methodology

The primary methodology used for the analysis and prediction of the environmental sound level was a computer noise model. This model was created with the acoustic modeling software Cadna/A. Cadna/A uses the Control of Accuracy and Debugging for Numerical Applications (CADNA) computation engine developed by the Pierre et Marie Curie University of Paris. The Cadna/A model utilizes the International Organization for Standardization (ISO) 9613 standard for predicting outdoor sound levels.

Sound propagation over distances greater than 1,000 feet is strongly influenced by meteorological conditions. Special atmospheric conditions, such as inverted thermal gradients or downwind conditions, can create a downward-refracting atmosphere that could potentially increase sound levels at large distances. The effects of a moderately downward-refractive atmosphere are included in the standard algorithm of the Cadna/A model, consistent with ISO 9613, to create a conservative representation of the predicted sound environment. While the sound levels at great distances may be greater, under some atmospheric conditions the received sound levels should generally be less (when no downward-refraction occurs) or much less (when upward-refraction occurs).

The Cadna/A model was built from computer aided design (CAD) drawings and Geographic Information System data provided by King County, satellite imagery, and on-site observations. The data contained within the noise model includes: existing site layouts, topography, property boundaries, zoning, and streets (where applicable). In order to calibrate the model, sound emissions from the existing facility and the dominant surrounding noise sources (e.g., freeways) were activated in the model and compared with measured ambient conditions. After the calibration process was complete, sound emissions from various analysis conditions were provided based on future traffic conditions predicted by The Transpo Group.

Due to the substantial number of traffic modeling scenarios, prediction of future sound emissions was limited to the conditions with the greatest potential increase in noise emissions to determine the maximum "noise capacity" for each site. Where potential impacts were identified during this assessment, potential mitigation measures were identified.

Data Collection

The analysis performed in this study includes three locations: Bow Lake Recycling and Transfer Station, Renton Recycling and Transfer Station, and Shoreline Recycling and Transfer Station. Data collection was conducted at each location, over multiple days, which included weekday and Saturday operations. Ambient monitoring was completed by an un-manned Sound Level Meter (SLM) that was deployed, locked and set to record, at a fixed location. The SLM recorded for the set time span, after which the recorded ambient sounds are manually uploaded for further evaluation.

Documenting the sound levels associated with discreet sources and with the influence of the reverberant-field sound was conducted with a manned SLM. These measurements characterized specific noise sources, such as goat trucks, vehicles, compactors, and tipping floor activities. During these manual collection periods, traffic data was collected by others, which allowed for synchronization of the collected noise data with actual on-site operations. Site visits during the weekday and Saturday were necessary to capture the vast change in volume of activity and type of activity between days.

Measurements were not conducted at the Factoria Recycling and Transfer Station, due to ongoing construction at that site renovating the existing facility. A noise analysis prepared for the renovation served as the basis for an assessment of potential effects of changes to operations at the site, scheduled to open for service in late 2017 (HDR 2012).

Existing Environmental Noise Levels

Sound level meters were installed near property lines and noise-sensitive receivers to document hourly sound levels for extended time periods, typically 4 weekdays and 3 Saturday days (see **Figures N-1**, **N-2**, and **N-3**). The purpose of this monitoring was to document sound emissions from site activity and other ambient noise sources to correlate with vehicle count data collected by others and for use in calibration of the noise model. A summary of measured ambient sound levels, including both site sound emissions and ambient environmental noise sources, is shown in **Table N-38**.

Table N-38
Existing Sound Levels, Median of Hourly L_{eq} values, dBA

Site and Duration		Weekday (Loc A / B)		Saturday (Loc A / B)	
		Daytime	Nighttime	Daytime	Nighttime
Bow Lake	9/10-12/14	66 / 64	61 / 59	64 / 62	57 / 58
	9/26-29/14				
Renton	9/17-22/14	58 / 53	45 / 42	53 / 51	48 / 45
Shoreline	9/12-13/14	57 / 63	57 / 60	56 / 62	60 / 61
	9/13-17/14				

All equipment was laboratory calibrated within 1-year of the measurement date. Field calibrations were also performed prior to the start of monitoring and verified at the end of the monitoring periods. Equipment used during the ambient noise monitoring was as follows:

- Location A (Bow Lake, Renton, and Shoreline)
  - Rion NL-32 sound level meter SN 00161681
    - Rion NH-21 preamplifier SN 18454
    - Rion UC-53A microphone SN 309751
  - Larson Davis CAL200 SN 5463
- Location B (Bow Lake, Renton, and Shoreline)
  - Rion NL-52 sound level meter SN 821097
    - Rion NH-25 preamplifier SN 21138
    - Rion UC-59 microphone SN 4064
  - Larson Davis CAL200 SN 5463

