Stantec

SR 520 Bridge Traffic and Revenue Study 2018 Report

March 26, 2019

Prepared for:

WSDOT Toll Division

Prepared by:

Stantec Consulting Services Inc.

Sign-off Sheet

This document entitled SR 520 Bridge Traffic and Revenue Study 2018 REPORT was prepared by Stantec Consulting Services Inc. ("Stantec") for the account of WSDOT Toll Division (the "Client"). Any reliance on this document by any third party is strictly prohibited. The material in it reflects Stantec's professional judgment in light of the scope, schedule and other limitations stated in the document and in the contract between Stantec and the Client. The opinions in the document are based on conditions and information existing at the time the document was published and do not take into account any subsequent changes. In preparing the document, Stantec did not verify information supplied to it by others. Any use which a third party makes of this document is the responsibility of such third party. Such third party agrees that Stantec shall not be responsible for costs or damages of any kind, if any, suffered by it or any other third party as a result of decisions made or actions taken based on this document.

Prepared by _____
(signature)

Reviewed by _____
(signature)

Approved by _____
(signature)

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Stantec Consulting Services Inc. ("Stantec") has been retained by the Washington State Department of Transportation (WSDOT) to conduct a Traffic and Revenue (T&R) study for the existing SR 520 bridge across Lake Washington near Seattle in the Central Puget Sound Region. The study includes forecasts of traffic and gross toll revenue potential for fiscal years 2019 through 2056.

1.1 STUDY PURPOSE

The purpose of this study is to develop an updated traffic and gross toll revenue potential forecast to support ongoing SR 520 traffic and revenue needs after the final SR 520 bond sale. This effort has been conducted on an annual basis since 2012, first by CDM Smith while they served as Traffic Consultant to WSDOT for this facility, and by Stantec beginning in fall of 2017. Stantec's 2017 forecast was based on detailed transaction information for the first half of Fiscal Year (FY) 2017, supplemented by preliminary detailed data for the second half of the fiscal year. Fiscal years run from July 1st through June 30th. Additionally, the 2017 forecast considered a revised bridge configuration with the funding of the SR 520 West Side improvements, revised closure schedule, revised economic forecast, revised toll rate schedule, and exemption policy formally adopted by the Washington State Transportation Commission (WSTC) in May 2016.

Stantec's efforts for this 2018 study included building upon our 2017 effort by collecting recent data from available sources, evaluating the current traffic conditions and revenue collected on the bridge, refining and calibrating a travel forecasting model for the project, reviewing future year model networks, and preparing a gross potential T&R stream. This 2018 study incorporated actual traffic and revenue data through September 2018.

As part of Stantec's on-call T&R contract with WSDOT, BERK Consulting (BERK) was retained to provide an independent review of the regional economic forecasts in the Central Puget Sound region. Their most recent update to this review, completed in September 2018, was used in this study.

1.2 ORGANIZATION OF THE REPORT

The remainder of this report is organized in the following chapters:

- Chapter 2.0 – Project Description and Historical Performance: This chapter describes the study corridor, its current configuration, and its role in the highway network. It also discusses the project history in terms of its configuration changes, toll policy and actual traffic and revenue.
- Chapter 3.0 – Existing Conditions: This chapter gives an overview of the existing traffic conditions on SR 520 and summarizes the travel conditions in the corridor in terms of traffic volumes, classification data, travel speeds, and current payment shares.
- Chapter 4.0 – Socioeconomic Variables and Land Use: This chapter describes the socioeconomic projections used to develop the traffic forecasts, and an assessment of the region's economy and future development in the study area.

- Chapter 5.0 – Model Development and Calibration: This chapter explains the modeling methodology used to produce the traffic and gross toll revenue potential forecasts. It includes a discussion of the regional travel demand model and the toll diversion model.
- Chapter 6.0 – Traffic and Gross Toll Revenue Potential Forecast: This chapter presents the long-range traffic and gross toll revenue potential forecasts for the SR 520 bridge, as well as the assumptions and methodology used to prepare the forecasts.

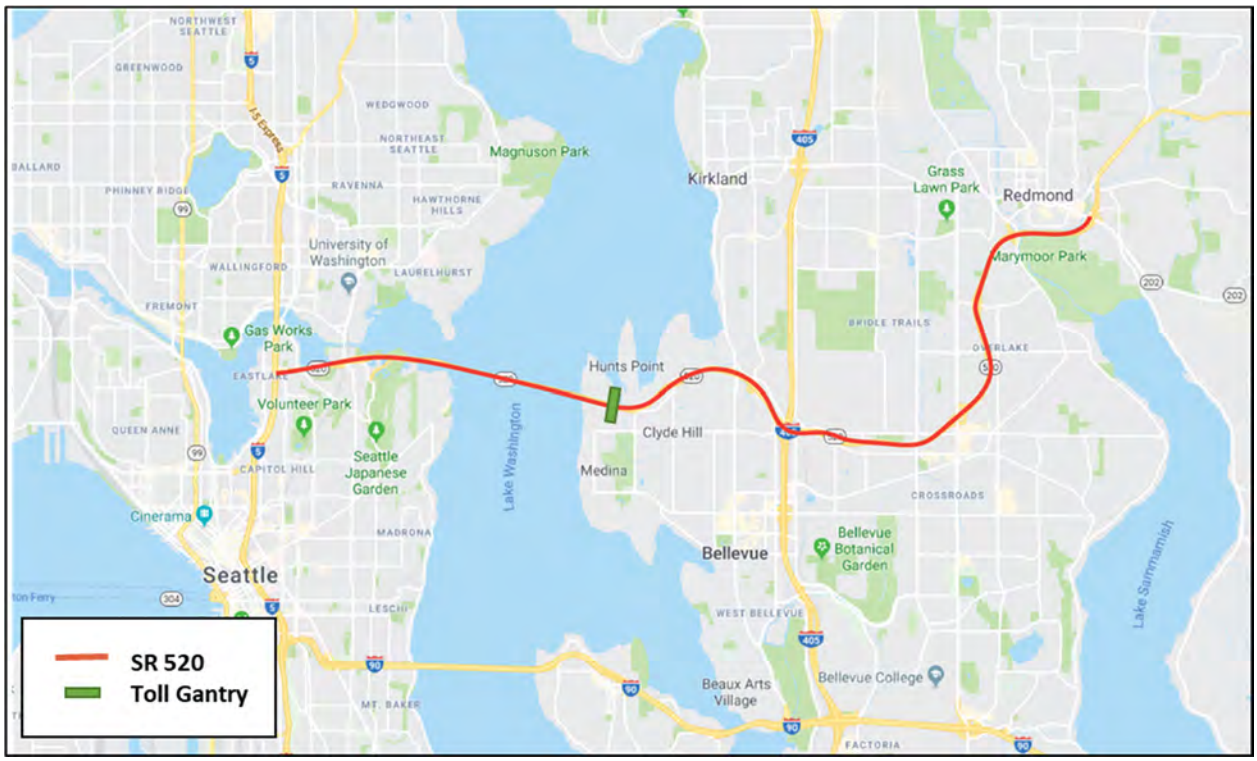
2.0 PROJECT DESCRIPTION AND HISTORICAL PERFORMANCE

This chapter provides an overview of the SR 520 project, as well as the description of the WSDOT's SR 520 Bridge Replacement and HOV Program, and details of the existing and future configuration of the facility. The historical toll rates and traffic and gross toll revenue potential are also discussed.

2.1 PROJECT CORRIDOR

SR 520 extends about 13 miles between I-5 in the west, over Lake Washington, and SR 202 in the east. it has a major interchange with I-405 on the east side of the Lake. The facility provides a vital highway link between Seattle on the west side of Lake Washington and the eastside communities including Bellevue, Kirkland and Redmond. Figure 2-1 shows the location of SR 520 in the Seattle area. Tolls in both directions for crossing the floating bridge portion of the facility crossing Lake Washington are collected on the east side of the bridge via electronic tolling. The purpose of this study is to update the future toll traffic and gross toll revenue potential forecasts based on the most recent data available.

Figure 2-1: SR 520 Location Map



2.2 SR 520 BRIDGE REPLACEMENT AND HOV PROGRAM

WSDOT is making major enhancements to the SR 520 Bridge Replacement and HOV Program between I-5 and I-405. The program is improving traffic safety by replacing SR 520's aging and vulnerable bridges, while making other key highway improvements to enhance public mobility and transportation options throughout the corridor. The portion of SR 520 that is part of the SR 520 Bridge Replacement and HOV Program is highlighted in Figure 2-2.

Figure 2-2: SR 520 Bridge Replacement and HOV Program

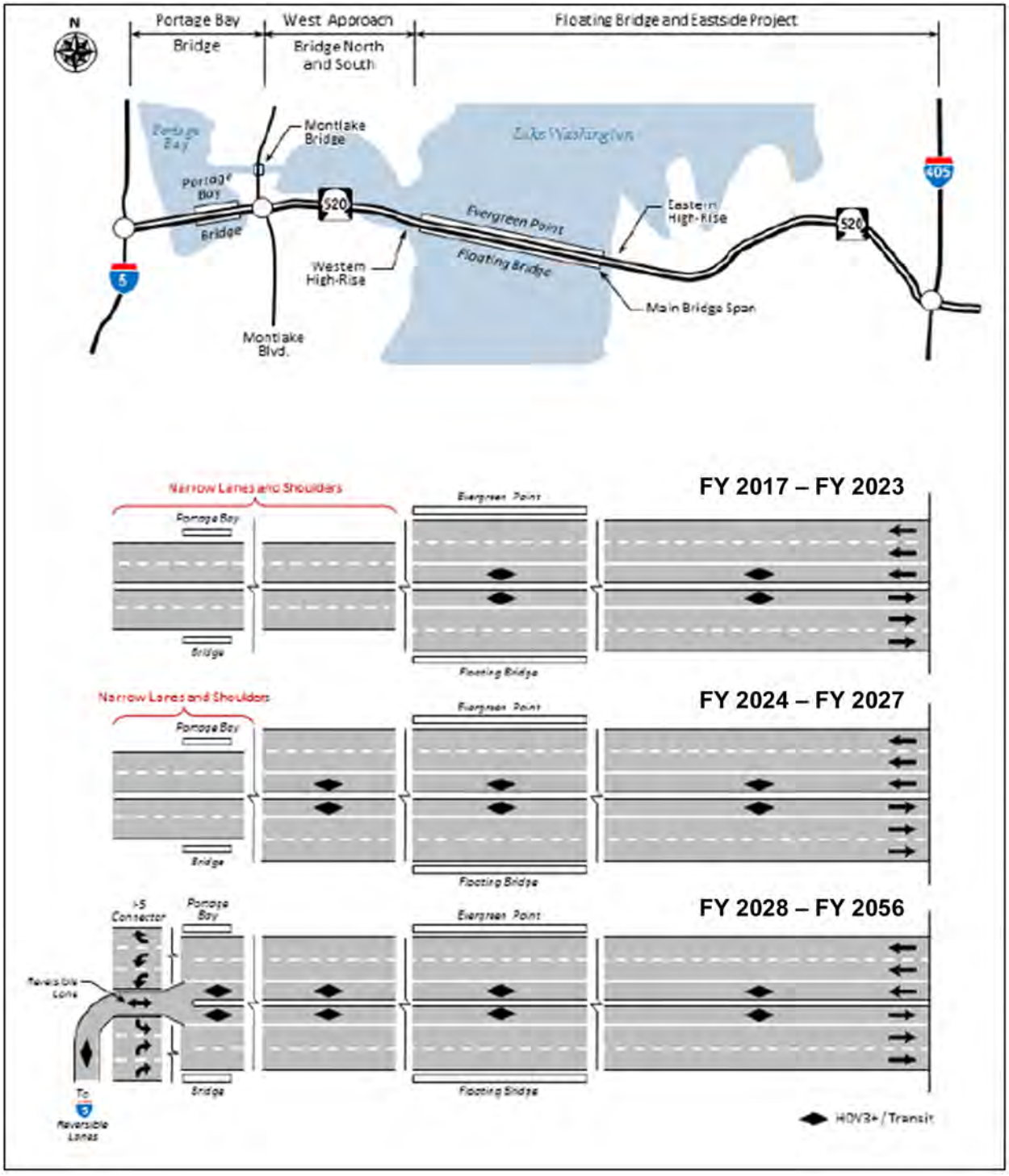
The SR 520 Bridge Replacement and HOV Program consists of five major components:

- The Pontoon Construction (complete),
- The Eastside Transit and HOV Project (complete),
- The Floating Bridge and Landings Project (complete),
- The West Approach Bridge North (complete), and
- The I-5 to Lake Washington (“Rest of the West”), including the West Approach Bridge South, the new Portage Bay Bridge and the second Montlake Boulevard bascule bridge across the Montlake Cut.

These improvements include: a new, safer, six-lane floating bridge, with a cross-lake bicycle and pedestrian path; 77 bridge pontoons built at facilities in Grays Harbor and Tacoma; the corridor's Eastside transit and HOV improvements between Lake Washington and I-405; the north (westbound) half of a new west approach bridge connecting Seattle to the new floating bridge (WABN); a replacement West Approach Bridge South for eastbound traffic connecting Seattle to the new floating bridge; a second Montlake Boulevard bascule bridge over the Montlake Cut; a new, six-lane Portage Bay Bridge; an extension of a regional bicycle and pedestrian path from Montlake to I-5; and mitigation of the program's environmental impacts.

Figure 2-3 shows the timeline of improvements used in this study. The timeline shows the configuration of the roadway that will be in place in each year. As shown, the roadway configuration of the floating bridge and the area to the east of the floating bridge have no changes planned at this time. West of this area, an additional HOV lane in each direction is scheduled to be constructed by FY 2024 and extended by FY 2028. Planned construction closures through 2026 are presented in Section 6.2.1 of this report.

Figure 2-3: SR 520 Bridge Replacement and HOV Program Construction Assumptions



2.3 SR 520 BRIDGE TOLLING HISTORY

2.3.1 Toll Rate History

Tolling on the original SR 520 bridge began in both directions on December 29, 2011 to supplement funding for the construction of the new floating bridge which opened in April 2016. Tolls vary by time of day and by weekday and weekend, but not by direction. Two primary toll payment methods are available: a *Good To Go!* prepaid account which detects the customer via a pass or license plate recognition, and Pay By Mail in which the vehicle's registered owner name and address are identified from the license plate and mailed a toll bill. There is no cash toll collection. The Washington State Transportation Commission (WSTC) has approved and implemented six separate toll increases since tolling began. These increases commenced on July 1, which is the start of each Fiscal Year (FY), of every year between 2013 and 2018. No further toll increases are planned at this time; the current toll rates are assumed to be in effect through the forecast period. Table 2.1 and Table 2.2 show the directional weekday *Good to Go!* and Pay by Mail passenger car toll schedules in effect from FY 2012 onward. Table 2.3 and Table 2.4 show the directional weekend *Good to Go!* and Pay by Mail passenger car toll schedules in effect from FY 2012 onward. The weekday *Good to Go!* passenger car rates are also shown in Figure 2-4.

Table 2.1: SR 520 Weekday 2-Axle Toll Schedule - *Good to Go!* Rates, Each Direction, FY 2012 to Future

Time Period	Actual and Planned Rate Assumptions	5-6 AM	6-7 AM	7-9 AM	9-10 AM	10AM-2PM	2-3 PM	3-6 PM	6-7 PM	7-9 PM	9-11 PM	11PM-5AM
FY 2012	Opening Rates	$1.60	$2.80	$3.50	$2.80	$2.25	$2.80	$3.50	$2.80	$2.25	$1.60	$0.00
FY 2013	+2.5% (No Rounding)	$1.64	$2.87	$3.59	$2.87	$2.31	$2.87	$3.59	$2.87	$2.31	$1.64	$0.00
		+2.5%	*+2.5%*	*+2.6%*	*+2.5%*	*+2.7%*	*+2.5%*	*+2.6%*	*+2.5%*	*+2.7%*	*+2.5%*	
FY 2014	+2.5% Nickel Rounding	$1.70	$2.95	$3.70	$2.95	$2.35	$2.95	$3.70	$2.95	$2.35	$1.70	$0.00
		+3.7%	*+2.8%*	*+3.1%*	*+2.8%*	*+1.7%*	*+2.8%*	*+3.1%*	*+2.8%*	*+1.7%*	*+3.7%*	
FY 2015	+2.5% Nickel Rounding	$1.75	$3.00	$3.80	$3.00	$2.40	$3.00	$3.80	$3.00	$2.40	$1.75	$0.00
		+2.9%	*+1.7%*	*+2.7%*	*+1.7%*	*+2.1%*	*+1.7%*	*+2.7%*	*+1.7%*	*+2.1%*	*+2.9%*	
FY 2016	+2.5% Nickel Rounding	$1.80	$3.10	$3.90	$3.10	$2.45	$3.10	$3.90	$3.10	$2.45	$1.80	$0.00
		+2.9%	*+3.3%*	*+2.6%*	*+3.3%*	*+2.1%*	*+3.3%*	*+2.6%*	*+3.3%*	*+2.1%*	*+2.9%*	
FY 2017	+5.0% Nickel Rounding	$1.90	$3.25	$4.10	$3.25	$2.55	$3.25	$4.10	$3.25	$2.55	$1.90	$0.00
		+5.6%	*+4.8%*	*+5.1%*	*+4.8%*	*+4.1%*	*+4.8%*	*+5.1%*	*+4.8%*	*+4.1%*	*+5.6%*	
FY 2018 and After	+5.0% and Night Tolling with Nickel Rounding	$2.00	$3.40	$4.30	$3.40	$2.70	$3.40	$4.30	$3.40	$2.70	$2.00	$1.25
		+5.3%	*+4.6%*	*+4.9%*	*+4.6%*	*+5.9%*	*+4.6%*	*+4.9%*	*+4.6%*	*+5.9%*	*+5.3%*	

Note: Fiscal Year (FY) is defined as the 12-month period ending June 30 of that year. For example, FY 2013 refers to the 12-month period beginning July 1, 2012 and ending June 30, 2013.