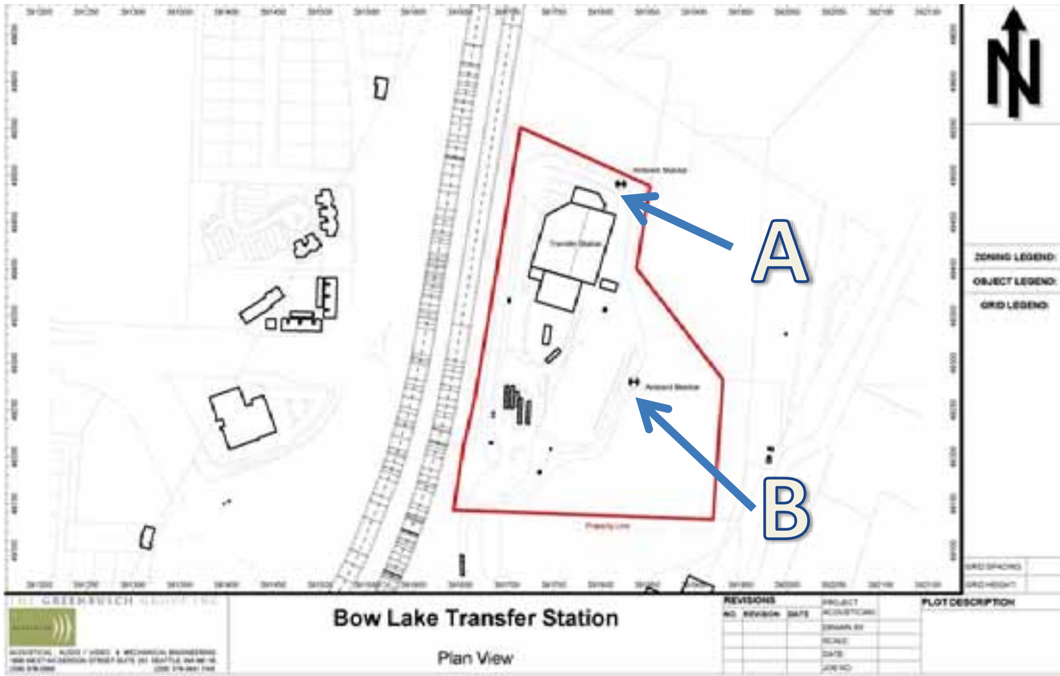

Figure N-47
Bow Lake Recycling and Transfer Station –Noise Monitoring Locations

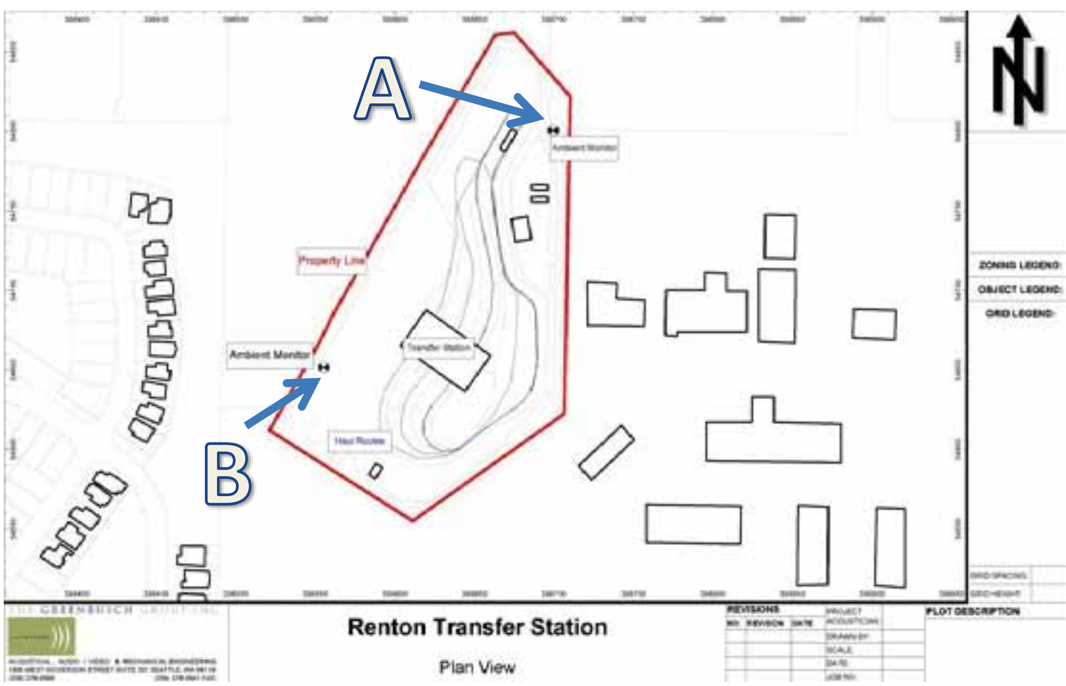

Figure N-48
Renton Recycling and Transfer Station –Noise Monitoring Locations

Figure N-49
Shoreline Recycling and Transfer Station –Noise Monitoring Locations

Sounds Levels for Individual Sources

In order to predict sound levels associated with changes to site activity, sound monitoring was conducted for individual sources. During this shorter time window, ambient monitoring conducted near the property lines (discussed in **Existing Environmental Noise Levels**) continued to allow for comparisons of specific on-site noise sources and far field sound levels received at the noise monitoring stations. Two general methods were used to document specific activities: free field and reverberant field measurements.

Free field measurements include performing a SPL measurement at a specific distance from a noise source. Using the resulting SPL and measured distance (a last distance measurement device was used to improve accuracy), the overall sound emission of the noise source can be determined. This results in the PWL. For indoor acoustic environments where multiple noise sources blend together, measurements become more complex due to reverberation and interference from other noise sources. In these scenarios, reverberant field measurements can be used to determine the total sound emissions within the space. For example, a tipping floor typically includes equipment to maintain the waste pile (front end loader, bulldozer, etc.), vehicles entering and leaving the building, recycling and compaction activities, and various other noise sources common to a solid waste transfer facility. With a microphone placed in the reverberant field, far from the noise sources, the reverberant properties of the building and measured SPLs can be used to calculate the overall sound emission level, or PWL, from all of the noise sources within the building.

After the dominant noise sources are documented, hourly occurrences of these individual sound sources can be adjusted to reflect the current, planned, and potential conditions of site activity. Therefore, making individual sound sources a dynamic tool in the computer sound modeling process. A summary of sound source data that was collected during the fieldwork is presented in **Table N-39**.

Table N-39
Measured Individual Noise Sources

Noise Source	Bow Lake		Renton		Shoreline	
	Weekday	Saturday	Weekday	Weekday	Weekday	Saturday
Self-haul vehicle	5	5	24	24	19	9
Commercial haul vehicle	9	9	9	9	29	9
Compactor	1	1	1	1	1	1
Recycling dumpster	1	1	-	-	-	-
Goat truck	2	2	1	1	1	1

Modeling Input Parameters

On-Site Equipment, Vehicles, and Activities

Sound levels used in the modeling process are summarized in **Table N-40**, based on sound level measurements at the existing facilities.

Table N-40
Modeled Noise Sources for Existing Conditions, L_{eq}, dBA

Noise Source	Bow Lake		Renton		Shoreline	
	Weekday	Saturday	Weekday	Weekday	Weekday	Saturday
Residential vehicle	65 @ 50’	65 @ 50’	58 @ 50’	58 @ 50’	57 @ 50’	58 @ 50’
Commercial vehicle	79 @ 59’	79 @ 59’	64 @ 50’	64 @ 50’	64 @ 50’	64 @ 50’
Tipping floor	81 @ rev	79 @ rev	73-83 @ openings	70-77 @ openings	77 @ rev	77 @ rev
Compactor	84 @ rev	84 @ rev	66 @ 5’	66 @ 5’	84 @ rev	84 @ rev
Recycling dumpster	87 @ 6’	87 @ 6’	87 @ 6’	87 @ 6’	87 @ 6’	87 @ 6’
Goat truck pulling trailer	79-82 @ 25’	79-82 @ 25’	77 @ 17’	77 @ 17’	85 @ 10’	85 @ 10’
Note: “rev” represents reverberant field measurements.						

Traffic Volumes

In order to predict changes to sound emissions from the sites, the noise model requires input for the quantity and class of vehicles accessing the site, including speeds and travel routes. Once these parameters are known, they were paired with sound levels of the respective vehicle class. Analysis in the noise model was focused on the peak-hour, defined as the hour during the day with the highest amount of expected traffic. Vehicle count data collected by Transpo Group was used to determine these peak hours, and the distribution of residential and commercial vehicles at each site.

For future conditions, the trip generation estimates generated by Transpo Group for the year 2023 (including applying future mix percentages) were used to predict future conditions. Existing conditions of vehicle mix were estimated based on overall vehicle count data collected by Transpo Group during field investigations. Traffic data used as modeling input for the existing condition is summarized in **Table N-41**.

Table N-41
Modeled Peak-Hour Traffic Volumes, Existing Peak-Hour

Site	Day			Night		
	Commercial Haul	Self-Haul	Hauling Trucks	Commercial Haul	Self-Haul	Hauling Trucks
Bow Lake – weekday	7	59	1	2	4	0
Bow Lake – Saturday	1	73	1	1	27	0
Renton – weekday	6	32	1	1	4	0
Renton – Saturday	3	45	1	1	27	0
Shoreline – weekday	3	55	1	1	9	0
Shoreline – Saturday	0	83	0	0	30	0

Source: Transpo Group, The Greenbusch Group, Inc.

Due to the large number of traffic conditions being modeled for the facilities, the maximum expected traffic at each site was modeled for the future (2023) condition to determine potential worst-case noise effects. Some of the traffic modeling concepts included in the future trip generation estimates are as follows:

- Extended operating hours
- Provide wait time information
- Lower cost curbside bulky waste collection
- Mandatory curbside garbage collection
- Lower regional direct fee to encourage haulers to use their own transfer stations
- Banner materials – yard/wood waste and hazardous household waste
- Incentive/peak pricing
- Higher minimum fee
- Increased tipping floor capacity
- Increased staffing to reduce tipping floor dwell time
- Closure of the Renton Transfer Station

Modeling input conditions for the worst-case site usage results based on anticipated future conditions based on the above concepts is summarized in **Table N-42**.

Table N-42
Modeled Peak-Hour Traffic Volumes, Peak-Hour Maximum Traffic – 2023

Site	Day			Night		
	Commercial Haul	Self-Haul	Transfer Trailer Trucks	Commercial Haul	Self-Haul	Transfer Trailer Trucks
Bow Lake – weekday	25	94	7	8	19	2
Bow Lake – Saturday	9	149	5	5	55	2
Renton – weekday	10	44	2	1	6	0
Renton – Saturday	9	56	2	2	34	0
Shoreline – weekday	14	103	3	1	17	0
Shoreline - Saturday	19	89	3	0	32	0

Source: Transpo Group, The Greenbusch Group, Inc.

Issue Identification

Potential noise issues were identified using a two-prong method during the screening process (described in **Analysis**); compliance with regulatory requirements and increases to existing noise conditions.

Regulatory Compliance

Regulatory requirements vary between each site, based on the governing codes of the station and nearby properties. However, none of the regulatory standards described in this section define noise metrics for the permissible sound levels. Common interpretation of the sound level limits is for the typical hourly sound level limit between two properties is an L_{25}, with increased sound level limits permitted for louder sound events not to exceed 15 minutes, 5 minutes, and 1.5 minutes as L_8, L_2, and L_{max} respectively. For the purposes of this analysis, given the level of detail available for projected site operations, the analysis assesses hourly L_{eq} values only, and compares the resulting levels against the standard code limits, taking no allowances for louder events of short duration.

Bow Lake

The Bow Lake station is located within the City of Tukwila and is zoned Commercial. Surrounding properties to the East are also in Tukwila, while properties to the West are in the City of SeaTac. The City of Tukwila controls sound emissions within City limits in Tukwila Municipal Code (TMC) Chapter 8.22, based on the land use zoning of the source and receiving properties. The SeaTac Municipal Code includes a nuisance ordinance in Chapter 8.05.360, but does not establish permissible sound level limits between adjacent properties. Therefore, sound level limits in SeaTac would default to those identified in the Washington Administrative Code (WAC) Chapter 173.60 (**Table N-43**). WAC sound level limits as based on the Environmental Designation for Noise Abatement (EDNA) of the properties, which are by default based on land use, unless the local jurisdiction adopts a zoning ordinance that correlates land use zoning with EDNA. While the sound level limits are comparable between TMC and WAC, WAC sound level limits are based on land use, while TMC limits are based on zoning. However, due to the proximity of vacant residential parcels, application of this code to the analysis applies sound level limits at all properties based on zoning, not use.