Table 2.2: SR 520 Weekday 2-Axle Toll Schedule - Pay by Mail Rates, Each Direction, FY 2012 to Future

Time Period	Actual and Planned Rate Assumptions	5-6 AM	6-7 AM	7-9 AM	9-10 AM	10AM-2PM	2-3 PM	3-6 PM	6-7 PM	7-9 PM	9-11 PM	11PM-5AM
FY 2012	Opening Rates	$3.10	$4.30	$5.00	$4.30	$3.75	$4.30	$5.00	$4.30	$3.75	$3.10	$0.00
FY 2013	+2.5% (No Rounding)	$3.18	$4.41	$5.13	$4.41	$3.84	$4.41	$5.13	$4.41	$3.84	$3.18	$0.00
		+2.6%	*+2.6%*	*+2.6%*	*+2.6%*	*+2.4%*	*+2.6%*	*+2.6%*	*+2.6%*	*+2.4%*	*+2.6%*	
FY 2014	+2.5% Nickel Rounding	$3.25	$4.50	$5.25	$4.50	$3.95	$4.50	$5.25	$4.50	$3.95	$3.25	$0.00
		+2.2%	*+2.0%*	*+2.3%*	*+2.0%*	*+2.9%*	*+2.0%*	*+2.3%*	*+2.0%*	*+2.9%*	*+2.2%*	
FY 2015	+2.5% Nickel Rounding	$3.35	$4.60	$5.40	$4.60	$4.05	$4.60	$5.40	$4.60	$4.05	$3.35	$0.00
		+3.1%	*+2.2%*	*+2.9%*	*+2.2%*	*+2.5%*	*+2.2%*	*+2.9%*	*+2.2%*	*+2.5%*	*+3.1%*	
FY 2016	+2.5% Nickel Rounding	$3.45	$4.70	$5.55	$4.70	$4.15	$4.70	$5.55	$4.70	$4.15	$3.45	$0.00
		+3.0%	*+2.2%*	*+2.8%*	*+2.2%*	*+2.5%*	*+2.2%*	*+2.8%*	*+2.2%*	*+2.5%*	*+3.0%*	
FY 2017	Good To Go! Toll Rates + $2.00 PBM increment	$3.90	$5.25	$6.10	$5.25	$4.55	$5.25	$6.10	$5.25	$4.55	$3.90	$0.00
		+13.0%	*+11.7%*	*+9.9%*	*+11.7%*	*+9.6%*	*+11.7%*	*+9.9%*	*+11.7%*	*+9.6%*	*+13.0%*	
FY 2018 and After	Good To Go! Toll Rates + $2.00 PBM increment	$4.00	$5.40	$6.30	$5.40	$4.70	$5.40	$6.30	$5.40	$4.70	$4.00	$3.25
		+2.6%	*+2.9%*	*+3.3%*	*+2.9%*	*+3.3%*	*+2.9%*	*+3.3%*	*+2.9%*	*+3.3%*	*+2.6%*	

Note: Fiscal Year (FY) is defined as the 12-month period ending June 30 of that year. For example, FY 2013 refers to the 12-month period beginning July 1, 2012 and ending June 30, 2013.

Table 2.3: SR 520 Weekend 2-Axle Toll Schedule-*Good to Go!* Rates, Each Direction, FY 2012 to Future

Time Period	Actual and Planned Rate Assumptions	5-8 AM	8-11 AM	11AM-6PM	6-9 PM	9-11 PM	11PM-5AM
FY 2012	Opening Rates	$1.10	$1.65	$2.20	$1.65	$1.10	$0.00
FY 2013	+2.5% (No Rounding)	$1.13	$1.69	$2.26	$1.69	$1.13	$0.00
		+2.7%	*+2.4%*	*+2.7%*	*+2.4%*	*+2.7%*	
FY 2014	+2.5% Nickel Rounding	$1.15	$1.75	$2.30	$1.75	$1.15	$0.00
		+1.8%	*+3.6%*	*+1.8%*	*+3.6%*	*+1.8%*	
FY 2015	+2.5% Nickel Rounding	$1.20	$1.80	$2.35	$1.80	$1.20	$0.00
		+4.3%	*+2.9%*	*+2.2%*	*+2.9%*	*+4.3%*	
FY 2016	+2.5% Nickel Rounding	$1.25	$1.85	$2.40	$1.85	$1.25	$0.00
		+4.2%	*+2.8%*	*+2.1%*	*+2.8%*	*+4.2%*	
FY 2017	+5.0% Nickel Rounding	$1.30	$1.95	$2.50	$1.95	$1.30	$0.00
		+4.0%	*+5.4%*	*+4.2%*	*+5.4%*	*+4.0%*	
FY 2018 and After	+5.0% and Night Tolling with Nickel Rounding	$1.40	$2.05	$2.65	$2.05	$1.40	$1.25
		+7.7%	*+5.1%*	*+6.0%*	*+5.1%*	*+7.7%*	

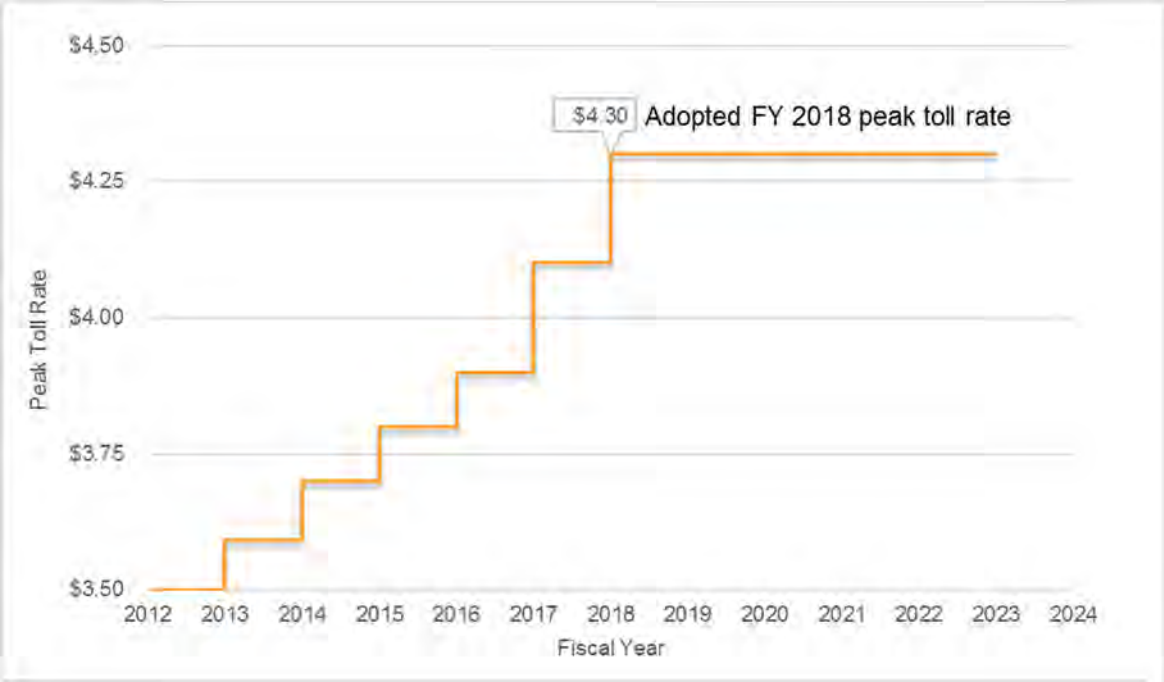
Table 2.4: SR 520 Weekend 2-Axle Toll Schedule-Pay by Mail Rates, Each Direction, FY 2012 to Future

Time Period	Actual and Planned Rate Assumptions	5-8 AM	8-11 AM	11AM-6PM	6-9 PM	9-11 PM	11PM-5AM
FY 2012	Opening Rates	$2.60	$3.15	$3.70	$3.15	$2.60	$0.00
FY 2013	+2.5% (No Rounding)	$2.67	$3.23	$3.79	$3.23	$2.67	$0.00
		+2.7%	*+2.5%*	*+2.4%*	*+2.5%*	*+2.7%*	
FY 2014	+2.5% Nickel Rounding	$2.75	$3.30	$3.90	$3.30	$2.75	$0.00
		+3.0%	*+2.2%*	*+2.9%*	*+2.2%*	*+3.0%*	
FY 2015	+2.5% Nickel Rounding	$2.80	$3.40	$4.00	$3.40	$2.80	$0.00
		+1.8%	*+3.0%*	*+2.6%*	*+3.0%*	*+1.8%*	
FY 2016	+2.5% Nickel Rounding	$2.85	$3.50	$4.10	$3.50	$2.85	$0.00
		+1.8%	*+2.9%*	*+2.5%*	*+2.9%*	*+1.8%*	
FY 2017	Good To Go! Toll Rates + $2.00 PBM increment	$3.30	$3.95	$4.50	$3.95	$3.30	$0.00
		+15.8%	*+12.9%*	*+9.8%*	*+12.9%*	*+15.8%*	
FY 2018 and After	Good To Go! Toll Rates + $2.00 PBM increment	$3.40	$4.05	$4.65	$4.05	$3.40	$3.25
		+3.0%	*+2.5%*	*+3.3%*	*+2.5%*	*+3.0%*	

From FY 2013 through FY 2016, toll rates were increased by 2.5 percent per year; however, because rounding to the nearest $0.05 (nickel rounding) was instituted in FY 2014, the FY 2014 through FY 2016 rates vary slightly; some toll rates show increases slightly lower than 2.5 percent while others show increases slightly higher than 2.5 percent. In FY 2017 and 2018, *Good to Go!* rates were increased by 5 percent. Again, the actual increases were slightly different than the 5 percent because toll were rounded to the nearest nickel. Also beginning in FY 2017, the Pay by Mail rate is equal to the *Good to Go!* rate plus a $2.00 increment. The multi-axle vehicle toll rate is equal to the per-axle rate for 2-axle vehicles multiplied by the number of axles and then rounded to the nearest $0.05. The toll rate for a vehicle with more than six axles is 6-axle vehicle rate. As shown, overnight tolling, between 11 PM and 5 AM, began in FY 2018 on both weekdays and weekends.

The maximum *Good to Go!* 2-axle toll in the current toll schedule is $4.30 which is in effect on weekdays from 7 to 9 AM and from 3 to 6 PM, the peak commuting hours. The maximum weekend 2-axle *Good to Go!* toll is $2.65. Overnight tolls on both weekdays and weekends are lower; the *Good to Go!* 2-axle rate is $1.25.

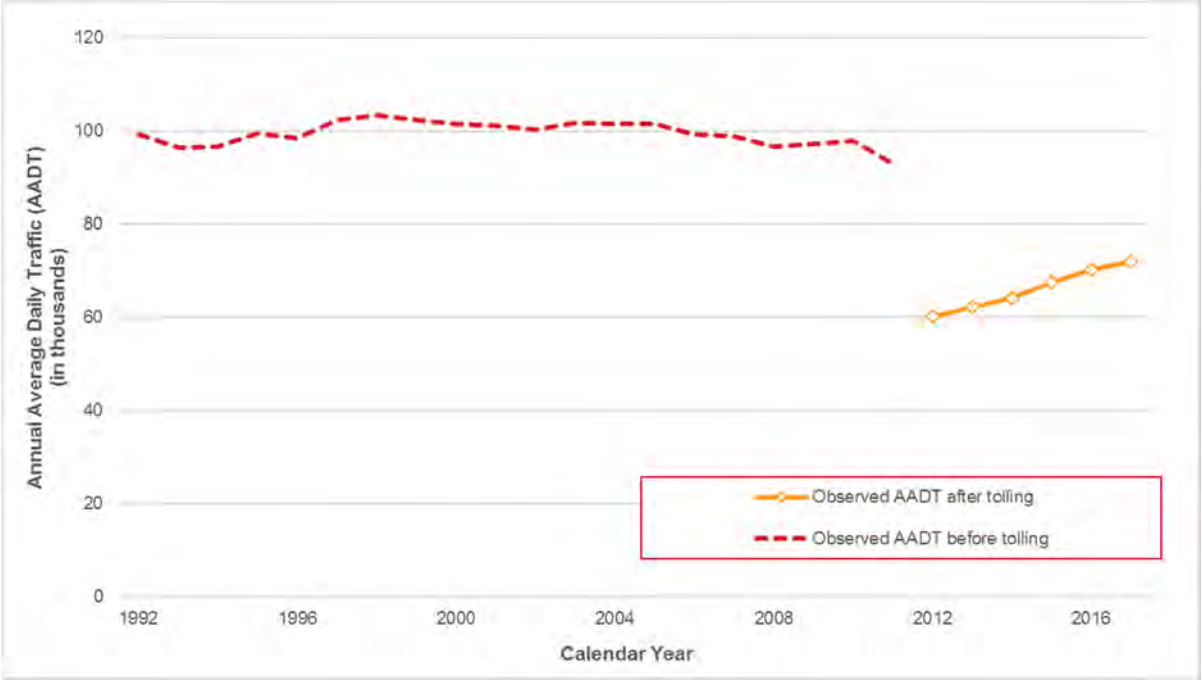
Figure 2-4: SR 520 2-Axle *Good to Go!* Weekday Maximum Toll Rate History, Each Direction



2.3.2 Traffic and Revenue History

Figure 2-5 shows the historical two-way AADT, by calendar year, on the SR 520 bridge. AADT is the Average Annual Daily Traffic and is equivalent to the total annual traffic (tolled and non-tolled) divided by the number of days in a given year. As shown, before tolling commenced, traffic was generally flat on SR 520; capacity constraints prevented traffic growth even through the region was growing in population and employment. Traffic did show a slight decrease in the late 2000's during the recession and the subsequent prolonged economic recovery. As shown, traffic decreased by about 36 percent when tolling commenced in December 2011; this number represents an estimate of the percent traffic diversion due to the implementation of tolling.

Figure 2-5: SR 520 Bridge Two-way Average Annual Daily Traffic (AADT), CY 1992 to 2017



Source: WSDOT's annual traffic reports

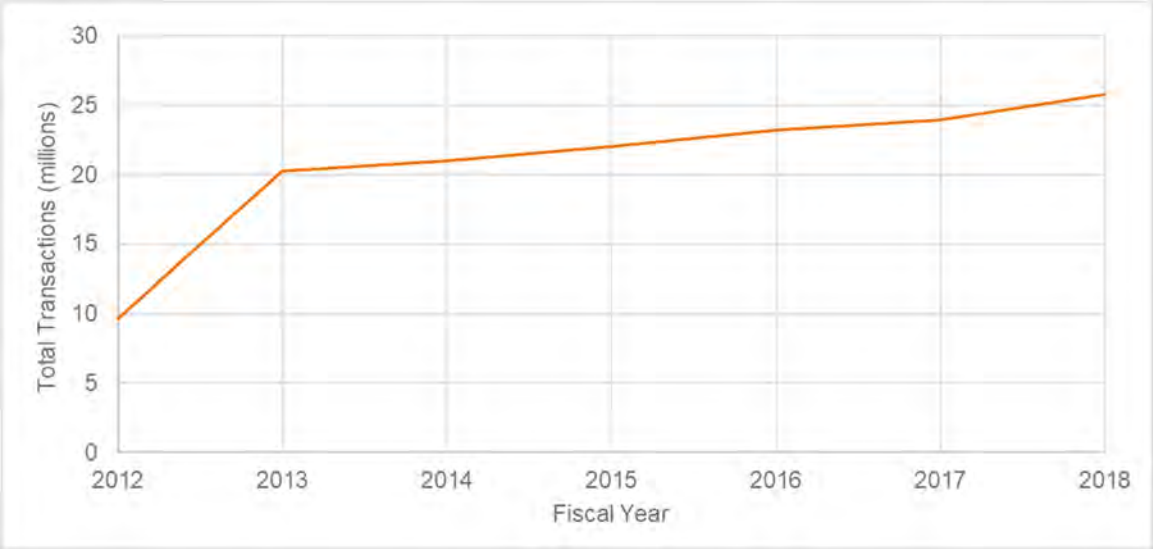
Table 2.5 and Figure 2-6 show the annual fiscal year transactions on SR 520, beginning when tolls commenced on December 29, 2011. Annual toll transactions have increased from 20.2 million transactions in FY 2013, the first full year of toll operations, to 25.8 million transactions in FY 2018, a total increase of 5.6 million or about 27.5 percent. Between FY 2017 and FY 2018, annual transactions increased by 7.6 percent, partially due to the start of overnight tolling at the start of FY 2018. Prior to overnight tolling, trips between the hours of 11PM and 5AM were not included in the toll transaction count.

Table 2.5: Historical Annual Toll Transactions and Gross Toll Revenues, FY2012 to 2018

Fiscal Year	Total Transactions (millions)	Gross Toll Revenue (millions)
2012	9.6	$28.1
2013	20.2	$61.3
2014	21.0	$64.6
2015	22.0	$69.4
2016	23.2	$75.0
2017	24.0	$81.9
2018*	25.8	$90.3

Note: Tolling started in December 29, 2011, half-way through FY2012.
*Prior to FY 2018, untolled trips between 11PM and 5AM were not included in the transaction total
Source: Annual Toll Traffic & Revenue (T&R) Reports (https://www.wsdot.wa.gov/Tolling/520/Finance.htm)

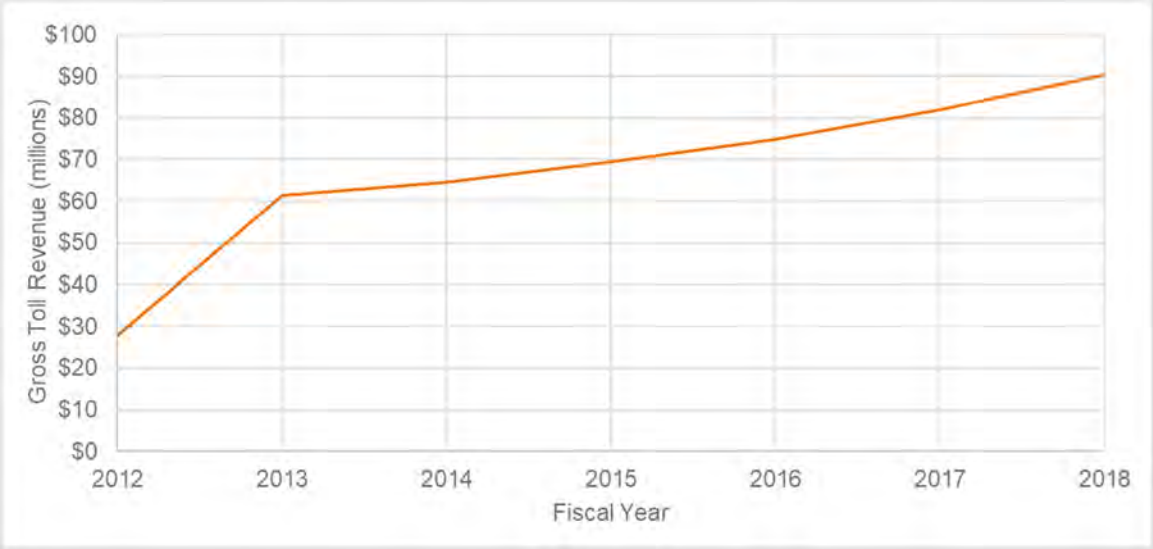
Figure 2-6: Historical SR 520 Bridge Two-way Toll Transactions, FY 2012 to 2018



Notes: Tolling started in December 29, 2011, half-way through FY2012.
Prior to FY 2018, untolled trips between 11PM and 5AM were not included in the transaction total
Source: Annual T&R reports (https://www.wsdot.wa.gov/Tolling/520/Finance.htm)

Table 2.5 and Figure 2-7 show the annual gross toll revenues on SR 520, beginning when tolls commenced on December 29, 2011. Annual toll revenues have increased from $61.3 million in the first full year of tolling, FY 2013, to $90.3 million in FY 2018, a total increase of 29.0 million or about 47.4 percent. Between FY 2017 and FY 2018, annual gross toll revenue increased by 10.3 percent.