Table N-43
Bow Lake Hourly Sound Level Limits, dBA

Receiving Property	Day	Night
Residential zoning (Class A EDNA)	57	47
Commercial zoning (Class B EDNA)	60	60
Industrial zoning (Class C EDNA)	65	65

Source: TMC Chapter 8.22, WAC 173.60

Renton

The Renton station and all surrounding properties are located within the City of Renton. The zoning of the transfer station site is Industrial (Class C EDNA) and nearby properties are a mixture of Residential (Class A EDNA), Commercial (Class B EDNA), and Industrial. The Renton Municipal Code (RMC) adopts WAC sound level limits and assigns land use zonings to EDNAs in RMC Section 8.7.4 (**Table N-44**).

Table N-44
Renton Hourly Sound Level Limits, dBA

Receiving Property	Day	Night
Residential zoning (Class A EDNA)	60	50
Commercial zoning (Class B EDNA)	65	65
Industrial zoning (Class C EDNA)	70	70

Source: RMC 8.7.4, WAC 173.60

Factoria

The Factoria station is located within the City of Bellevue, which regulates sound emissions within City limits in Bellevue City Code (BCC) Chapter 9.18 (**Table N-45**). BCC adopts WAC sound level limits and applies land use zoning to EDNA classifications for properties. The site is zoned Industrial, which corresponds to Class C EDNA . Receiving properties adjacent to the site are Industrial and Commercial zoning (Class B EDNA). Residential properties (Class A EDNA) are located northeast of the site. Nighttime hours are defined between 10:00 p.m. and 7:00 a.m., 7 days a week.

Table N-45
Factoria Hourly Sound Level Limits, dBA

Receiving Property	Day	Night
Residential zoning (Class A EDNA)	60	50
Commercial zoning (Class B EDNA)	65	65
Industrial zoning (Class C EDNA)	70	70

Source: BCC Chapter 9.18

Shoreline

The Shoreline station, and all surrounding properties, are located within the City of Shoreline. The Shoreline Municipal Code (SMC) does not include sound level limits, only a nuisance ordinance codified in Chapter 9.05 (**Table N-46**). Therefore, the regulatory criteria would default to WAC limits, based on land use.

Table N-46
Shoreline Hourly Sound Level Limits, dBA

Receiving Property	Day	Night
Residential use (Class A EDNA)	60	50
Commercial use (Class B EDNA)	65	65
Industrial use (Class C EDNA)	70	70

Source: TMC Chapter 8.22, WAC 173.60

Increases to Existing Noise Condition

This section discusses the potential noise effects of proposed operational options. It is important to note that satisfaction of applicable noise ordinances do not, in itself, ensure the absence of noise impacts. It is possible for sound emissions to be below these prescribed limits and still disturb nearby properties. Therefore, it is common industry practice to also assess increases to existing noise conditions to predict the level of community annoyance from a project under review. **Table N-47** details criteria that were developed from U.S. Environmental Protection Agency (EPA) guidelines to analyze impacts (EPA 1973).

Table N-47
Noise Impact Criteria based on Increases to Existing Conditions

Impact Scale	Criteria and Description
None/Negligible	Existing sound levels at nearby noise-sensitive properties would experience little or no increase. Project sound emissions would be below regulatory thresholds.
Minor	Existing sound levels at nearby noise-sensitive properties would experience a minor increase of up to 5 dB, likely resulting in few noise complaints. Project sound emissions would be within or below regulatory thresholds. Mitigation measures would reduce potential adverse effects.
Moderate	Existing sound levels at nearby noise-sensitive properties would experience a moderate increase of up to 10 dB, likely resulting in more noise complaints. Mitigation measures would likely be necessary to reduce project sound emissions below regulatory thresholds and/or reduce adverse effects.
Major	Existing sound levels at nearby noise-sensitive properties would experience a major increase in excess of 10 dB, likely resulting in a substantial number of noise complaints. Mitigation measures would be necessary to reduce adverse effects, though non-compliance with regulatory thresholds and long-term increases to existing noise conditions would be expected.

Analysis

The intent of the noise screening process for this study is to compare the predicted site noise emissions based on the “worst case” condition from the traffic study concepts and criteria defined, both to assess regulatory compliance and increases to existing noise conditions that may constitute noise impacts.

Bow Lake

Results from the noise modeling for future conditions (2023) are shown in **Tables N-12** and **N-13**.

As shown in **Tables N-12** and **N-13**, regulatory compliance may require mitigation at the southern adjacent properties during the day and western adjacent properties at night. Mitigation measures could include a noise wall at the southwest corner or a mixture of operational restrictions, such as:

- Reducing weekday nighttime commercial haul to a maximum of six vehicles per hour
- Limit Saturday operations to the following:
  - Self-haul Garbage, 90 vehicles per hour
  - Self-haul Yard and Recycle, 23 vehicles per hour
  - Commercial haul, 6 vehicles per hour
  - Hauling trucks, 3 vehicles per hour

No noise impacts due to increasing the existing condition are expected since increases are all 5 dB or less.

Table N-48
Bow Lake Regulatory Compliance, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Predicted Sound Levels (Code limits)			
		North	West	East	South
Day	Weekday	53 (57)	54 (57)	54 (60)	**65 (60)**
	Saturday	49 (57)	50 (57)	53 (60)	**62 (60)**
Night	Weekday	47 (47)	**48 (47)**	51 (60)	60 (60)
	Saturday	46 (47)	47 (47)	51 (60)	60 (60)

Source: Transpo Group, The Greenbusch Group, Inc.

Table N-49
Bow Lake Increase to Existing, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Existing Sound Levels[1]		Future Sound Levels (increase to existing)[1,2]	
		Location A	Location B	Location A	Location B
Day	Weekday	63	68	65 (2)	69 (1)
	Saturday	62	65	65 (3)	68 (3)
Night	Weekday	61	64	65 (4)	67 (3)
	Saturday	62	67	65 (3)	67 (0)

1. Includes contributions from site and ambient noise sources, assessed at ambient monitoring locations.
2. Assumes no changes to existing ambient, such as increased traffic on local roadways and highways.

Source: Transpo Group, The Greenbusch Group, Inc.

Renton

Results from the noise modeling for future conditions (2023) are shown in **Tables N-14** and **N-15**.

Table N-50
Renton Regulatory Compliance, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Predicted Sound Levels (Code limits)			
		North	West	East	South
Day	Weekday	36 (65)	50 (60)	60 (70)	45 (60)
	Saturday	36 (65)	50 (60)	60 (70)	45 (60)
Night	Weekday	34 (65)	50 (50)	59 (70)	45 (50)
	Saturday	34 (65)	50 (50)	59 (70)	45 (50)

Source: Transpo Group, The Greenbusch Group, Inc.

Table N-51
Renton Increase to Existing, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Existing Sound Levels[1]		Future Sound Levels (increase to existing)[1,2]	
		Location A	Location B	Location A	Location B
Day	Weekday	56	61	56	61
	Saturday	54	56	54	56
Night	Weekday	50	62	50	62
	Saturday	54	57	54	57

1. Includes contributions from site and ambient noise sources, assessed at ambient monitoring locations.
2. Assumes no changes to existing ambient, such as increased traffic on local roadways and highways.

Source: Transpo Group, The Greenbusch Group, Inc.

As shown in **Tables N-14** and **N-15**, regulatory compliance is anticipated. One potential noise impact was identified due to increasing the existing condition during nighttime hours at Location A by 6 dB, which is likely due to the conservative modeling assumptions. However, it does reveal a potential noise sensitivity to nighttime operations at the Renton site.

Factoria

The highest anticipated utilizations of the Factoria station are a 215 percent increase in vehicles during the peak weekday hour (1:00 to 2:00 p.m.) and a 254 percent increase during the peak Saturday day hour (2:00 to 3:00 p.m.). These increases would result in an overall increase in site noise emissions of 3 dB for the weekday peak-hour and 4 dB for the Saturday peak-hour. This analysis assumes increased site activity is evenly distributed throughout the site, and not focused in particular areas.

Sound emission levels from operation of the facility currently under construction, once the facility is operational, are expected to be 44 dBA at nearby properties and result in no substantive increase to existing sound levels at nearby residential properties (HDR 2012). An increase of 4 dB (based on a 254 percent increase in hourly traffic) would result in a 48 dBA facility sound level, which complies with Code limits. This facility sound level would be expected to increase the cumulative sound level of the site and ambient environment of 54 dBA (HDR 2012) to 55 dBA, 1 dB increase. This is less than the 5 dB threshold for anticipated noise effects, therefore mitigation would not be warranted.

Shoreline

Results from the noise modeling for future conditions (2023) are shown in **Tables N-16** and **N-17**.

As shown in **Tables N-16** and **N-17**, regulatory compliance may require mitigation at the northern adjacent properties during the night. Mitigation measures could include extending the existing noise wall 30 to 40 feet west or closing roll up doors on the northwest side transfer station building.

No noise impacts due to increasing the existing condition are expected since increases are all 5 dB or less.

Table N-52
Shoreline Regulatory Compliance, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Predicted Sound Levels (Code limits)			
		North	West	East	South
Day	Weekday	51 (60)	52 (60)	46 (60)	39 (60)
	Saturday	51 (60)	52 (60)	44 (60)	38 (60)
Night	Weekday	**52 (50)**	47 (50)	46 (50)	38 (50)
	Saturday	49 (50)	46 (50)	43 (50)	36 (50)

Source: Transpo Group, The Greenbusch Group, Inc.

Table N-53
Shoreline Increase to Existing, Peak-Hour Maximum Traffic – 2023

Time Period	Day Period	Existing Sound Levels[1]		Future Sound Levels (increase to existing)[1,2]	
		Location A	Location B	Location A	Location B
Day	Weekday	57	65	57	65
	Saturday	54	64	54	64
Night	Weekday	60	62	60	62
	Saturday	57	63	57	63

1. Includes contributions from site and ambient noise sources, assessed at ambient monitoring locations.
2. Assumes no changes to existing ambient, such as increased traffic on local roadways and highways.

Source: Transpo Group, The Greenbusch Group, Inc.

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Air Quality

This report presents the air quality analysis for King County's Transfer Plan update. It addresses the transportation elements only, as these are unique for each station by concept; air quality associated with solid waste and landfills is not included, as this does not change between concepts. This report describes how air quality is measured and categorized, and discusses appropriate regulatory criteria, the expected effects of the Transfer Plan update, and potential mitigation measures. This report includes evaluation of existing year 2014 and design year 2023 concepts. Only Concept 0 is evaluated for this update, as this concept incorporates a redistribution of disposal, thereby affecting traffic patterns. Four stations are evaluated for air quality: Factoria, Renton, Shoreline, and Bow Lake. Each of these is evaluated with and without Renton being open.