Figure 2-7: Historical SR 520 Bridge Two-way Reported Gross Toll Revenues, FY 2012 to 2018



Notes: Tolling started in December 29, 2011, half-way through FY2012.
Prior to FY 2018, untolled trips between 11PM and 5AM were not included in the transaction total
Source: Annual T&R reports (https://www.wsdot.wa.gov/Tolling/520/Finance.htm)

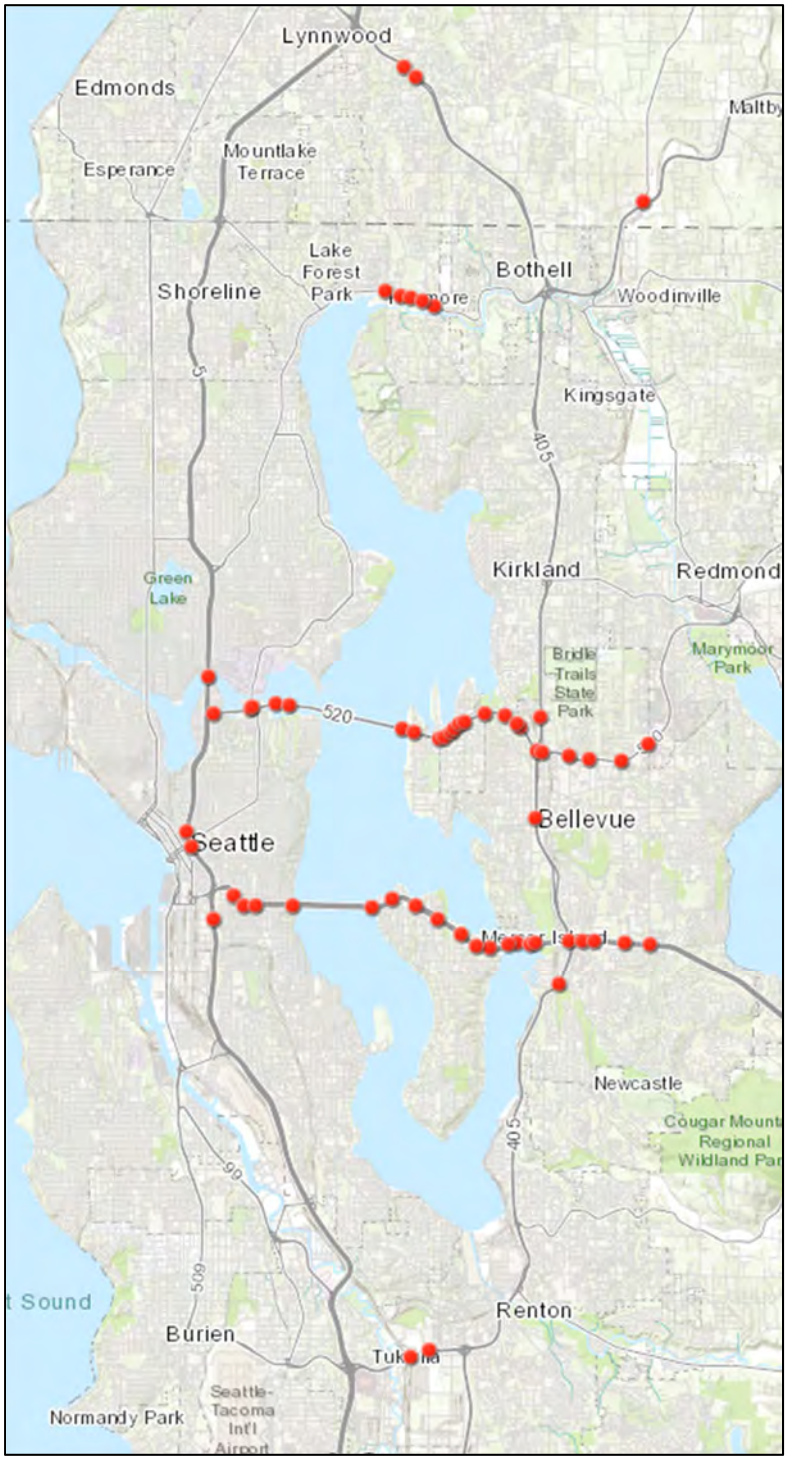
3.0 EXISTING CONDITIONS

The base model year for the project is 2018. As such, existing 2018 traffic data on SR 520 were used to calibrate corridor-specific volumes and speeds to the regional transportation model. Most of the data collection was focused on SR 520; however, screenline traffic counts along the main feeder and collector routes were summarized to support the model calibration in detailing the travel movements throughout the study area. This chapter details the existing traffic volumes and speeds along with the current payment shares on SR 520.

The focus of the traffic data summaries was to reflect typical weekday traffic on the SR 520 bridge, as well as critical parallel and feeder routes. The primary source for these data was the WSDOT network of permanent pavement loops that collect traffic and speed data on the major routes throughout the region. Stantec used the WSDOT data retrieval software, the Compact Disk Data Retrieval software (CDR), to access the data. The CDR software is used to download and analyze a designated subset of the data based on specific days, locations, and analysis options. Tuesday to Thursday volumes from February to April 2018 were summarized using the CDR software. Historic speeds were also summarized from the CDR software and were supplemented with publicly available data from the SigAlert website. SigAlert collects cell phone data to estimate real-time speeds along major traffic corridors throughout the United States and makes the data available online. Figure 3-1 shows the permanent count locations that were reviewed.

In addition, data were summarized from the Toll Customer Service Center (CSC) records for fiscal year FY 2018. These data were used to verify the count data from the permanent count locations and were used in both the calibration and the evaluation of recent trends on the facility. Furthermore, detailed transaction data from FY 2016 were used to determine the historical payment type splits on the SR 520 bridge. Payment splits by day of the week for FY 2018 were estimated based on a combination of overall FY 2018 payment type splits and the FY 2016 more detailed payment type splits.

Figure 3-1: SR 520 Study Area Permanent Count Locations

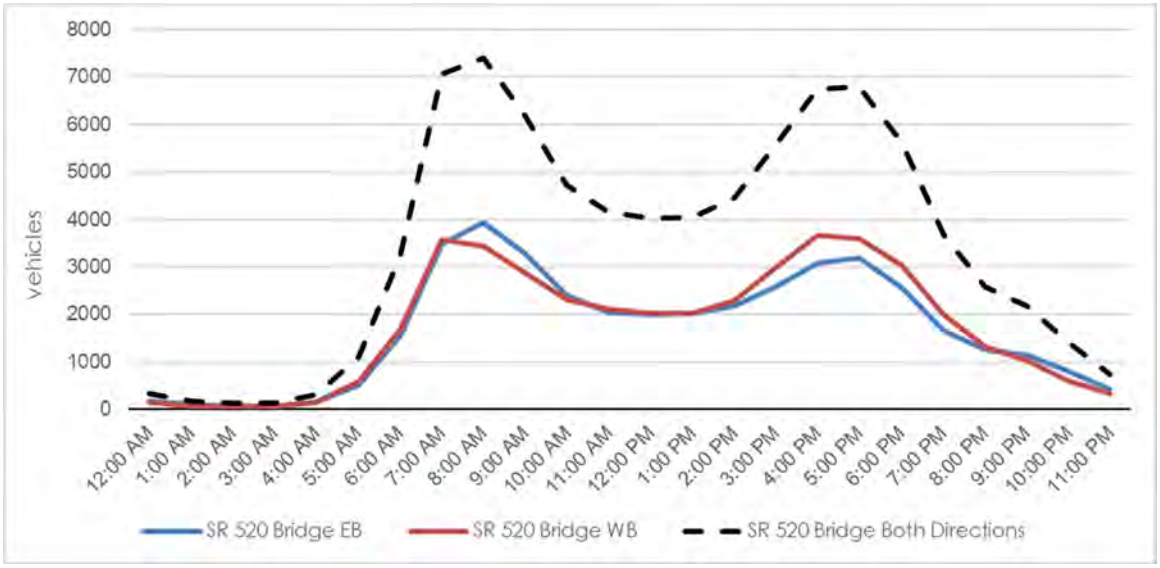


3.1 SR 520 BRIDGE TRAFFIC VOLUMES

3.1.1 Hourly Traffic Volumes on a Typical Weekday

The typical hourly traffic over the SR 520 bridge was calculated by averaging the non-holiday hourly traffic for available weekdays between February and April 2018. Data from WSDOT's permanent count location network were downloaded from the CDR site. Stantec considered the "validity of data" statistic which is a measure of quality/reliability for the reported data when summarizing the data. Holidays that were removed from Tuesday through Thursday data included the Fourth of July, Thanksgiving, and the day after Christmas. Figure 3-2 shows the traffic that travels over the SR 520 bridge on an average weekday (Tuesday through Thursday). The morning traffic peaks around 8:00 AM in the eastbound direction with about 3,900 vehicles per hour. In the westbound direction, morning traffic peaks slightly earlier around 7:00 AM, with roughly 3,600 vehicles per hour. In the afternoon, eastbound traffic peaks around 5:00 PM with around 3,200 vehicles per hour, while westbound traffic again peaks slightly earlier, around 4:00 PM, with roughly 3,700 vehicles per hour. AM and PM peak period volumes do not differ drastically by direction. In the westbound direction, AM and PM peak volumes are similar, while in the Eastbound direction, the AM peak is somewhat higher than the PM peak hour volume. The bridge carries an average of 83,000 vehicles per weekday, with just over 40,000 vehicles in each direction.

Figure 3-2: Typical Tuesday to Thursday (Weekday) SR 520 Bridge Traffic, by Direction, February to April 2018



Source: Tuesday-Thursday CDR data, February – April 2018

3.1.2 Toll Transaction Volumes by Day of the Week

Table 3.1 shows the summarized annual CSC toll transaction data by day of the week for FY 2017 and FY 2018. Note that these data for FY 2017 do not include overnight transactions as tolls were not collected during the overnight hours in FY 2017. These summaries also are not adjusted for the times when the bridge was impacted by construction. Since overnight volumes tend to be very low and the number of days affected by construction are also low when considering all the days of the year, these data do serve to approximate the distribution of traffic volumes crossing the SR 520 bridge by day. As shown, traffic crossing the bridge is much lower over the weekend than on a

weekday. Sunday is the least traveled day while Wednesday and Thursday are the most traveled days of the week. Monday is the least traveled weekday. FY 2018 shows an increase in the portion of transactions attributed to Saturdays and Sundays, which can be attributed to the inclusion of overnight transactions beginning in FY 2018.

Table 3.1: SR 520 Bridge Annual Toll Transactions by Day of the Week, FY 2017 and 2018

Day of Week	FY 2017 - Transactions		FY 2018 - Transactions	
	Day Total	Percent of Annual	Day Total	Percent of Annual
Mon	3,487,827	14.2%	3,732,475	14.2%
Tue	4,010,255	16.4%	4,188,587	16.0%
Wed	4,083,324	16.7%	4,315,592	16.5%
Thu	4,112,242	16.8%	4,333,789	16.5%
Fri	4,009,340	16.4%	4,263,261	16.3%
Sat	2,619,712	10.7%	2,989,326	11.4%
Sun	2,162,516	8.8%	2,380,340	9.1%
Total	**24,485,216**	**100%**	**26,203,370**	**100%**

Source: CSC data for FY 2017 and FY 2018. Note that these data for FY 2017 do not include overnight transactions as overnight toll collection was not in effect in FY 2017.

3.1.3 Toll Transactions by Month

Table 3.2 shows the historical toll transactions by month since the bridge began tolling in December 2011. The amount of toll transactions each month is affected by factors including construction closures, weather events, traffic events, and the number of weekdays and weekend days each month. In addition, toll transactions prior to FY 2018 do not include overnight transactions, as overnight toll collection was not in effect prior to FY 2018. These summaries also are not adjusted for the times when the bridge was impacted by construction and it is assumed that these data also serve to approximate the distribution of traffic volumes crossing the SR 520 bridge by month. As shown by the percentages, traffic crossing the bridge tends to be generally lower in the winter months than the summer months.

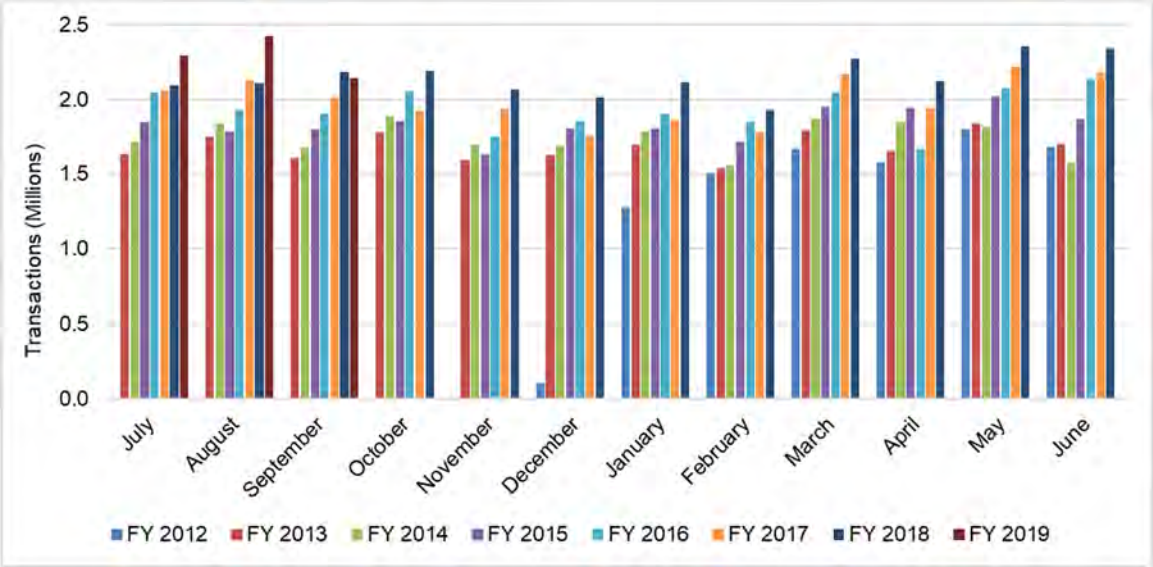
Table 3.2: SR 520 Bridge Total Toll Transactions in Both Directions by Month, FY 2012 to FY 2019

Month	FY 2012	FY 2013		FY 2014		FY 2015		FY 2016		FY 2017		FY 2018		FY 2019
	Monthly Transactions	Monthly Transactions	Percent of Annual	Monthly Transactions	Percent of Annual	Monthly Transactions	Percent of Annual	Monthly Transactions	Percent of Annual	Monthly Transactions	Percent of Annual	Monthly Transactions	Percent of Annual	Monthly Transactions
Jul		1,634,862	8.1%	1,714,340	8.2%	1,845,510	8.4%	2,047,488	8.8%	2,058,224	8.6%	2,092,864	8.1%	2,291,708
Aug		1,748,279	8.6%	1,843,593	8.8%	1,785,013	8.1%	1,931,941	8.3%	2,129,472	8.9%	2,106,767	8.2%	2,421,851
Sep		1,605,673	7.9%	1,672,627	8.0%	1,796,980	8.2%	1,901,386	8.2%	2,013,952	8.4%	2,181,021	8.5%	2,143,861
Oct		1,780,703	8.8%	1,891,073	9.0%	1,853,706	8.4%	2,053,773	8.8%	1,920,209	8.0%	2,193,259	8.5%	
Nov		1,595,208	7.9%	1,698,416	8.1%	1,632,066	7.4%	1,749,637	7.5%	1,937,514	8.1%	2,063,777	8.0%	
Dec	101,620	1,627,330	8.0%	1,692,471	8.1%	1,804,291	8.2%	1,853,500	8.0%	1,758,571	7.3%	2,009,346	7.8%	
Jan	1,275,306	1,697,451	8.4%	1,782,226	8.5%	1,804,665	8.2%	1,901,672	8.2%	1,860,068	7.8%	2,116,081	8.2%	
Feb	1,505,263	1,537,817	7.6%	1,555,759	7.4%	1,714,604	7.8%	1,849,759	8.0%	1,780,747	7.4%	1,929,376	7.5%	
Mar	1,667,299	1,794,438	8.9%	1,871,405	8.9%	1,949,255	8.9%	2,046,140	8.8%	2,172,872	9.1%	2,275,483	8.8%	
Apr	1,579,205	1,651,778	8.2%	1,848,497	8.8%	1,940,953	8.8%	1,667,332	7.2%	1,941,236	8.1%	2,122,191	8.2%	
May	1,800,544	1,843,724	9.1%	1,816,370	8.7%	2,021,484	9.2%	2,075,349	8.9%	2,216,001	9.2%	2,355,439	9.1%	
Jun	1,679,936	1,703,339	8.4%	1,572,796	7.5%	1,871,243	8.5%	2,139,023	9.2%	2,185,913	9.1%	2,339,752	9.1%	
Annual	**9,609,173**	**20,220,602**	**100%**	**20,959,573**	**100%**	**22,019,770**	**100%**	**23,217,000**	**100%**	**23,974,779**	**100%**	**25,785,356**	**100%**	

Note: Overnight tolling began FY 2018. FY 2012 is a partial year as tolling began in December 2012. At the time of this report, data were only available through September of FY 2019.

Figure 3-3 shows the monthly trends in toll transactions since opening. As shown, the trend is generally increasing each year for each month. Note that transaction volumes prior to FY 2018 do not include overnight transactions. Overnight tolling began at the start of FY 2018.

Figure 3-3: SR 520 Bridge Total Toll Transactions in Both Directions by Month, FY 2012 to FY 2019



Notes: Tolling began in December 29, 2011 (FY 2012). Overnight tolling began FY 2018. At the time of this report, data were only available through September of FY 2019.

3.1.4 Heavy Vehicle Classification

Vehicle classification data from the permanent count recorders were also summarized for Tuesdays, Wednesdays, and Thursdays from February to April 2018. The recorders classify the vehicles into four categories based on the vehicle length. For calibration purposes, Stantec used this to represent the distribution of vehicles across the bridge. Table 3.3 shows the vehicle length distribution by direction and time period. Vehicles categorized into the 42.1'-72.0' and 72.1'-115.0' bins were considered heavy vehicles. As shown, heavy vehicles represent a small portion of the traffic on SR 520. The highest percentages of heavy vehicles occurs during the overnight period (11 PM through 5 AM) in both the eastbound and the westbound direction, with 3.1 percent and 3.6 percent respectively.

Table 3.3: SR 520 Bridge Average Tuesday to Thursday Weekday Shares of Heavy Vehicle Longer than 42 feet[1]

Direction	AM (5-9am)	MD (9am-3pm)	PM (3-6pm)	EV (6-11pm)	ON (11pm-5am)	Daily
EB	2.6%	2.4%	2.4%	2.3%	3.1%	2.5%
WB	3.3%	2.2%	2.8%	1.5%	3.6%	2.5%

[1]Vehicles that are more than 42 feet long are considered heavy vehicles.
Source: Tuesday-Thursday CDR data, February – April 2018

SR 520 tolls are categorized by the number of axles. As shown in Table 3.4, summarized Tuesday through Thursday toll transaction data from the Customer Service Center for full FY 2018 showed that heavy vehicles with more than 2-axles represented 1.9 to 3.6 percent of the total vehicles crossing the bridge in both directions. While the two data

sources classified heavy vehicles using different parameters, both indicated that the heavy vehicle usage percentage was less than three percent of total daily traffic. CSC data for full FY 2018 average Tuesday through Thursday suggests its closer to 2 percent of daily traffic.

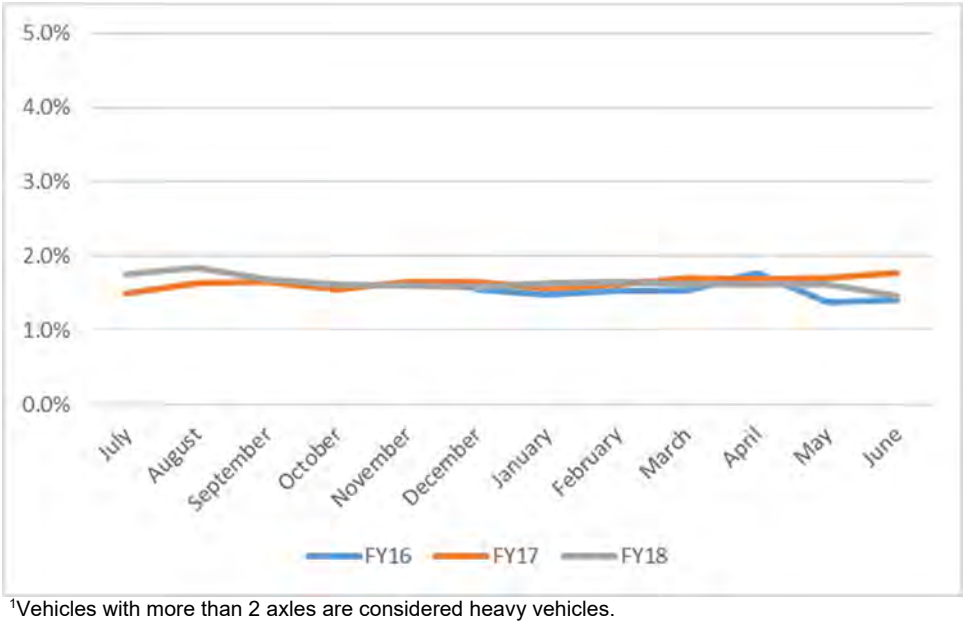
Table 3.4: FY 2018 SR 520 Bridge Average Tuesday to Thursday Weekday Shares of Heavy Vehicle with More Than 2 Axles[1]

Direction	AM (5-9am)	MD (9am-3pm)	PM (3-6pm)	EV (6-11pm)	ON (11pm-5am)	Daily
Both Directions	2.4%	2.2%	1.9%	1.4%	3.6%	2.0%

[1]Vehicles with more than 2 axles are considered heavy vehicles.
Source: Total eastbound and westbound directions; CSC data, FY 2018

Heavy vehicles as a percent of overall toll traffic on SR 520 are presented in Figure 3-4. This graph was developed by compiling the monthly raw CSC estimates of 24 axle classification counts, and shows that although there is some monthly fluctuation in heavy vehicle share, the percentage has continued to be around 1.6 percent of traffic for most of FY 2016, FY 2017 and FY 2018. This percentages shown in this Figure are slightly lower than the percentages presented in Table 3.3 and Table 3.4 because these include all days of the week, not just Tuesday through Thursday.

Figure 3-4: SR 520 Bridge Share in Both Directions of Monthly Toll Transactions that are Heavy Vehicles with More Than 2 Axles[1]



[1]Vehicles with more than 2 axles are considered heavy vehicles.
Source: Total eastbound and westbound directions; CSC data, FY 2018

3.2 SCREENLINE TRAFFIC VOLUMES

To understand the distribution of traffic and regional traffic trends around the Puget Sound region, traffic volume data were summarized along five screenlines, as shown in Figure 3-5. The most important screenline in terms of understanding the travel behavior on the SR 520 bridge is Screenline 1, which accounts for traffic crossing the Lake Washington screenline. Table 3.5 summarizes the daily volumes at each of the screenline locations by direction. As shown, I-90 carries about 33 percent of the daily traffic across the Lake Washington screenline while SR 520 carries about 17 percent of this traffic for both eastbound and westbound direction. Data for these summaries was derived from the CDR data site and the WSDOT online geoportal count data site. Volumes were summarized for Tuesdays, Wednesdays, and Thursdays from February to April 2018.

Figure 3-5: Screenline Location Map

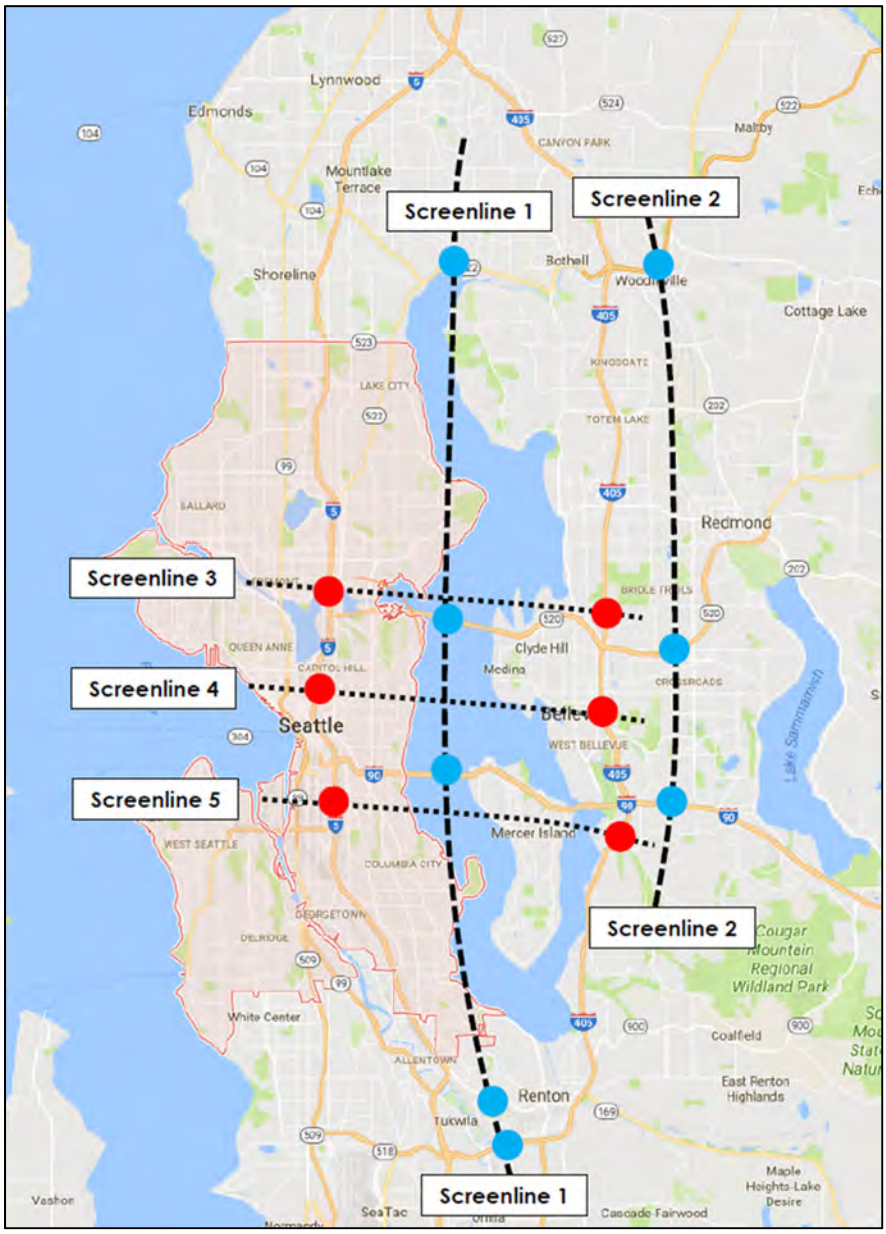


Table 3.5: Average Tuesday to Thursday (Weekday) Daily Traffic Volumes by Direction by Screenline, February to April 2018

Screenline	Facility	Daily Traffic Volume			
		Northbound/Eastbound		Southbound/Westbound	
		Obs	%Share	Obs	%Share
1: Lake Washington	SR 522 at 68th Ave NE	17,442	7%	22,879	9%
	SR 520/Evergreen Point Floating Bridge	40,711	17%	42,045	17%
	I-90/Murrow Memorial Bridge	81,154	33%	83,773	33%
	SR 900 East of I-5	15,000	6%	15,000	6%
	I-405 East of SR 181	88,609	36%	88,919	35%
	Total	**242,916**	**100%**	**252,617**	**100%**
2: East of I-405	SR 522	26,357	15%	28,505	17%
	SR 520	63,772	37%	60,264	36%
	I-90	82,078	48%	77,484	47%
	Total	**172,208**	**100%**	**166,253**	**100%**
3: North of SR-520	I-5	102,126	51%	102,148	50%
	I-405	98,535	49%	100,148	50%
	Total	**200,661**	**100%**	**202,296**	**100%**
4: Between SR-520 and I-90	I-5	102,323	54%	122,795	61%
	I-405	87,092	46%	79,423	39%
	Total	**189,415**	**100%**	**202,218**	**100%**
5: South of I-90	I-5	105,778	57%	131,520	65%
	I-405	80,603	43%	72,127	35%
	Total	**186,381**	**100%**	**203,648**	**100%**

Source: Tuesday-Thursday CDR data, Feb – April 2018

Table 3.6 summarizes the Screenline 1 traffic volumes by time period and by direction. The SR 520 share in the eastbound direction is greatest (compared to itself in other time periods of the day) in the AM period (21 percent) while the I-90 share is also greatest in the eastbound direction during the AM period (37 percent). The SR 520 share in the westbound direction is greatest in the PM period (21 percent) while the I-90 share in the westbound direction is greatest during the AM period (36 percent).

Table 3.6: Average Tuesday to Thursday (Weekday) Daily Traffic Volumes by Direction by Time Period, Screenline 1, February to April 2018

Facility	Northbound/Eastbound											
	AM (6:00 to 9:00)		MD (9:00 to 3:00)		PM (3:00 to 6:00)		EV (6:00 to 10:00)		NI (10:00 to 6:00)		DAILY	
	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share
SR 522 at 68th Ave NE	3,444	8%	5,840	7%	4,182	8%	2,500	7%	1,476	5%	17,442	7%
SR 520/Evergreen Point Floating Bridge	8,962	21%	13,917	18%	8,860	17%	5,502	15%	3,471	11%	40,711	17%
I-90/Murrow Memorial Bridge	15,682	37%	26,031	33%	18,930	36%	11,958	33%	8,554	26%	81,154	33%
SR 900 East of I-5	2,962	7%	5,023	6%	3,596	7%	2,150	6%	1,269	4%	15,000	6%
I-405 East of SR 181	11,505	27%	27,988	36%	16,695	32%	14,638	40%	17,784	55%	88,609	36%
Total	**42,554**	**100%**	**78,799**	**100%**	**52,263**	**100%**	**36,747**	**100%**	**32,553**	**100%**	**242,916**	**100%**

Facility	Southbound/Westbound											
	AM (6:00 to 9:00)		MD (9:00 to 3:00)		PM (3:00 to 6:00)		EV (6:00 to 10:00)		NI (10:00 to 6:00)		DAILY	
	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share	Obs	% Share
SR 522 at 68th Ave NE	4,565	9%	7,826	9%	4,931	10%	3,250	9%	2,307	7%	22,879	9%
SR 520/Evergreen Point Floating Bridge	8,705	17%	13,644	16%	10,265	21%	6,369	18%	3,062	9%	42,045	17%
I-90/Murrow Memorial Bridge	18,277	36%	27,563	33%	17,440	35%	11,760	33%	8,733	27%	83,773	33%
SR 900 East of I-5	2,993	6%	5,131	6%	3,233	7%	2,130	6%	1,512	5%	15,000	6%
I-405 East of SR 181	16,587	32%	29,390	35%	13,809	28%	11,860	34%	17,273	53%	88,919	35%
Total	**51,127**	**100%**	**83,555**	**100%**	**49,679**	**100%**	**35,369**	**100%**	**32,887**	**100%**	**252,617**	**100%**

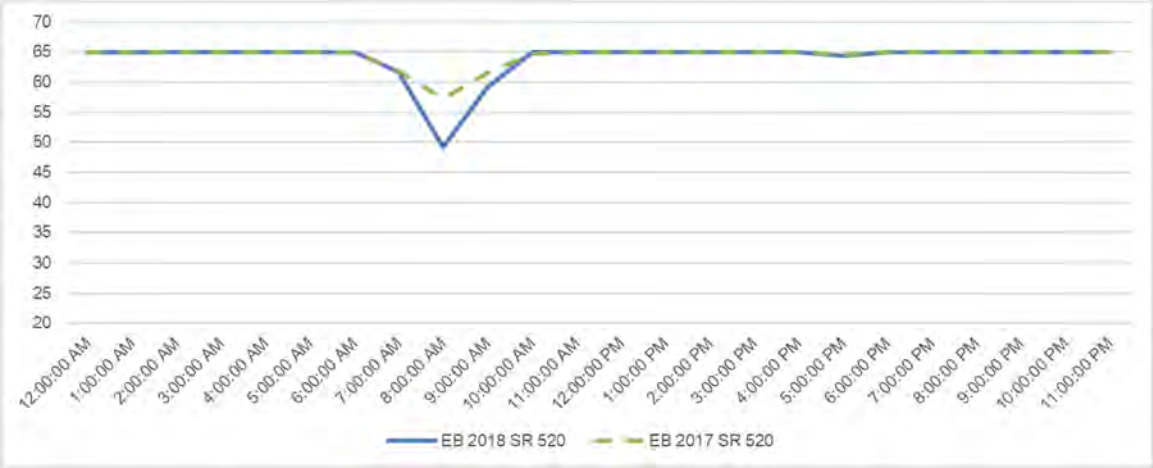
Source: Tuesday-Thursday CDR data, Feb – April 2018

3.3 TRAVEL SPEEDS

3.3.1 SR 520 Bridge Travel Speeds

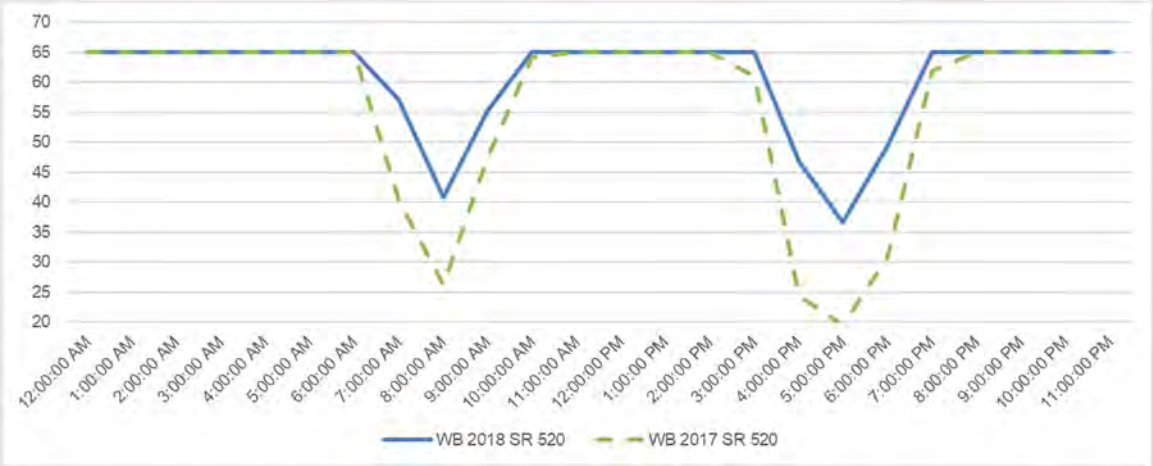
Figure 3-6 and Figure 3-7 show the hourly travel speed profile by direction of travel for a typical Tuesday to Thursday weekday for vehicles traveling across the SR 520 bridge. The speed profile is the summarized speed measure from the CDR site for the Tuesdays, Wednesdays, and Thursdays from February to April 2017 and 2018. Westbound traffic generally experiences lower speeds than the eastbound traffic during peak periods. In the westbound direction, average AM peak period speeds slow to about 40 mph in the AM period and to about 35 mph in the PM peak period. In the eastbound direction, average AM peak period speeds slow to about 50 mph in the AM period, down from 55 to 60 mph in 2017. This change in average speed could be due to increased peak hour traffic demand consistent with the toll transaction growth discussed in Section 2.3.2. Eastbound PM Peak period slows only slightly, and similar to average midday and overnight periods in both directions, speeds hover between 60 and 65 mph.

Figure 3-6: Eastbound SR 520 Bridge Average Tuesday to Thursday (Weekday) Hourly Travel Speeds, by Direction, February to April 2017 and 2018



Source: Tuesday-Thursday CDR data, February – April 2018 and February – April 2017

Figure 3-7: Westbound SR 520 Bridge Average Tuesday to Thursday (Weekday) Hourly Travel Speeds, by Direction, February to April 2017 and 2018



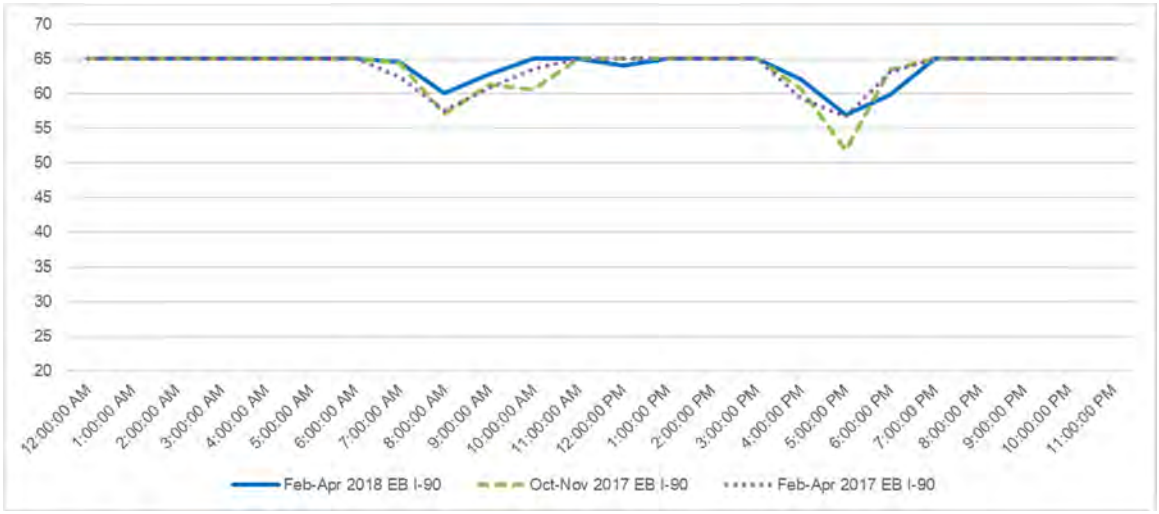
Source: Tuesday-Thursday CDR data, February – April 2018 and February – April 2017

3.3.2 I-90 Bridge Travel Speeds

Figure 3-8 and Figure 3-9 show the February through April 2018 hourly travel speed profile by travel direction for a typical Tuesday to Thursday weekday for vehicles traveling across the I-90 bridge. The speed summaries are the raw speed measure from the CDR site for the Tuesdays, Wednesdays, and Thursdays. A significant majority of westbound speed data for the period February through April 2017 from the CDR site was unavailable, so westbound data for the months of October and November 2017 (used in the preparation of the November 2017 Forecast) was substituted as a comparison against the February through April 2018 data.