Existing Air Quality

Air quality in the project area is regulated by the U.S. Environmental Protection Agency (EPA), the Washington State Department of Ecology (Ecology), and Puget Sound Clean Air Agency (PSCAA). Under the Clean Air Act (CAA) and its amendments (CAAA), EPA has established the National Ambient Air Quality Standards (NAAQS), which specify maximum concentrations for carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), ozone (O_3), sulfur oxides (SO_x), lead (Pb), and nitrogen dioxide (NO_2). Current Washington State Ambient Air Quality Standards are established in the Washington Administrative Code (WAC) Title 173. The federal standards (NAAQS) were adopted in December 2013, per WAC 173-476. Federal and state standards for the four pollutants relevant to vehicular emissions (CO, PM_{10}, $PM_{2.5}$, and O_3) are listed in **Table A-54**.

Nonattainment areas are geographic regions where air pollutant concentrations exceed the NAAQS for a pollutant. Air quality maintenance areas are regions that have recently attained compliance with the NAAQS. The project study area is located in the Central Puget Sound region which is currently considered a maintenance area for CO and ozone (see **Figure A-50**). Air quality emissions in the region are currently being managed under the provisions of the State Implementation Plan (SIP), which has adopted the Central Puget Sound Area CO maintenance plan (FR 1996a) and the ozone maintenance plan for the Seattle-Tacoma Puget Sound Area (FR 1996b); these plans were updated on August 5, 2004, when EPA approved the Central Puget Sound Area 2nd 10-year CO/ozone maintenance plan (69 FR 47365).

Ozone is considered a "regional" pollutant, with emissions directly at the source and effects occurring at considerable distances from emission sources due to complex atmospheric reactions (with precursor pollutants, such as hydrocarbons [HC] and nitrogen oxides [NO_x]) and prevailing meteorological conditions. Therefore, emissions of ozone and its reactive precursors from the Central Puget Sound area can contribute to ambient concentrations recorded at monitoring locations throughout the region. Other air quality effects, such as odor, fugitive dust, and CO from vehicle traffic are more localized in nature. The air quality analysis for Transfer Plan update only addresses the transportation portion of air emissions. On a regional level, there are little to no changes in emissions between the Concept 0 options, as traffic is only being redistributed. Therefore, the air quality study area is local near-field effects, defined as the immediate vicinity (i.e., within 1-mile) of the scenario routes for the four solid waste facilities included in this air quality analysis.

Table A-54
Ambient Air Quality Standards

Pollutant	Averaging Time	Level	Remarks
Particulate Matter Less than or Equal to 2.5 micrometers in Diameter ($PM_{2.5}$)	Annual	12.0 µg/m^3	Annual mean, averaged over 3 years.
	24-hour	35 µg/m^3	98th percentile, averaged over 3 years.
Particulate Matter Less than or Equal to 10 micrometers in Diameter (PM_{10})	24-hour	150 µg/m^3	Not to be exceeded more than once per year averaged over 3 years.
Ozone (O_3)	8-hour	0.075 ppmv (147 µg/m^3)	Annual fourth highest daily maximum 8-hr concentration, averaged over 3 years.
Carbon Monoxide (CO)	8-hour	9 ppmv (10 mg/m^3)	Not to be exceeded more than once per year.
	1-hour	35 ppmv (40 mg/m^3)	

Notes:
mg/m^3 = milligrams per cubic meter.
µg/m^3 = micrograms per cubic meter.
ppbv = parts per billion by volume.
ppmv = parts per million by volume.

Source: EPA 40 CFR Part 50 (http://www.epa.gov/air/criteria.html) and WAC Chapter 173-476 (http://www.ecy.wa.gov/laws-rules/ecywac.html#air)

Historically, concentrations of CO have exceeded the NAAQS in the Central Puget Sound area. Ozone levels have remained fairly stable; however, the ozone NAAQS has been lowered (and is expected to be revised lower again in the near future). Therefore, concentrations have more recently exceeded the NAAQS. Consequently, these two pollutants are of concern in the project area. High ozone concentrations may occur at locations downwind of the source of the pollutants; therefore, emissions control strategies must address sources in the entire Central Puget Sound area. In contrast, high CO volumes are more localized and are strongly influenced by emissions of CO from nearby vehicles. The maintenance plans for both pollutants (see above) focus on reducing emissions from vehicles, reducing the total miles traveled by vehicles in the area, and (more specifically for CO) reducing congestion conditions. Any regionally significant transportation project in these areas must conform to the SIP. Conformity is demonstrated by showing that the project would not cause or contribute to any new violation of any NAAQS, would not increase the frequency or severity of any existing violation of any NAAQS, or would not delay timely attainment of the NAAQS. Puget Sound Regional Council (PSRC) is the local Metropolitan Planning Organization (MPO) responsible for coordinating the regional transportation processes, including performing regional conformity assessments.

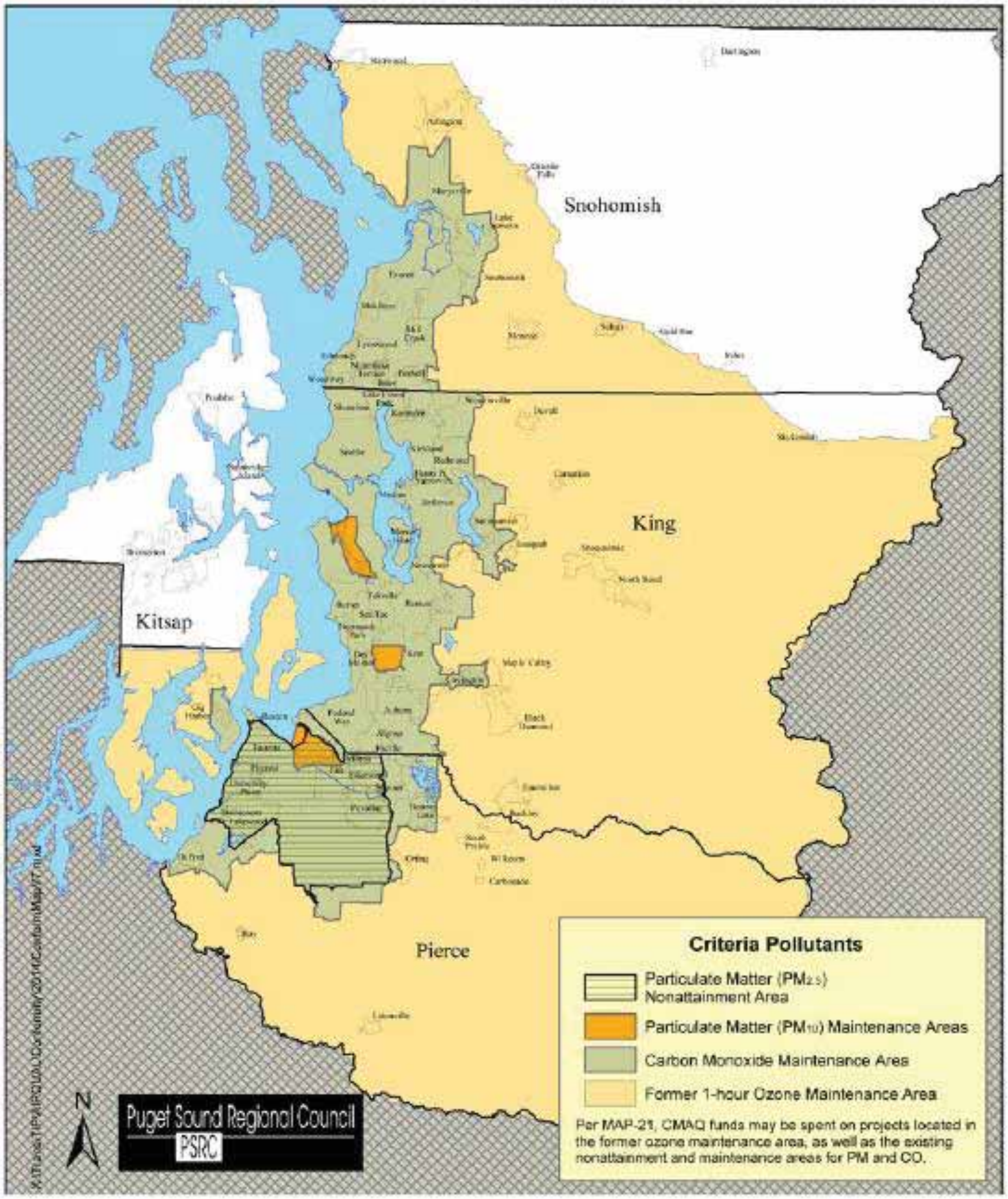

Figure A-50
Current Central Puget Sound Region Designated Maintenance and Nonattainment Areas
Puget Sound Regional Council, February 2014 (http://www.psrc.org/assets/11904/Designated-Maint-Nonattain-Areas-201402.pdf)

Methodology

Proposed projects must meet conformity rules on a regional level and on a localized (i.e., project) level. The facility locations included this Transfer Plan update analysis lie within the CO and O_3 maintenance area and must comply with the project-level conformity criteria of the EPA Conformity Rule. As discussed earlier, regional emissions should not be affected by the Transfer Plan update, as Concept 0 only redistributes traffic. Therefore, it is expected to meet conformity on a regional basis. In addition, because Concept 0 is not expected to have an effect on regional emissions, no evaluations are made for Mobile Source Area Toxics (MSAT) or greenhouse gases (GHG); these pollutants are expected to be unaffected by the Transfer Plan update.

To meet conformity at a localized or project level, a project must not cause or contribute to a new violation of the NAAQS, increase the severity of an existing violation, or delay timely attainment or maintenance of the standards. To determine whether a proposed project meets project-level conformity, traffic levels at local intersections must be examined. A hot-spot analysis is required if the project is forecast to increase intersection-level traffic and degrade the intersection performance. A hot-spot analysis may involve air quality modeling to determine whether a project meets the NAAQS.

Traffic data for the No-Build and Build Alternatives for existing year 2014 (No-Build only), and design year 2023 is provided in **Attachment H** of the Traffic Section. Based on this data/report, 'critical intersections' near the facilities were evaluated by level-of-service (LOS) and volume-to-capacity ratio (v/c) to assess the need for hot-spot analyses. Typically, evaluations are not required for intersections LOS C or better.

Environmental Consequences

Table A-55 lists intersection operations (LOS and v/c) by each facility (Factoria, Renton, Shoreline, and Bow Lake) for Concept 0. The table is also broken out by weekday and Saturday operations.

All of the intersections associated with the Factoria station show LOS C or better for each scenario. Therefore, no hot-spot analysis would be required to demonstrate compliance with the CO standards. In addition, these intersections show no change in LOS due to Concept 0, except for an LOS improvement (C to B) for Intersection 1 (Richards Rd / Lake Hills Connector).

For the Renton station, Intersection 2 (I-405 SB Ramps / SR900 / Maple Valley Hwy / SR 169) shows LOS D for the future weekday operation, and LOS E for the future Saturday operation, without the project and for Concept 0. There are no differences in LOS or v/c between the future without the project or for Concept 0. Intersection 3 (SR 900 / NE 3rd St) shows similar results, with LOS E for both weekday and Saturday future operations, and no differences in LOS or v/c between the future without the project, or for Concept 0. Intersection 5 (Duvall Ave NE / NE 4th St) shows LOS D for Saturday future operations without the project and for Concept 0. The v/c for Concept 0 is slightly higher than without the project (0.87 vs. 0.86). This minor difference is expected to have no impact on air quality between the alternatives.