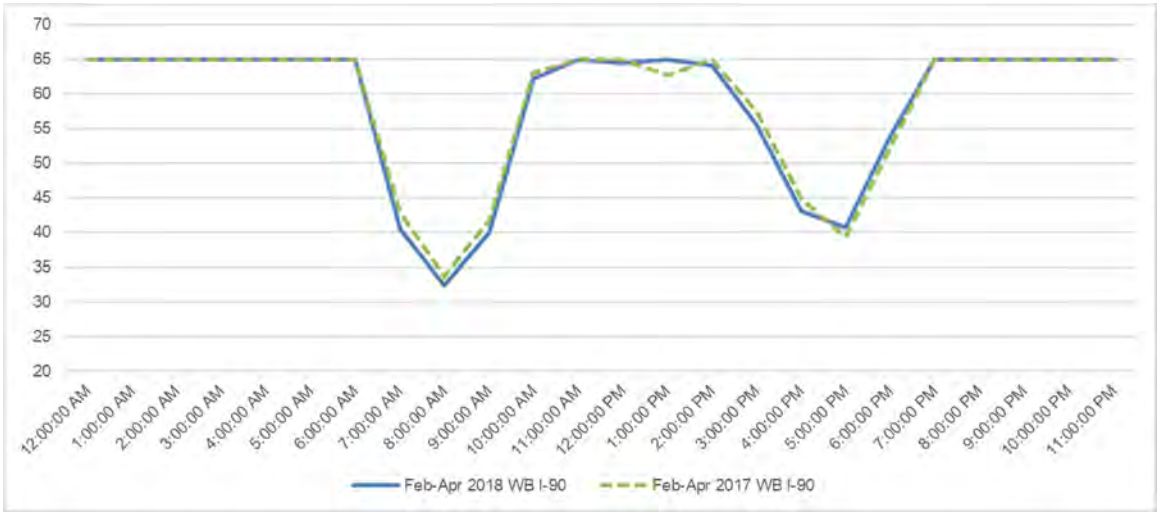
Figure 3-8 presents a comparison of eastbound 2018 speed data versus both February through April 2017 as well as October and November 2017. Eastbound AM speeds for 2018 are shown to be very similar in both 2017 data sets, while the average PM speeds are slightly lower in the October through November 2017 data set. Westbound speed data, illustrated by Figure 3-9, shows that traffic generally experiences lower speeds than the eastbound traffic during peak periods, partly due to increased discretionary trips in the westbound direction towards downtown Seattle. In the westbound direction, traffic slows to between 30 and 35 mph in the AM period and to about 40 mph in the PM peak period. In the eastbound direction AM peak traffic slows slightly to around 60 mph and PM peak period speeds slow to between 55 and 60 mph. Average midday speeds and overnight speeds hover between 60 and 65 mph. It should be noted that construction between Mercer Island and Seattle as part of the I-90 Two-Way Transit and HOV Operations project was completed in June 2017.

Figure 3-8: Eastbound I-90 Bridge Average Tuesday to Thursday (Weekday) Hourly Travel Speeds, by Direction, February to April 2017 and 2018



Source: Tuesday-Thursday CDR data, February – April 2018, February – April 2017 and October – November 2017

Figure 3-9: Westbound I-90 Bridge Average Tuesday to Thursday (Weekday) Hourly Travel Speeds, by Direction, February to April 2018



Source: Tuesday-Thursday CDR data, February – April 2018 and October – November 2017

3.4 TOLL TRANSACTIONS BY PAYMENT TYPE

Table 3.7 shows the toll transactions by payment type for FY 2014 through FY 2018. The majority of transactions are paid using a *Good to Go!* account. Slowly increasing over time, roughly 85 percent of transactions were paid using *Good to Go!* Accounts in FY 2018. While the share of customers using a *Good to Go!* tag has been decreasing, from 67.7 percent of all toll revenue transactions in FY 2014 to 63.0 percent of all toll revenue transactions in FY 2018, pay by plate with a *Good to Go!* account has been increasing, from 16.8 percent of all toll revenue transactions in FY 2014 to 22.4 percent of all toll revenue transactions in FY 2018. Unbillable transactions are defined as those that cannot be billed for reasons such as blurry or unusable camera images of the vehicle license plate or an invalid customer address, while unresolved transactions are those that are still pending billing or payment and have not yet been categorized as paid or unbillable. Note that the non-revenue transactions represent about two percent of the total transactions that are processed by the CSC each year.

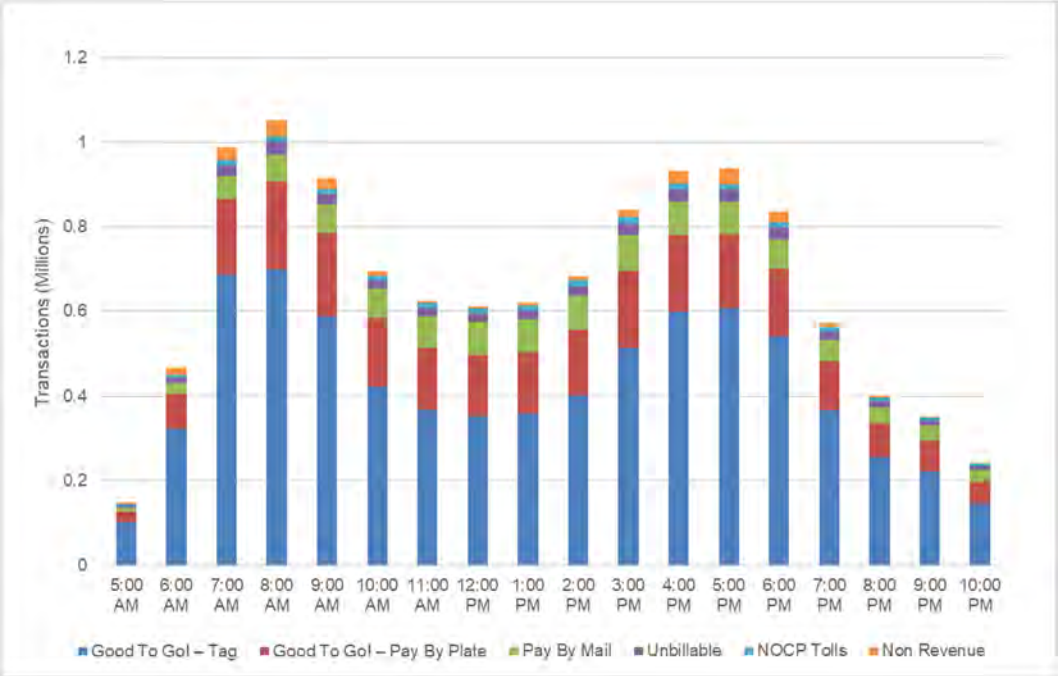
Table 3.7: Toll Transactions by Payment Type, FY 2014 to 2018

Year	*Good To Go!*		*Pay By Mail*	Unbillable	Unresolved	Total	Non-Rev
	Pass	Pay By Plate	Paid				
Reported Transactions							
FY 2014	14,212,029	3,519,316	2,242,176	744,439	273,862	20,991,822	405,721
FY 2015	14,285,240	4,285,568	2,412,976	828,701	228,585	22,041,070	418,797
FY 2016	14,593,233	5,037,684	2,400,204	872,148	307,402	23,210,671	462,059
FY 2017	15,009,101	5,286,632	2,210,942	988,704	450,318	23,945,697	507,641
FY 2018	16,201,414	5,750,018	2,240,280	924,737	598,785	25,715,234	583,642
Payment Share of Tolled Transactions							
FY 2014	67.7%	16.8%	10.7%	3.5%	1.3%	100.0%	
FY 2015	64.8%	19.4%	10.9%	3.8%	1.0%	100.0%	
FY 2016	62.9%	21.7%	10.3%	3.8%	1.3%	100.0%	
FY 2017	62.7%	22.1%	9.2%	4.1%	1.9%	100.0%	
FY 2018	63.0%	22.4%	8.7%	3.6%	2.3%	100.0%	

Source: WSDOT Disposition Summary, September 2018

Figure 3-10 shows the weekday toll transactions by time of day for FY 2016, the most recent data available at this level of detail. As shown, toll transactions are the highest during the peak periods and are about 25 percent lower than the peaks in the midday period. The number of transactions increase rapidly before the AM Peak and decrease rapidly after the PM Peak. This figure also shows the distribution of the FY 2016 transactions by each payment type. As expected, *Good to Go!* payments are most frequent in the AM and PM Peak periods, when the most frequent users, commuters, are on the facility. Pay by Mail is not as prevalent in the AM peak but more so in the midday and early PM peak; these are the times of the day when less frequent users who are less likely to have a tag or account would be using the facility.

Figure 3-10: FY 2016* Weekday Annual Toll Transaction Payment Type by Hour



*Most recent data available.

Table 3.8 shows the revenue distribution by payment type by class for FY 2016, the most recent data set available with this level of detail. As shown, most of the traffic is 2-axle vehicles. It is worth noting that the 3-axle vehicle category includes transit buses.

Table 3.8: FY 2016* Annual Toll Transactions by Payment Type and Vehicle Class

Vehicle Class	*Good To Go!*		*Pay By Mail*	Unbillable	Unresolved	Non-Revenue	Total Transactions	Share of Revenue Transactions
	Pass	Pay By Plate	Paid					
2	14,506,000	4,915,200	2,403,600	760,700	437,000	305,100	23,327,600	99.3%
3	46,500	19,900	12,700	10,000	1,900	173,100	264,100	0.4%
4	13,900	6,700	3,900	2,200	400	150	27,250	0.1%
5	8,600	5,900	4,100	2,700	400	50	21,750	0.1%
6	18,100	5,100	1,700	1,900	100	10	26,910	0.1%

*Most recent data available.

4.0 SOCIOECONOMIC VARIABLES AND LAND USE

A key factor in the development of the traffic and revenue forecast is the forecast of households, population, and employment. Stantec retained BERK Consulting to provide an independent review of available regional and subarea land use forecasts for the Central Puget Sound region. The purpose of this independent review was to inform the preparation of a new land use forecast to be used in the development of SR 520 traffic and revenue forecasts. BERK prepared an adjusted land use forecast, reviewing the latest available regional macroeconomic forecast and selected regional targets for population, household and employment, and then determining the likely distribution of regional growth by county by reviewing historic county growth trends. To determine the allocation of growth to cities and transportation analysis zones (TAZ), BERK analyzed permitted and pipeline development, historic growth patterns, major investments such as light rail station openings, capacity for growth, and planning for growth at the jurisdictional scale. This chapter describes the key findings of their review, and the methodology used to develop their 2018 baseline estimates and the socioeconomic forecasts for the years 2025 and 2045.

4.1 DATA REVIEWED

To evaluate the reasonableness of the existing socioeconomic forecasts, BERK reviewed several sources of demographic, land use, and planned development data including:

- the Puget Sound Regional Council (PSRC) Macroeconomic Forecast (released in 2018),
- the PSRC Land Use Vision (LUV) version 2.0 (released in 2017, developed based on a previous 2015 version of the PRSC Macroeconomic Forecast),
- the Washington State Employment Security Department (ED) Employment Projections,
- the Office of Financial Management (OFM) Growth Management Act County Projections,
- PSRC Total Employment by Census Tract (2017),
- Census LEHD Origin-Destination Employment Statistics (LODES) (2015),
- PSRC Pipeline and Master Planned Development Inventory,
- Permitted Development in Seattle, Bellevue, Kirkland and Redmond,
- PSRC Land Capacity,
- City of Seattle 2018 and Proposed Land Capacity,
- The Washington State OFM Small Area Estimates, and
- the Comprehensive Plans of local jurisdictions.

4.2 2018 BASELINE

As our model was calibrated to 2018, BERK established a 2018 baseline socioeconomic dataset. BERK created a 2018 households and population baseline using 2017 OFM estimates and a combination of sources for employment.

4.2.1 2018 Households and Population

BERK obtained OFM small area estimates by census block group for the year 2017 and used GIS analysis to reaggregate housing unit estimates by TAZ. Results were then compared to PSRC's 2015 housing and population estimates by TAZ and adjusted the 2017 totals upwards to reflect OFM 2018 housing estimates for counties. OFM small area assumptions about housing occupancy rates and average household size were then used to derive household and household population estimates. A similar process was used to allocate population estimates from OFM to TAZ and adjust upward to reflect 2018 estimates by county. To determine the breakdown of households by income level, BERK applied assumed percentage splits in the PSRC LUV forecast, interpolating for the year 2018. Finally, the results of this analysis at the county scale were compared to OFM estimates for consistency.

4.2.2 2018 Employment

The starting point for baseline employment was PSRC's total employment estimates for 2017. The first step was to develop estimates for suppressed data values at the tract scale. To do this, BERK utilized LODES data for the year 2015 to estimate percentage shares of employment to place in suppressed job sector categories. These preliminary proportional shares were refined to address known limitations in the LODES data with regards to K-12 Education jobs.1 BERK mapped school locations in Snohomish, King, and Pierce Counties and used this information to help inform estimates of K-12 Education jobs in cases of suppressed values. BERKS's model controlled for PSRC's 2017 county level total employment by sector. Finally, BERK reaggregated the estimated employment to TAZ using GIS analysis of LODES data to determine the relative shares of employment by TAZ part.

To modify the 2017 employment estimates to 2018, BERK began by using the PSRC Macroeconomic Forecast for a regional control total. Next, ESD's short-term employment forecasts were analyzed by county/region and sector to determine the relative rates of growth among the four counties. Then employment was grown at the TAZ scale based on historic growth patterns up to the 2018 county control totals. Finally, minor sectoral adjustments were necessary at the TAZ scale to match PSRC's forecasted sector breakdowns.

4.3 2025 AND 2045 FORECASTS

BERK reviewed and accepted the total population and employment forecasts for 2025 and 2045 available in the 2018 PSRC Macroeconomic Forecast. PSRC's LUV forecast is based on a previous (2015) release of the PSRC Macroeconomic Forecast. It should be noted that the 2018 forecast shows a significantly higher rate of population growth and a faster rate of employment growth through 2025 than previously forecasted, remaining steady through 2045.

Berk conducted additional analysis to determine the likely allocation of regional population and employment growth at the county, city and TAZ scale. To do this, they considered county and jurisdiction level data.

4.3.1 County Population Forecasts

Table 4.1 shows a comparison of compound annual growth rates (CAGR) of population for each county in the PSRC region. Since 2010, King County has grown most rapidly among the four counties. Looking forward to 2025, the LUV forecast shows a significant slowdown in rate of growth for King County, as well as a slower rate for King County

[1] LODES data commonly places educational workers at school district headquarters rather than school locations.

when compared to the other counties. After 2025, LUV shows an even more significant slowing of growth in King County relative to the other counties.

To evaluate PSRC's county-scale forecast, BERK reviewed planned transportation projects and other investments that have potential to shape real estate market dynamics and the shares of future household and employment growth that may be expected by each of the counties in the Puget Sound region. The most significant change expected before 2025 is the opening of Sound Transit's Link light rail extensions to Northgate and Bellevue/Overlake in King County. These extensions are expected to create significant demand for housing and employment near both current and future light rail stations as well as neighboring communities that are accessible to the light rail stations.

BERK identified no other demographic or real estate trends that indicate King County's growth rate will slow compared to neighboring counties during the 2018 to 2025 forecast period. As mentioned previously, this study assumes the total rate of regional growth from 2015-2025 will increase compared to the PSRC LUV forecast, while decreasing compared to trends during the past three years. BERK's 2018 to 2025 rates of growth by county shows a significant increase in rate of growth for King County, more moderate increases in rate of growth for Pierce and Snohomish Counties and a lower rate of growth for Kitsap County.

For the later 2025 to 2045 period, BERK's rate of growth for the four-county region is slightly higher than assumed in the PSRC LUV forecast (0.96 percent vs. 0.83 percent). During this period relative rates of growth between counties more closely conform to PSRC's LUV forecast. BERK's forecast shows both King and Snohomish County growing somewhat faster than predicted in LUV 2.0, due in part to the expected introduction of new light rail service following 2025.

Table 4.1: Comparison of Historic and Forecasted Population by CAGR, 2010 to 2045

	Historic Growth		PSRC LUV Forecast		BERK Adjusted Forecast		
	2010-2015	2015-2018	2015-2025	2025-2040	2015-2025	2018-2025	2025-2045
King	1.23%	2.18%	0.95%	0.55%	1.81%	1.65%	0.71%
Kitsap	0.56%	1.14%	1.64%	1.44%	0.98%	0.91%	1.42%
Pierce	0.86%	1.66%	1.27%	0.94%	1.39%	1.28%	0.96%
Snohomish	1.21%	2.05%	1.48%	1.17%	1.92%	1.86%	1.42%
Total	1.10%	1.98%	1.17%	0.83%	1.69%	1.57%	0.96%

Source: OFM, 2018; PSRC, 2017; BERK, 2018.

Table 4.2 compares total population by county in each forecast. BERK forecasts that regionwide population will be 5.3 percent higher than the PSRC LUV forecast for 2025. Much of that difference is due to a higher population forecast for King County and to a lesser extent Snohomish County than was included in the dataset behind the PSRC LUV forecast. Additionally, BERK compared adjusted forecast results to OFM population forecasts to confirm consistency. All county forecasts fall within the middle of OFM's forecast range for 2025 and 2045.

Table 4.2: Comparison of County Population Forecasts, 2025 and 2045

	PSRC LUV Forecast		BERK Adjusted Forecast		Percent Difference
	2025	2040	2025	2045	2025
King	2,255,388	2,449,065	2,456,418	2,832,326	8.90%
Kitsap	303,749	376,362	284,571	377,498	-6.30%
Pierce	941,915	1,083,980	953,260	1,153,089	1.20%
Snohomish	877,328	1,044,543	916,200	1,214,892	4.40%
Total	4,378,380	4,953,950	4,610,449	5,577,805	5.30%

Source: PSRC, 2017; BERK, 2018.

4.3.2 County Employment Forecasts

Employment has grown rapidly since 2010, but that growth has been unevenly distributed across the region. As shown in Table 4.3, between 2010 and 2017 King County has grown at a 3 percent compound annual rate, while Snohomish County has been growing at 2.3 percent. Kitsap and Pierce Counties have been growing at somewhat slower rates. PSRC's LUV Forecast shows a significant slowdown in growth rates across the region as well as much less variation in rates of growth. ESD's total employment forecast, on the other hand, indicates that King County will continue to grow at a significantly faster rate than the other counties.

BERK's adjusted 2025 total employment forecast reflects the regionwide rate of growth expected in the PSRC Macroeconomic Forecast which is slightly lower than ESD's forecast. The forecast also reflects the relative differences in growth rates observed in recent historic trends and the ESD forecast. As noted previously, the most significant infrastructure change during this period that could impact the distribution of employment growth will be the introduction of new light rail stations in Seattle, Mercer Island, and Bellevue.

The newest PSRC Macroeconomic Forecast predicts a somewhat slower rate of growth from 2025 to 2045 than was assumed in the previous forecast on which PSRC's LUV is based. However, total employment in 2045 is expected to be slightly higher than assumed in the previous forecast. BERK's adjusted forecast also reflects these new assumptions. With regards to the distribution of growth by county, BERK assumes the same relative rates as the LUV 2025 to 2040 forecast, adjusted downward to reflect expected macroeconomic conditions.

Table 4.3: Comparison of Historic and Forecasted Employment by CAGR, 2010 to 2045

	Historic Growth	PSRC LUV Forecast		ESD Forecast*	BERK Adjusted Forecast	
	2010-2017	2015-2025	2025-2040	2018-2026	2018-2025	2025-2045
King	3.03%	0.98%	1.30%	1.75%	1.52%	1.20%
Kitsap	0.99%	1.10%	1.29%	1.28%*	1.08%	1.15%
Pierce	1.70%	0.98%	1.18%	1.12%	1.09%	1.07%
Snohomish	2.33%	1.12%	1.75%	1.13%	1.36%	1.65%
Total	2.61%	1.01%	1.35%	1.56%	1.41%	1.24%

* ESD does not provide a forecast for Kitsap County. This tables shows the Olympic Region forecasted rate of growth, which includes Kitsap County.

Source: PSRC, 2017; PSRC, 2018; ESD, 2018; BERK, 2018.

Table 4.4 compares the LUV and BERK Adjusted county employment forecasts.

Table 4.4: Comparison of County Employment Forecasts, 2025, 2040 and 2045

	PSRC LUV Forecast		BERK Adjusted Forecast		Percent Difference
	2025	2040	2025	2045	2025
King	1,544,032	1,875,067	1,653,571	2,097,259	7.1%
Kitsap	115,369	149,408	114,565	144,137	-0.7%
Pierce	386,148	498,086	393,647	487,155	1.9%
Snohomish	347,770	458,937	353,164	490,154	1.6%
Total	2,393,319	2,981,498	2,514,947	3,218,706	5.1%

Source: PSRC, 2017; BERK, 2018.

4.4 JURISDICTION FORECAST REVIEW AND ADJUSTMENTS

4.4.1 Population

BERK's review of PSRC's jurisdiction-level population forecasts focused primarily on cities located within ten miles of the SR 520 corridor. To evaluate these growth forecasts for the 2018 to 2025 period, BERK compared them to actual growth trends between the years 2010 and 2018[2]. Where LUV projections were consistent or close to historic trends, BERK assumes a future rate of growth consistent with the historic trend. Where discrepancies occurred, BERK used supporting information from discussions with local planners, local comprehensive plans[3], and subsequent city planning efforts that may impact the capacity and rate of growth within a city. BERK's underlying default assumption is that as long as there is capacity for new growth, the factors driving population growth are unlikely to change before 2025.

There are a few exceptions to these default assumptions. First, BERK considered local factors that resulted in an uncommonly high growth rate for the 2010 to 2018 period, such as a large master planned development. Second, some jurisdictions are actively planning for increased growth in the future based on anticipated improvement in transit accessibility. The introduction of light rail, and to a much lesser extent transit-oriented development planned around bus rapid transit, represent a major change in factors supporting growth. Communities that are planning now for these changes will likely see higher rates of growth over the next ten years than the historic trend. In these cases, a higher rate consistent with PSRC forecasted growth is assumed. A summary of the growth rates for King County and the four major cities (Bellevue, Kirkland, Redmond and Seattle) is provided in Table 4.7. Details about BERK's research and outreach to individual cities is available in the final section of this report.

BERK's adjustments also consider known development pipeline projects summarized by jurisdiction as well as limitations to buildable land capacity for new growth[4]. As discussed previously, BERK obtained and analyzed all active building permits in Seattle, Bellevue, Kirkland, and Redmond as of August 2018 to support this analysis.

[2] Population growth estimates for cities were obtained from Washington State Office of Financial Management (OFM). To measure actual population growth rather than growth due to annexation, BERK calculated growth rates for cities based on consistent geographic boundaries using OFM's small area estimates at the census block group scale.
[3] Jurisdictional population growth targets are set by counties in consultation with cities as part of the process of setting countywide planning policies. Cities then adopt projections consistent with their growth targets in their Comprehensive Plans.
[4] Total population growth allocations were limited by available capacity minus a standard 25% market factor deduction. This deduction is common in land capacity studies and reflects the fact that not every available parcel in a jurisdiction with additional zoned capacity is expected to become available for development or redevelopment within the forecast period. In BERK's forecast

A similar process was used to review and adjust growth during the 2025 to 2045 forecast period. However, during this period more deference was given to rates of growth expected in PSRC's LUV forecast, after accounting for BERK's adjustment to countywide rates of growth. Total growth by jurisdiction was then compared to available land capacity. In situations where anticipated growth exceeds PSRC's estimated capacity, BERK reviewed comprehensive plans and reached out to selected city planning officials to further review land capacity estimations. Following any relevant land capacity adjustments, BERK reallocated growth exceeding capacity to jurisdictions with excess capacity in proportion to expected shares of forecasted county growth. Finally, BERK compared the results to LUV, historic trends, and adjusted rates of growth during the 2015 to 2025 period for reasonableness.

Table 4.5 presents a comparison of historic, PSRC forecasted, and BERK's adjusted population growth rates by Jurisdiction.

calculations, any growth in excess of capacity was reallocated to other jurisdictions with excess capacity, proportional to their total forecasted growth.

Table 4.5: Comparison of PSRC and BERK Population Growth CAGR, select King County Jurisdictions*

Jurisdiction	2010 – 2018	LUv 2015 - 2025	BERK 2018 - 2025	LUv 2025 - 2040	BERK 2025 - 2045
Auburn	1.49%	1.13%	1.23%	0.77%	0.74%
Bellevue	1.34%	1.12%	2.50%	0.69%	1.13%
Bothell	1.75%	1.12%	1.44%	0.50%	0.69%
Burien	1.09%	0.96%	0.90%	0.49%	0.51%
Clyde Hill	0.25%	0.07%	0.21%	0.18%	0.15%
Hunts Point	0.80%	0.39%	0.66%	0.17%	0.29%
Issaquah	2.51%	0.75%	0.48%	0.76%	0.49%
Kenmore	1.43%	1.41%	1.11%	1.01%	0.81%
Kent	1.13%	0.64%	0.94%	0.31%	0.45%
Kirkland	1.05%	0.73%	1.20%	0.37%	0.56%
Lake Forest Park	0.48%	0.56%	0.39%	0.35%	0.28%
Medina	1.12%	0.49%	0.92%	0.14%	0.37%
Mercer Island	0.84%	0.65%	0.97%	0.43%	0.51%
Newcastle	2.26%	0.79%	1.87%	0.25%	0.73%
Normandy Park	0.50%	0.42%	0.41%	0.28%	0.26%
Redmond	2.04%	1.38%	2.13%	0.96%	1.12%
Renton	1.59%	1.21%	1.31%	0.59%	0.69%
Sammamish	1.28%	0.43%	0.55%	0.32%	0.32%
SeaTac	1.00%	1.56%	0.82%	1.42%	0.89%
Seattle	2.31%	1.01%	1.91%	0.57%	0.88%
Shoreline	0.63%	0.76%	1.42%	0.52%	0.70%
Tukwila	0.45%	1.68%	1.22%	1.56%	1.08%
Woodinville	0.98%	1.97%	0.81%	1.67%	1.00%
Yarrow Point	0.78%	0.45%	0.64%	0.21%	0.30%
Unincorporated Urban Growth Are	1.53%**	0.55%	1.63%	0.29%	0.67%

* All rates based on growth in constant geography to avoid influence of annexations.

** Historic CAGR based on 2010-2015 period for unincorporated UGAs only.

Source: OFM, 2018; PSRC, 2017; BERK, 2018.

4.4.2 Employment

BERK applied a similar method for reviewing and adjusting the PSRC LUV forecasted employment growth rates by jurisdiction. Table 4.6 compares historic, PSRC forecasted, and BERK's adjusted employment growth rates by selected jurisdiction in King County. The review of historic trends revealed that, in many communities, some of the employment growth from 2010 to 2017 reflects recovery from the economic recession rather than new development. Details about BERK's research and outreach to individual cities are available in the final section of this chapter.

Table 4.6: Comparison of PSRC and BERK Employment Growth CAGR, select King County Jurisdictions*

Jurisdiction	2010 – 2017**	LUv 2015 - 2025	BERK 2018 - 2025	LUv 2025 - 2040	BERK 2025 - 2045
Auburn	2.92%	1.49%	1.36%	1.71%	1.51%
Bellevue	2.05%	0.98%	1.86%	1.49%	1.39%
Bothell	4.17%	0.66%	1.60%	1.24%	1.09%
Burien	2.38%	1.88%	0.95%	1.47%	1.29%
Clyde Hill	1.95%	1.88%	0.22%	-0.09%	0.04%
Covington	1.03%	0.44%	0.52%	0.90%	0.79%
Issaquah	4.11%	2.24%	1.72%	2.59%	2.29%
Kenmore	0.49%	3.96%	1.90%	2.49%	2.19%
Kent	3.05%	0.58%	1.11%	0.76%	0.67%
Kirkland	6.03%	1.24%	2.05%	1.72%	1.52%
Lake Forest Park	-0.90%	0.26%	1.78%	0.61%	0.53%
Medina	1.40%	0.16%	0.00%	-0.09%	-0.08%
Mercer Island	0.50%	0.76%	0.60%	0.80%	0.70%
Newcastle	4.98%	0.19%	0.75%	1.27%	1.11%
Normandy Park	3.75%	0.95%	2.51%	0.64%	-0.03%
Redmond	3.03%	1.02%	1.41%	1.08%	1.56%
Renton	1.96%	1.26%	1.03%	1.73%	1.52%
Sammamish	5.65%	0.66%	1.65%	0.94%	0.83%
SeaTac	4.16%	2.93%	1.99%	2.58%	2.27%
Seattle	3.32%	0.63%	1.54%	1.07%	0.98%
Shoreline	0.10%	1.16%	0.88%	1.17%	1.02%
Tukwila	1.42%	0.93%	4.36%	1.30%	1.14%
Woodinville	2.81%	2.46%	1.09%	1.70%	1.49%
Unincorporated Urban Growth Are	6.71%	1.96%	3.65%	0.72%	0.63%

* All rates based on growth in constant geography to avoid influence of annexations.

** Historic CAGR based on PSRC covered employment estimates by City. UGA estimated based on Census LEHD employment estimates, 2010-2014.

Source: PSRC, 2017 & 2018; Census LEHD, 2017; BERK, 2018.

Table 4.7 presents a summary of BERK's Population and Employment Forecasts by CAGR for King county and the four main cities.

Table 4.7: Summary of BERK Population and Employment Forecasts by CAGR, 2018 to 2045

Jurisdiction		Population		Employment	
		CAGR 2018-25	CAGR 2025-45	CAGR 2018-25	CAGR 2025-45
King County		1.7%	0.7%	1.5%	1.2%
Four Main Cities	Seattle	1.9%	0.9%	1.5%	1.0%
	Bellevue	2.5%	1.1%	1.9%	1.4%
	Kirkland	1.2%	0.6%	2.1%	1.5%
	Redmond	2.1%	1.1%	1.4%	1.6%

* All rates based on growth in constant geography to avoid influence of annexations.

Source: OFM, 2018; PSRC, 2017; BERK, 2018.

4.5 ALLOCATION OF JURISDICTION GROWTH TO TAZ

4.5.1 Housing and Employment Growth Capacity

BERK used data about future land use assumptions from PSRC to calculate housing unit and total employment capacity on vacant and redevelopable parcels by TAZ. Within the City of Seattle, BERK used updated parcel-based land capacity calculations based on newly passed and proposed zoning changes. This analysis assumes 25 percent of total aggregate capacity in vacant and underutilized parcels will remain unavailable for development. In cases where the known development pipeline exceeds calculated capacity, the capacity estimates were modified to accommodate all planned growth.

4.5.2 Population and Household Allocation

Beginning with the 2025 forecast period, BERK allocated the adjusted population forecasts for each jurisdiction to households within TAZ. First, population forecasted in LUV at the jurisdictional scale was subtracted from BERK's adjusted population forecasts and assigned to TAZ consistently with the LUV forecast. Next, BERK allocated population growth to housing units in development pipeline projects expected to build out before 2025. Remaining population growth was then allocated to households[5] in TAZ proportionally to the amount of growth each TAZ was expected to receive in the LUV forecast. If a TAZ is limited by housing capacity, then overflow growth is allocated to other TAZ in the same jurisdiction proportional to their remaining capacity. Within each separate county, unincorporated UGAs and rural areas were each treated as a distinct jurisdiction using this same method.

4.5.3 Employment

The process for allocating total employment growth/loss to TAZ was similar to the approach used for population and households. However, additional work was required to address significant data suppression in the PSRC census tract

[5] BERK's review of LUV found that PSRC's forecasted rate of reduction in average household sizes by TAZ are faster than demographic trends and PSRC's regional macroeconomic forecast. Therefore, BERK's forecast includes adjusted assumptions about the rate of reduction in average household size by TAZ. In all cases, allocated population to households by TAZ reflect average household size reflect TAZ level conditions and trends.

forecast. In most cases the suppression was limited to the two or more sector totals, while in other cases total employment was also suppressed. Key steps in this process are described below.

4.5.3.1 Estimating Suppressed Values in LUV TAZ Forecast

To address data suppression in the 2025 LUV forecast, BERK's model first inserted the estimated 2018 values then made adjustments to accommodate all county-level growth or loss of employment by sector to match PSRC's LUV county level sector totals. Adjustments were controlled for total forecasted employment by TAZ and employment capacity in TAZ with suppressed totals. An identical process was used to estimate suppressed values for the 2040 LUV forecast products. Finally, BERK reaggregated census tract data by TAZ based on total employment capacity.

4.5.3.2 Review and Adjustment to LUV TAZ Forecast

Next, BERK's unsuppressed LUV forecast by TAZ was used as a key input for developing and reviewing the adjusted forecast product. To allocate BERK's adjusted jurisdictional total employment growth to TAZ, BERK began by placing development pipeline projects expected to build out before 2025. Remaining employment growth was then allocated to TAZ proportional to the amount of growth each TAZ was expected to receive in the unsuppressed LUV forecast, limited by BERK's calculated capacity. Growth exceeding capacity was then reallocated to other TAZ in the same jurisdiction proportional to their remaining capacity. For each TAZ, preliminary breakdowns by employment sector were based on proportions in the unsuppressed LUV forecast, controlling for consistency with building types in the development pipeline as well as BERK's countywide control totals by employment sector.

4.6 REVIEW AND ADJUSTMENT NOTES BY JURISDICTION

This section describes adjustments made to the LUV forecast for individual jurisdictions that diverge from the general assumptions and methodology described previously, with a focus on King County jurisdictions. Cases where the general assumptions for jurisdictional review and adjustment were confirmed by further research are not discussed here.

4.6.1 Bellevue

Bellevue worked closely with PSRC to explain and refine their growth projections and land capacity exceptions during the development of Land Use Vision. Light rail will be operative in 2023 and Bellevue has done extensive planning work to create transit-oriented development around future stations and to create a secondary urban center in the Bel-Red area. The city expects that with light rail coming online there will be more growth in the period before 2025 than in the following ten years. Master planned development of the Spring District is significant and already in the pipeline, likely to peak by 2025. The city also has two growth areas that are still waiting on land use planning and zoning changes that will increase capacity – the Eastgate Corridor, which is primarily employment capacity with some mixed use, and the Wilburton subarea which is likely to increase both employment and population capacity. Those are also expected to occur before 2025.

For both the 2025 and 2045 forecasts, BERK's growth rate adjustments reflect this large pipeline of expected development activity.

4.6.2 Issaquah

During recent years, Issaquah has experienced significant growth, Much of this growth was related to large master planned developments that are expected to reach capacity by 2025. Future growth is mainly expected to occur in the commercial core, as guided by the Central Issaquah Plan. However, in 2016 Issaquah enacted a moratorium on development in the commercial core, with the intent to rework portions of the plan in response to community concerns about land use intensity. The moratorium concluded in 2018 after council adopted several new development regulations, including an inclusionary zoning requirement. BERK expects that the impacts of the moratorium period and changes to regulations will slow future growth in Issaquah compared to historic trends and the LUV forecast.

4.6.3 Redmond

BERK's analysis of city permit data revealed an excess of 4,000 residential units in the short-term pipeline that were not reflected in PSRC's development pipeline database. BERK's forecast assumptions reflect this additional expected growth before 2025, resulting in a rate of residential growth higher than LUV and historic trends.

4.6.4 Seattle

BERK's analysis of city permit data revealed a large amount of new residential and employment pipeline development in both the short and long term which are not reflected in LUV. This includes commercial and industrial development with capacity over 38,000 jobs by 2025, as well as over 21,000 housing units. The availability of this permit data provides more certainty around the expected pattern of growth in Seattle, particularly in the 2025 forecast period.

Based on this known pipeline, as well as the high rate of growth in recent years, BERK forecasts show continued strong growth in Seattle compared to many other King County jurisdictions, and higher than the LUV forecast. However, the rate of employment growth is expected to slow somewhat from the very rapid recent trends due in part to Amazon's decision to locate a second headquarter outside of Seattle.

4.7 COMPARISON TO PREVIOUS BERK FORECASTS

In general, BERK forecasts of population and employment are slightly higher than the forecasts used in preparing Stantec's 2017 forecasts of traffic and revenue. Figure 4-1 presents a comparison of BERK's current forecast of total population by county versus the previous forecast. Please note that the left axis on the following series of comparison graphs is not consistent, to allow for clearer visual differentiation between the forecasts. King County and Snohomish County are forecasted to have higher population for all years of the forecast, while Kitsap County is forecasted to see slightly lower population than previously forecasted in the near term but matching previously forecasted levels by 2045. Population forecasts for Pierce County have remained roughly the same.

Figure 4-1: Comparison of BERK Forecasts for Total Population, by County

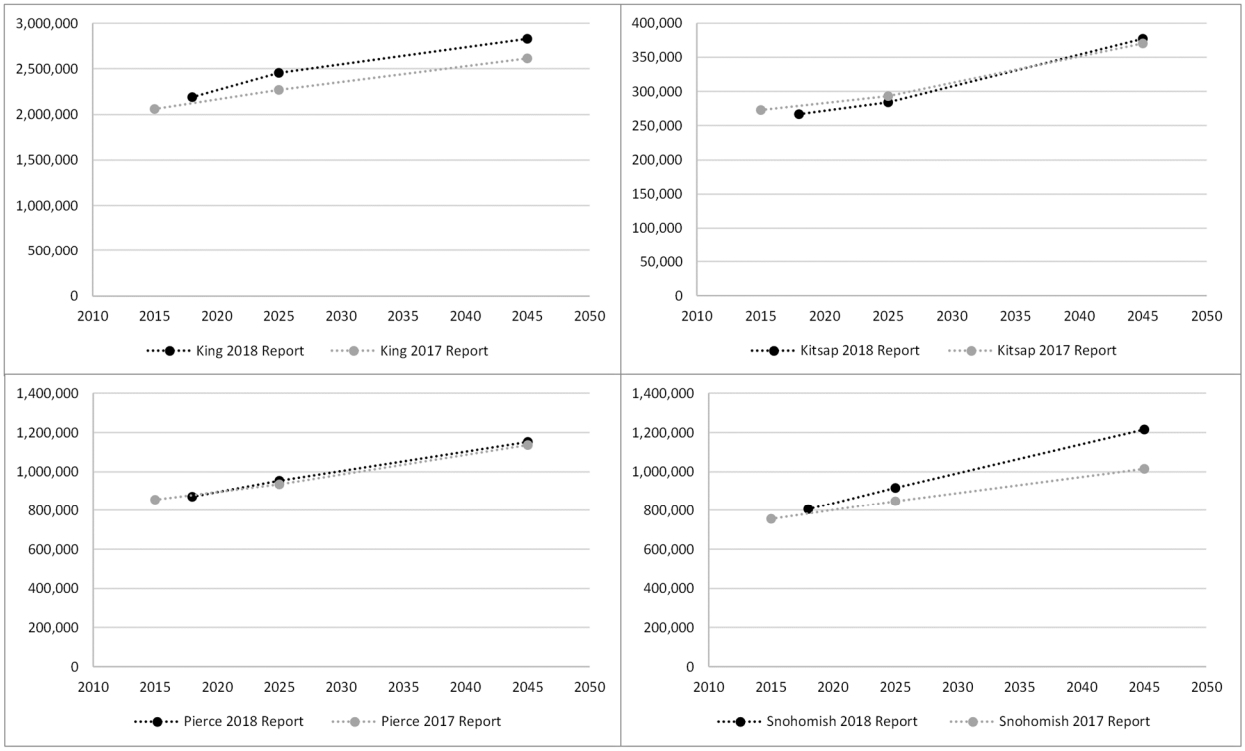


Figure 4-2 presents a comparison of BERK's current forecast of total employment by county versus the previous forecast. Forecasts for King County and Kitsap County employment have increased slightly over previous forecasts, and although BERK estimates that Snohomish County employment for the year 2018 is currently below 2015 levels, it is projected to return to previously forecasted levels in 2025 and 2045. Employment forecasts for Pierce County are matching well with the previous forecast for 2025 but are estimated to be somewhat lower than previously forecasted in 2045.