For the Shoreline station, Intersections 3 (I-5 NB Ramps / N 175th St) and 7 (5th Ave NE / NE 145th St) show LOS D for both the existing and future Saturday operations. There are no differences in LOS or v/c between the future without the project or for Concept 0.

The four intersections associated with the Bow Lake station show LOS of E or F for all future (2023) weekday operation alternatives (without project and for Concept 0). One of these, Intersection 3 (Orillia

Rd S / S 188th St, which is unsignalized), shows a future LOS of F for all future operation alternatives. There are no differences in LOS, and only minor differences in v/c between the future without the project and for Concept 0. These minor differences are expected to have no impact on air quality between the alternatives.

Although increased vehicle density is expected to create potential intersection congestion in future years, vehicle emission improvements are expected to create an overall decrease in emissions. Traffic associated with the transfer stations would be a small percentage of total regional traffic. In addition, the geographic dispersion of stations in King County already minimizes the potential for transfer vehicles to adversely affect air quality at any one intersection. In summary, the King County Transfer Plan would not cause or contribute to any violation of the NAAQS for CO. The project would not cause significant adverse air quality impacts.

The King County Transfer Plan would meet air quality conformity criteria, as discussed earlier; no operational air quality mitigation would be required. There is no construction associated with this project; therefore, no construction or equipment emission control measures would be required.

Table A-55
Intersection Data

Table A-2
Intersection Operations

Intersection	Weekday								Saturday							
	2014		2023						2014							
	Existing		Without Project		Concept 0 With Renton		Concept 0 Without Renton		Existing		Without Project		Concept 0 With Renton		Concept 0 Without Renton	
	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio	LOS	V/C Ratio
RENTON																
1. I-405 NB Ramps / Maple Valley Hwy / SR 169	B	0.40	C	0.65	C	0.65	–	–	B	0.39	B	0.55	B	0.55	–	–
2. I-405 SB Ramps / SR 900 / Maple Valley Hwy / SR 169	C	0.78	D	0.98	D	0.98	–	–	D	0.85	E	1.01	E	1.01	–	–
3. SR 900 / NE 3rd St	D	0.74	E	0.91	E	0.91	–	–	D	0.81	E	0.97	E	0.97	–	–
4. Jefferson Ave NE / NE 3rd St	A	0.45	B	0.54	B	0.54	–	–	B	0.51	B	0.61	B	0.61	–	–
5. Duvall Ave NE / NE 4th St	C	0.55	C	0.66	C	0.66	–	–	C	0.71	D	0.86	D	0.87	–	–
SHORELINE																
1. Meridian Ave N / N 175th St	C	0.60	C	0.61	C	0.61	C	0.61	C	0.70	C	0.72	C	0.72	C	0.72
2. I-5 SB Ramps / N 175th St	B	0.54	B	0.55	B	0.56	B	0.56	B	0.57	B	0.57	B	0.58	B	0.58
3. I-5 NB Ramps / N 175th St	B	0.56	B	0.58	B	0.58	B	0.58	D	0.87	D	0.89	D	0.89	D	0.89
4. Meridian Ave N / N 165th St (unsignalized)	B	–	B	–	B	–	B	–	B	–	B	–	B	–	B	–
5. Meridian Ave N / N 145th St	A	0.35	A	0.36	A	0.36	A	0.36	A	0.44	A	0.45	A	0.46	A	0.46
6. SB Ramps / N 145th St	C	0.64	C	0.65	C	0.65	C	0.65	B	0.86	B	0.87	B	0.88	B	0.88
7. 5th Ave NE / NE 145th St	C	0.80	C	0.82	C	0.82	C	0.82	D	1.06	D	1.09	D	1.09	D	1.09
BOW LAKE																
1. I-5 SB Ramps / S 188th St	B	0.36	E	1.04	E	1.06	E	1.06	B	0.36	B	0.68	B	0.71	B	0.74
2. I-5 NB Ramps / S 188th St	B	0.51	E	1.33	E	1.35	E	1.36	B	0.54	B	0.74	B	0.76	C	0.78
3. Orilla Rd S / S 188th St (unsignalized)	D	–	F	–	F	–	F	–	C	–	F	–	F	–	F	–
4. Orilla Rd S / S 200th St	C	0.52	F	1.13	F	1.14	F	1.14	B	0.33	C	0.71	C	0.71	C	0.72
FACTORIA																
1. Richards Rd / Lake Hills Connector	B	0.52	B	0.61	B	0.61	B	0.61	B	0.41	C	0.39	B	0.48	B	0.48
2. Richards Rd / SE 26th St	B	0.46	B	0.54	B	0.56	B	0.56	B	0.38	B	0.45	B	0.49	B	0.49
3. Richards Rd / SE 32nd St	A	0.39	A	0.45	A	0.52	A	0.54	A	0.36	A	0.43	A	0.55	A	0.57
4. Richards Rd / SE Eastgate Way	B	0.57	B	0.65	B	0.66	B	0.66	B	0.61	C	0.72	C	0.73	C	0.73
5. Factoria Blvd SE / I-90 EB Ramp	C	0.78	C	0.99	C	0.84	C	0.85	C	0.70	C	0.84	C	0.94	C	0.95
6. Factoria Blvd SE / Coal Creek Pkwy SE	B	0.47	B	0.54	B	0.54	B	0.55	B	0.68	C	0.82	C	0.82	C	0.83
7. 148th Ave SE / Eastgate Way	C	0.68	C	0.78	C	0.79	C	0.79	C	0.61	C	0.72	C	0.74	C	0.74

Note: v/c info not available for unsignalized intersections.

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