Figure 4-2: Comparison of BERK Forecasts for Total Employment, by County

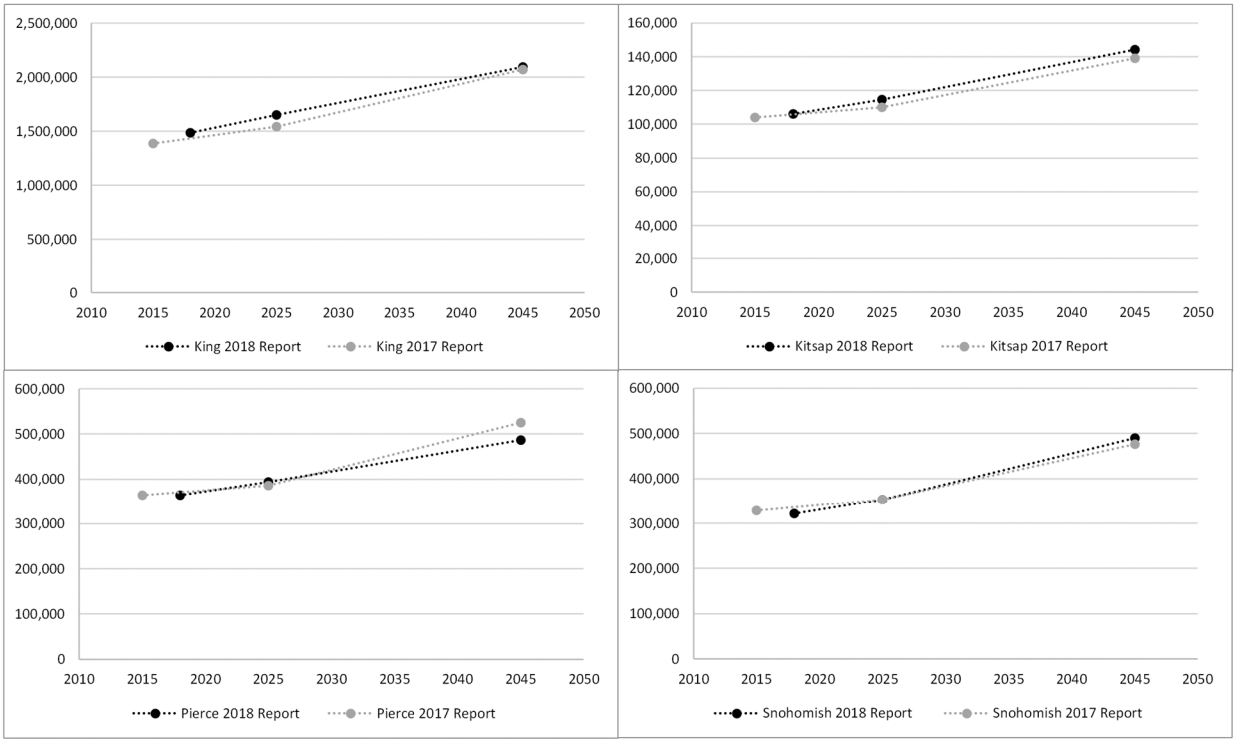


Figure 4-3 presents a comparison of BERK's current forecast of total population for each of King County's four main cities (Seattle, Bellevue, Kirkland and Redmond) versus the previous forecast. Similar to the King County forecast, the 2018 population forecasts for Seattle and Bellevue are generally higher than previous forecasts, while updated population forecasts for Kirkland and Redmond are in line with previous forecasts.

Figure 4-3: Comparison of BERK Forecasts for Total Population, Four Main Cities in King County

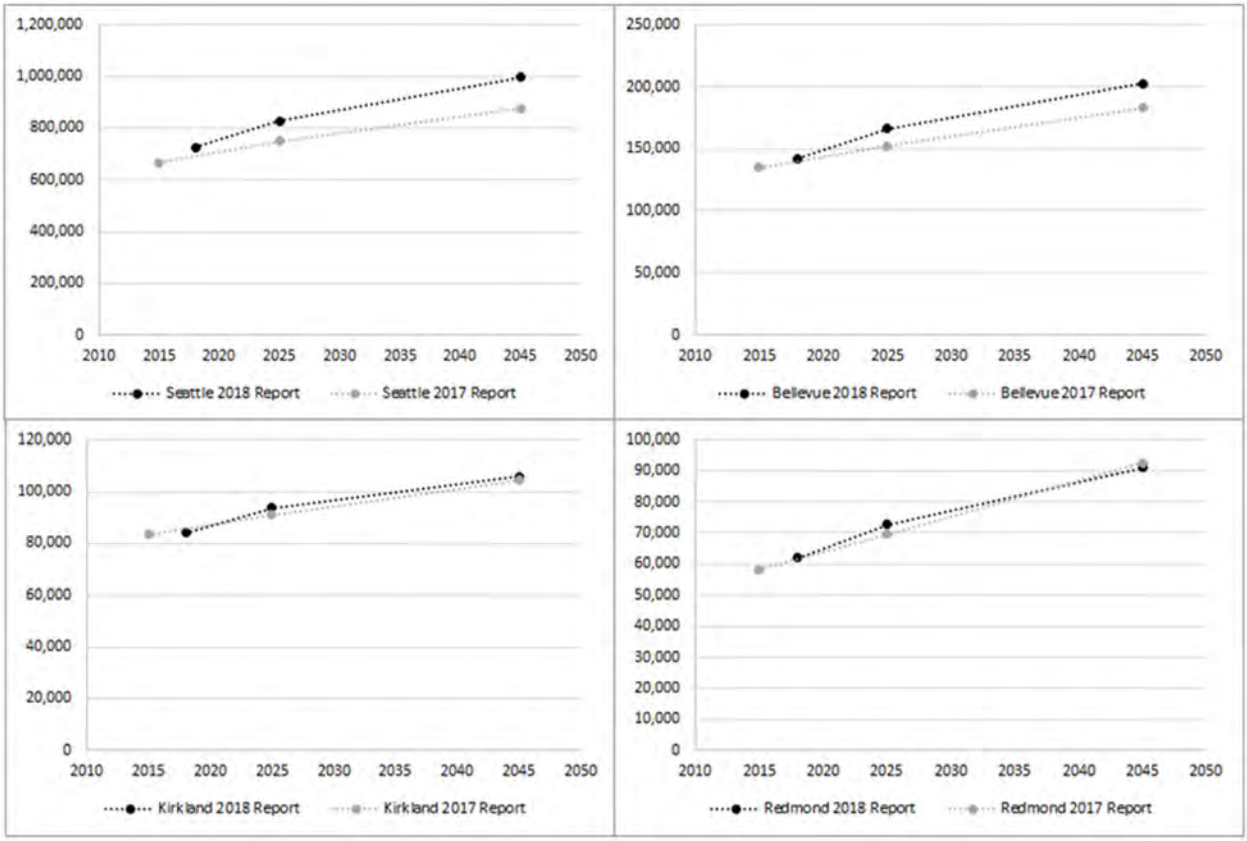
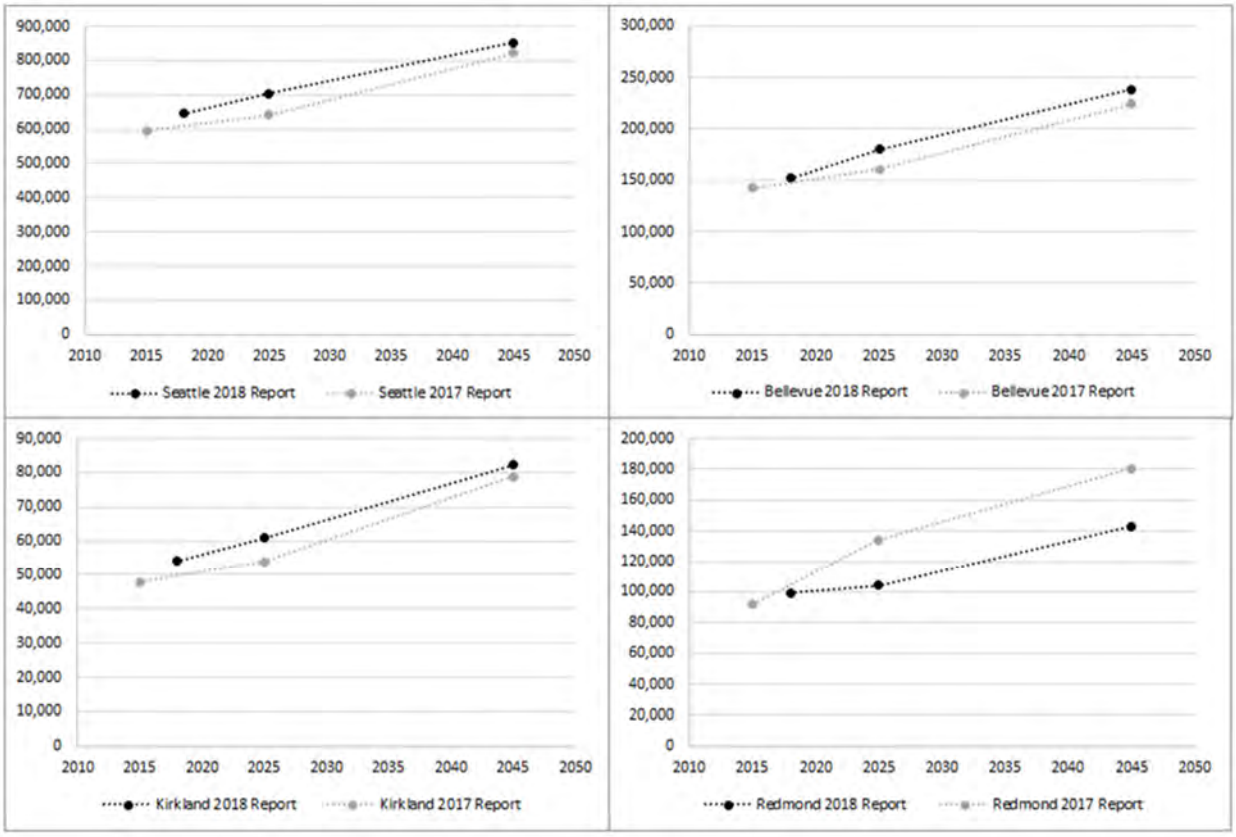


Figure 4-4 presents a comparison of BERK's current forecast of total employment for each of King County's four main cities (Seattle, Bellevue, Kirkland and Redmond) versus the previous forecast. While the employment forecast for King County as a whole was generally slightly higher than previous forecasts, it should be noted that employment for the city of Redmond is forecasted to be significantly lower than previous estimates. Redmond comprises only about a tenth of the four major city combined employment, and employment forecasts have increased for Seattle, Bellevue and Kirkland.

Figure 4-4: Comparison of BERK Forecasts for Total Employment, Four Main Cities in King County



5.0 MODEL DEVELOPMENT AND CALIBRATION

This chapter provides an overview of the modeling methodology, development, and calibration of the model used to produce the SR 520 bridge traffic and gross toll revenue potential forecasts.

5.1 METHODOLOGY OVERVIEW

A two-tiered travel demand modelling process was used to perform the traffic and revenue forecast. First, Stantec utilized the Puget Sound Regional Commission (PSRC) regional model encompassing Seattle and much of the surrounding area. Stantec then used a customized Toll Diversion Model (TDM) to analyze the SR 520 bridge patronage. For this second step, network and vehicle demand coverage were retained at the regional model level; however, the trips were subdivided into twelve time periods to reflect the variation in toll cost and traffic demand throughout the day. The toll diversion model results serve as the basis for the traffic and revenue forecast. The base model calibration reflects 2018 traffic conditions, using traffic volume and travel time data compiled for this effort as detailed in Chapter 3 of this report. The methodology has not changed from that which was outlined in the report accompanying the November 2017 Forecast. The roadway network, traffic data and socioeconomic assumptions have been updated where possible, but the calibration and modeling methodologies have remained constant.

5.2 REGIONAL TRAVEL DEMAND MODEL

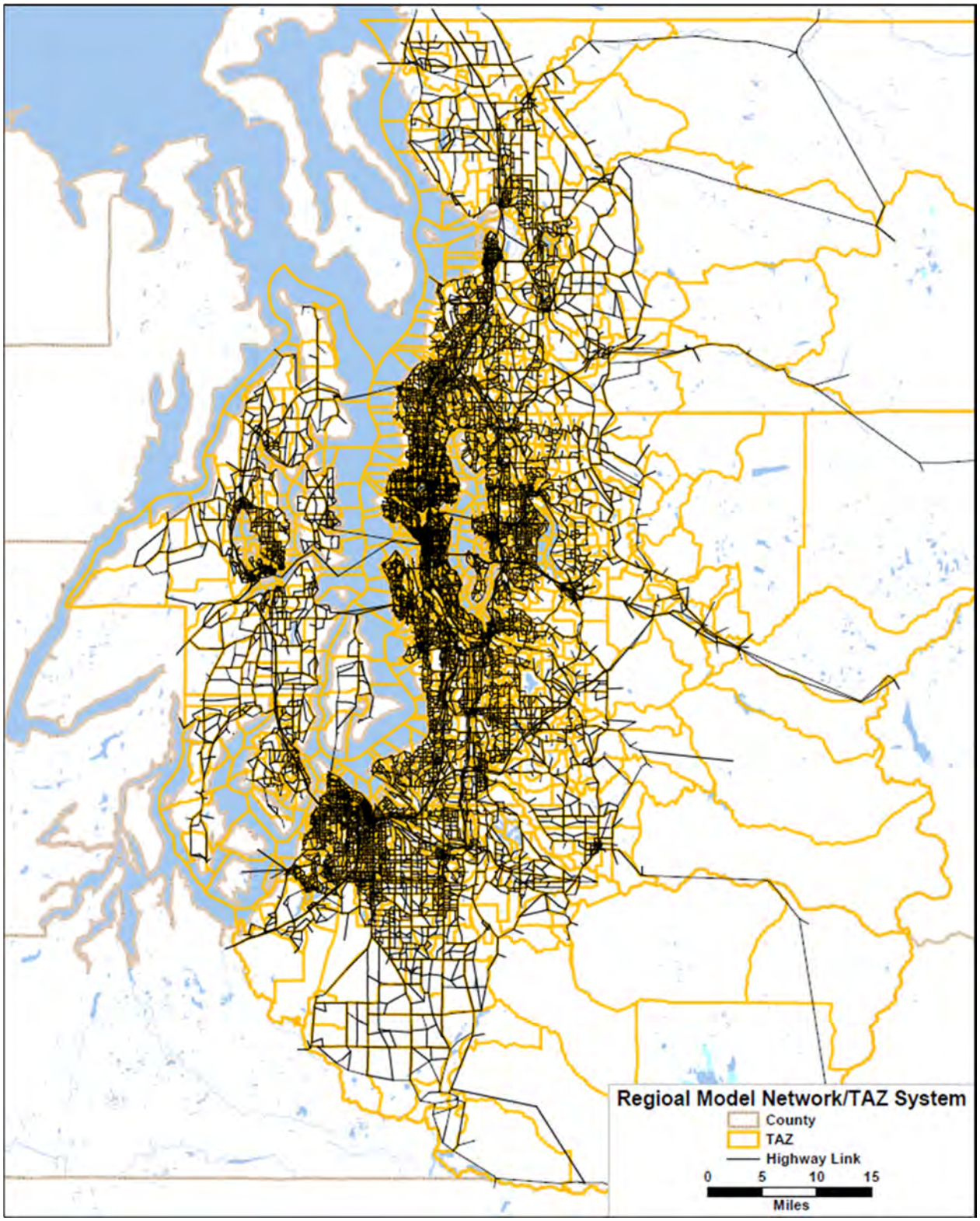
Stantec employed the Trip-Based Travel Model 4K Version 4.03 (2015) that is developed and maintained by PSRC as the regional modeling platform. Stantec's primary objective was to estimate the vehicular travel demand for the trans-Lake Washington corridor, to facilitate downstream toll diversion modeling for the early-2018 base year (model calibration), and the 2025 and 2045 horizon years. The effort for the November 2017 Forecast had utilized the same base PSRC model version but had been calibrated to a 2015 base year to match the base year land use forecast.

The PSRC 4K model is a full-featured, 4-step travel demand model that encompasses the Central Puget Sound region, including the counties of King, Pierce, Snohomish, and Kitsap. The model consists of 3,700 internal TAZs, 18 external stations, and an additional 150 zones representing Park-and-Ride facility locations within the region. Figure 5-1 shows the PSRC regional highway network coverage.

5.2.1 Traffic Analysis Zones (TAZs) System

The model coverage consists of the four-county Puget Sound region, including King, Snohomish, Kitsap, and Pierce counties, centering on the City of Seattle. The model has a total of 3,700 internal and 18 external TAZs, in addition to 150 Park-and-Ride (PNR) zones, with corresponding highway and transit network details to support the zonal system.

Figure 5-1: PSRC Regional Highway Network Coverage



5.2.2 Roadway Network Assumptions

The base model calibration year transportation network is reflective of average weekday 2018 traffic conditions, featuring the SR 520 bridge under the existing configuration with the HOV-lane implemented. For the 2025 and 2045 forecast years, interim-build and final build networks were created that include major highway capacity/connectivity improvement projects with relevance to this T&R effort, specifically along competitive and feeder roadways, including I-5, I-90 and I-405, as well as major state highways such as SR 167, SR 522, and SR 590. In addition, significant transit improvements as identified in the Sound Transit 3 Plan were also incorporated.

5.2.3 Corridor Calibration Summary at Regional Level

The goal of the regional calibration process is to ensure that the model can be relied upon to predict future traffic volumes. As such, the process was focused on replicating observed vehicular traffic flows consistent with 2018 base year travel conditions across the Trans-Lake Washington corridor. In Table 5.1, the combined GP and Express/HOV lane traffic estimated by the regional model was compared to observed data at various roadway segments along a screenline crossing Lake Washington. At an aggregate level, the estimated traffic flows resulting from the model are closely approximating the observed daily traffic, showing that the model overpredicts traffic by between two and four percent. Note that this regional-level calibration is an initial step in the broader calibration process and the differences for individual links in modelled versus observed traffic are corrected in the toll diversion model calibration.

Table 5.1: 2018 Estimated Average Daily Traffic, Observed v. Modeled,- Screenline 1, by Direction

Facility	Daily Volume					
	Eastbound			Westbound		
	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)
SR 522 at 68th Ave NE	17,442	18,631	7%	22,879	25,652	12%
SR 520/Evergreen Point Floating Bridge	40,711	39,497	-3%	42,045	38,785	-8%
I-90/Murrow Memorial Bridge	81,154	86,317	6%	83,773	86,365	3%
SR 900 East of I-5	15,000	15,734	5%	15,000	14,178	-5%
I-405 East of SR 181	88,609	90,184	2%	88,919	92,087	4%
Total	242,916	250,363	3%	252,617	257,067	2%

5.2.4 Regional Level Forecast Summaries

In the PSRC trip-based demand modeling process, daily person trips are estimated from the SED variables (including the number of households and jobs by employment type) pertinent to the internal TAZs within the Puget Sound region, based on a set of pre-defined trip production and attraction relationships, in additional to the trips specified for the 18 external stations in the model. A total of 7 trip purposes are maintained in the modeling process, from trip generation to mode choice with further stratification by four Income levels, where applicable:

- Home-Based Work (HBW)
- Home-Based College (COL)
- Home-Based School (SCH)
- Home-Based Shopping (HBS)
- Home-Based Other (HBO)
- Non-Home-Based Work (WBO)
- Non-Home-Based Other (OBO)

In addition to household resident trips, commercial vehicles (or trucks), are also considered in the PSRC model, respectively for light, medium, and heavy truck classes. Truck trips are generated for individual TAZ and specified for each external station from SED attributes (primarily zonal employment).

The mode choice modeling process apportions each person trip matrix by purpose to the available travel modes at a daily level after the trip distribution step. The available mode choice options are specified as below:

- Drive alone (SOV)—Single-occupancy auto trips
- Shared ride 2 (HOV2)—Auto trips with two occupants
- Shared ride 3+ (HOV3+)—Auto trips with three or more occupants
- Transit – Walk access
- Transit - Drive access
- Walk
- Bicycle

A time-of-day choice modeling process then respectively stratifies the household resident and commercial vehicle trips using pre-defined survey-based factors or, where applicable, probabilistic functions which consider the time period-specific congested highway travel time to stratify daily trips into different time periods. A total of five time periods are maintained in the PSRC trip-based model, including AM (6am to 9am), MD (9am to 3pm), PM (3pm to 6pm), EV (6pm to 1pm), and NI (10pm to 6am). A subsequent modeling step will then prepare the corresponding input trip matrices for traffic assignment purposes. For auto/highway vehicle assignment, person trips are converted to vehicles with appropriate occupancy factors for HOV2 and HOV3+ trips. The highway assignment considers a total of 11 vehicle classes as listed below:

- SOV (HBW Income 1)
- SOV (HBW Income 2)
- SOV (HBW Income 3)
- SOV (HBW Income 4)
- SOV (all other purposes)
- HOV2 (all purposes)
- HOV3+ (all purposes)
- Vanpool Vehicles
- Light Truck
- Medium Truck
- Heavy Truck

Travel demand in the Central Puget Sound region is forecasted to grow between 2018 and 2045, resulting in more travel delay, and decreasing network-wide travel speeds, as summarized in Table 5.2. While daily person-trips increase over the forecast period, it is important to note that the mode by which trips are made is shifting. The share of people walking and biking increases slightly, and conversely, the share of HOV2+ and SOV trips decreases slightly. The transit share stays relatively stable around 4.0 percent. While the overall share of transit trips remains relatively constant, the growth in daily transit trips outpaces the growth in daily vehicle trips. The total number of daily person trips is slightly higher in 2025 and 2045 than indicated by the 2017 modeling effort, with some fluctuations in the mode shares as well. Overall speeds are estimated to be slightly lower than the 2017 estimate. The reasons for these changes are both the different calibration year as well as updated socioeconomic forecasts.

Table 5.2: Travel Demand by Daily Person-trip, Mode Shares, VMT and VHT, 2018 Actual and Forecasted 2025 and 2045

		Model Results		
		2018	2025	2045
Daily Person Trip		16,341,400	19,254,600	24,379,600
Mode Shares	SOV	42.9%	42.4%	41.4%
	HOV2+	42.3%	41.4%	42.5%
	Transit	3.9%	3.9%	4.2%
	Walk & Bike	10.9%	12.4%	11.9%
Daily Vehicle Trips		10,382,000	12,026,300	15,082,800
Vehicle-Mile Traveled		81,399,200	89,550,100	110,282,600
Vehicle-Hour Traveled		2,789,900	3,289,900	4,024,500
Speed		29.2	27.2	27.4

Source: PSRC Trip-Based Travel Model 4K Version 4.03

The projected growth in vehicular travel demand in the region as estimated by model is summarized in Table 5.3. The enhanced roadway capacity is likely to attract/absorb additional traffic in the near-term future, as reflected by the compounded annual growth rate (CAGR) of 2.1 percent for the 2018 to 2025 period. With limited increases in roadway capacity in the region and growing congestion, a more modest compounded annual traffic growth rate of 1.1 is expected in the outer twenty forecast years, 2025 to 2045.

Table 5.3: Forecasted Vehicular Demand for the Corridor Subarea by Weekday Time Period, 2018, 2025 and 2045

Time Period	Model Results			CAGR	
	2018	2025	2045	2018-25	2025-45
AM (6:00-9:00)	1,777,200	2,010,100	2,515,800	1.8%	1.1%
MD (9:00-3:00)	3,938,800	4,619,100	5,771,200	2.3%	1.1%
PM (3:00-6:00)	2,220,400	2,522,700	3,157,900	1.8%	1.1%
EV (6:00-10:00)	1,853,000	2,154,800	2,706,000	2.2%	1.1%
NI (10:00-6:00)	592,600	719,600	931,900	2.8%	1.3%
Daily	10,382,000	12,026,300	15,082,800	2.1%	1.1%

Source: PSRC Trip-Based Travel Model 4K Version 4.03

5.3 TOLL DIVERSION MODEL (TDM) AND CALIBRATION

The second element of the modeling process involved a toll diversion model (TDM) incorporated into EMME software environment. The input trip tables were adopted from the regional level model and the highway network is adopted from the regional level highway network with enhanced coding to enable toll diversion modeling. The TDM is a logit-based route choice model embedded within an equilibrium assignment routine. The calibration of the base year 2018 model focused on both matching the observed corridor volumes as well as calibrating the model to adequately predict the SR 520 floating bridge usage.

In the TDM, the five time periods from the regional model are further broken down into 10 sub-periods, reflective of the 12 toll periods implemented by WSDOT on the SR 520 bridge under the existing and future year schemes. The regional model and the TDM time periods are listed in Table 5.4.

Table 5.4: Travel Demand Model (TDM) Weekday Time Periods Analyzed

Regional Model Period	Toll Diversion Model Period	Toll Periods
NI (10:00 PM - 6:00 AM)	NI2	12:00-5:00
	AM1	5:00-6:00
AM (6:00 AM - 9:00 AM)	AM2	6:00-7:00
	AM3	7:00-9:00
MD (9:00 AM - 3:00 PM)	MD1	9:00-10:00
	MD2	10:00-2:00
	MD1	2:00-3:00
PM (3:00 PM - 6:00 PM)	PM1	3:00-6:00
EV (6:00 PM - 10:00 PM)	EV1	6:00-7:00
	EV2	7:00-9:00
	NI1	9:00-11:00
NI (10:00 PM - 6:00 AM)	NI2	11:00-12:00

5.3.1 Toll Diversion Modeling (TDM) Parameters

The toll diversion model adopted for this project is based on a process that Stantec initially developed in 2001 for the Central Texas Turnpike System (CTTS) in Austin, Texas. This model has successfully predicted traffic and revenue for several toll facilities and, as noted within this report, was recently calibrated to replicate current conditions for the SR 520 bridge. The diversion model is essentially a logit-based route choice model embedded within a highway assignment routine to allocate traffic into appropriate toll-usage type. The structure of the toll diversion model is defined as follows:

$$\text{Toll Share} = (1 / (1 + e^{U}))$$

Where:

Toll Share = Probability of selecting a toll road
e = Natural Logarithm
U = “Utility” of Toll Route: a * (TimeTR-TimeFR) + b * Cost + CTR + CETC
TimeTR = Toll road travel time in minutes
TimeFR = Nontoll road travel time in minutes
Cost = Toll in dollars
CTR = Constant for toll road bias
CETC = Constant for ETC bias
a,b = Coefficients

The value of time used in the modelling effort varies by trip purpose and vehicle occupancy as shown in Table 5.5. Of the three trip purposes listed (Home Based Work (HBW), Home Based Other (HBO) and Non-Home Based (NHB)), HBW trips have the highest value of time. The value of time for vehicles with two and more occupants is higher than the value of time for single occupant vehicles because there is more than one individual in the vehicle who experiences time savings. For this study, the values of time were derived from 2015 Household Income supplied by The American Community Survey. The prior study used values of time derived from 2014 Household Income data from the same source.

Table 5.5: Travel Demand Model (TDM) Value of Time by Trip Purpose and Vehicle Occupancy (2015$)

Trip Purpose		Occupany/ Vehicle Type	Value of Time
HBW	Income 1	SOV	$9.40
	Income 2	SOV	$17.41
	Income 3	SOV	$24.12
	Income 4	SOV	$34.42
	All-Income	SOV	$20.33
		HOV2	$23.36
		HOV3+	$29.20
HBO		SOV	$16.37
		HOV2	$18.83
		HOV3+	$23.52
NHB		SOV	$16.90
		HOV2	$19.44
		HOV3+	$24.29
Trucks		Light	$16.90
		Medium	$26.54
		Heavy	$59.18

Source: Stantec derived from American Community Survey Data

5.3.2 Toll Diversion Model (TDM) Calibration Results

The TDM calibration efforts included segment-specific capacity and speed adjustments to match observed volumes. The objective of the calibration effort is to replicate the overall traffic level at the various screenlines (as illustrated previously in Figure 3-5) with the emphasis on traffic across Lake Washington (part of Screenline 1), and, ultimately, the patronage of SR 520 and its major competitive roadway, I-90. The results at individual time periods and the daily level for corresponding facilities across various screenlines, listed in Table 5.6, show that the model-estimated traffic by screenline is within 5 percent of the daily observed volumes, except for Screenline 2 located east of I-405. The differential on this screenline can be attributed to the lower highway network coverage (e.g. not all roadways are included) of arterial roadways in the model for the corresponding area.

Table 5.6: TDM Calibration Results by Screenline and by Time Period

Screenline	Facility	Total Two-Way Volume											
		AM1 (5:00-6:00)			AM2 (6:00-7:00)			AM3 (7:00-9:00)			MD1 (9:00-10:00/2:00-3:00)		
		GP + HOV			GP + HOV			GP + HOV			GP + HOV		
		Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)
1: Lake Washington	SR 522 at 68th Ave NE	1,108	918	-17%	2,518	2,137	-15%	5,490	5,752	5%	5,010	4,996	0%
	SR 520/Evergreen Point Floating Bridge	1,097	1,448	32%	3,226	3,744	16%	14,440	13,702	-5%	10,630	9,678	-9%
	I-90/Murrow Memorial Bridge	3,830	3,934	3%	9,651	9,683	0%	24,308	27,188	12%	20,030	22,804	14%
	SR 900 East of I-5	803	393	-51%	1,837	1,306	-29%	4,118	4,525	10%	3,727	3,567	-4%
	I-405 East of SR 181	8,010	5,399	-33%	9,237	9,153	-1%	18,856	22,690	20%	19,284	21,746	13%
	Total	**14,850**	**12,093**	**-19%**	**26,470**	**26,022**	**-2%**	**67,211**	**73,857**	**10%**	**58,681**	**62,791**	**7%**
2: East of I-405	SR 522	2,683	1,709	-36%	3,650	3,455	-5%	7,135	9,197	29%	6,489	9,015	39%
	SR 520	3,188	3,771	18%	5,767	7,070	23%	18,100	17,885	-1%	15,717	16,055	2%
	I-90	4,097	4,029	-2%	8,720	8,944	3%	22,252	24,179	9%	19,584	21,548	10%
	Total	**9,968**	**9,509**	**-5%**	**18,138**	**19,469**	**7%**	**47,487**	**51,261**	**8%**	**41,790**	**46,618**	**12%**
3: North of SR-520	I-5	6,357	6,374	0%	10,322	11,256	9%	24,791	29,942	21%	23,340	24,378	4%
	I-405	6,771	4,363	-36%	11,118	8,241	-26%	25,113	24,233	-4%	25,103	22,557	-10%
	Total	**13,129**	**10,736**	**-18%**	**21,440**	**19,497**	**-9%**	**49,904**	**54,175**	**9%**	**48,443**	**46,935**	**-3%**
4: Between SR-520 and I-90	I-5	7,994	7,156	-10%	11,801	12,326	4%	26,317	30,267	15%	25,141	26,500	5%
	I-405	6,727	4,645	-31%	10,280	8,700	-15%	21,904	22,511	3%	20,692	19,809	-4%
	Total	**14,722**	**11,801**	**-20%**	**22,080**	**21,025**	**-5%**	**48,221**	**52,778**	**9%**	**45,832**	**46,308**	**1%**
5: South of I-90	I-5	10,312	7,452	-28%	12,842	13,249	3%	25,320	32,002	26%	25,485	30,178	18%
	I-405	7,027	4,299	-39%	9,068	7,148	-21%	18,613	18,780	1%	17,316	16,062	-7%
	Total	**17,339**	**11,751**	**-32%**	**21,910**	**20,398**	**-7%**	**43,933**	**50,782**	**16%**	**42,801**	**46,240**	**8%**

Screenline	Facility	Total Two-Way Volume											
		MD2 (10:00-2:00)			PM1 (3:00-6:00)			EV1 (6:00-7:00)			EV2 (7:00-9:00)		
		GP + HOV			GP + HOV			GP + HOV			GP + HOV		
		Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)
1: Lake Washington	SR 522 at 68th Ave NE	8,656	9,308	8%	9,113	8,009	-12%	2,598	2,645	2%	3,151	3,181	1%
	SR 520/Evergreen Point Floating Bridge	16,932	15,682	-7%	19,125	18,448	-4%	5,612	5,503	-2%	6,259	5,987	-4%
	I-90/Murrow Memorial Bridge	33,564	41,581	24%	36,370	39,255	8%	10,865	12,240	13%	12,853	14,127	10%
	SR 900 East of I-5	6,427	7,659	19%	6,829	5,738	-16%	1,948	1,610	-17%	2,333	1,656	-29%
	I-405 East of SR 181	38,093	45,715	20%	30,504	35,919	18%	9,866	12,071	22%	16,632	15,519	-7%
	Total	**103,672**	**119,945**	**16%**	**101,941**	**107,370**	**5%**	**30,889**	**34,069**	**10%**	**41,228**	**40,469**	**-2%**
2: East of I-405	SR 522	11,684	17,334	48%	12,262	13,182	7%	3,244	4,977	53%	3,871	6,042	56%
	SR 520	26,930	31,035	15%	24,820	27,457	11%	7,755	8,703	12%	10,796	11,131	3%
	I-90	34,659	42,396	22%	34,212	36,730	7%	9,852	11,274	14%	12,903	13,474	4%
	Total	**73,273**	**90,765**	**24%**	**71,294**	**77,369**	**9%**	**20,852**	**24,954**	**20%**	**27,570**	**30,648**	**11%**
3: North of SR-520	I-5	46,640	49,411	6%	31,925	45,254	42%	11,271	13,361	19%	19,439	16,309	-16%
	I-405	45,741	47,024	3%	39,138	40,134	3%	11,012	12,999	18%	16,346	15,607	-5%
	Total	**92,381**	**96,435**	**4%**	**71,062**	**85,387**	**20%**	**22,283**	**26,360**	**18%**	**35,785**	**31,916**	**-11%**
4: Between SR-520 and I-90	I-5	49,220	52,326	6%	39,765	46,574	17%	12,699	14,267	12%	20,456	18,019	-12%
	I-405	37,518	38,762	3%	29,735	34,656	17%	8,574	11,432	33%	13,406	14,062	5%
	Total	**86,738**	**91,088**	**5%**	**69,500**	**81,230**	**17%**	**21,274**	**25,699**	**21%**	**33,862**	**32,081**	**-5%**
5: South of I-90	I-5	50,830	59,107	16%	41,410	47,413	14%	13,234	16,949	28%	22,242	21,890	-2%
	I-405	33,840	33,176	-2%	25,759	27,420	6%	7,919	9,537	20%	13,222	11,970	-9%
	Total	**84,670**	**92,283**	**9%**	**67,169**	**74,833**	**11%**	**21,153**	**26,486**	**25%**	**35,465**	**33,860**	**-5%**

Screenline	Facility	Total Two-Way Volume								
		NT1 (9:00-11:00)			NT2 (11:00-5:00)			Daily		
		GP + HOV			GP + HOV			GP + HOV		
		Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)	Obs	Est	% Diff (Est-Obs)
1: Lake Washington	SR 522 at 68th Ave NE	1,743	2,160	24%	931	1,396	50%	40,321	40,502	0%
	SR 520/Evergreen Point Floating Bridge	3,604	3,535	-2%	1,831	2,231	22%	82,757	79,958	-3%
	I-90/Murrow Memorial Bridge	8,129	9,309	15%	5,327	5,530	4%	164,927	185,649	13%
	SR 900 East of I-5	1,291	946	-27%	687	562	-18%	30,000	27,963	-7%
	I-405 East of SR 181	12,265	12,814	4%	14,781	7,545	-49%	177,528	188,569	6%
	Total	**27,033**	**28,764**	**6%**	**23,558**	**17,263**	**-27%**	**495,533**	**522,642**	**5%**
2: East of I-405	SR 522	1,800	4,013	123%	2,043	2,487	22%	54,862	71,411	30%
	SR 520	6,017	8,854	47%	4,947	5,479	11%	124,037	137,441	11%
	I-90	7,746	9,583	24%	5,536	5,806	5%	159,562	177,964	12%
	Total	**15,563**	**22,450**	**44%**	**12,526**	**13,772**	**10%**	**338,461**	**386,815**	**14%**
3: North of SR-520	I-5	14,913	11,972	-20%	15,278	7,672	-50%	204,274	215,929	6%
	I-405	9,721	10,403	7%	8,620	6,228	-28%	198,683	191,789	-3%
	Total	**24,634**	**22,375**	**-9%**	**23,897**	**13,900**	**-42%**	**402,957**	**407,718**	**1%**
4: Between SR-520 and I-90	I-5	15,220	14,954	-2%	16,505	10,162	-38%	225,118	232,551	3%
	I-405	8,638	10,885	26%	9,041	6,589	-27%	166,515	172,051	3%
	Total	**23,858**	**25,839**	**8%**	**25,546**	**16,751**	**-34%**	**391,633**	**404,602**	**3%**
5: South of I-90	I-5	16,835	17,429	4%	18,788	10,707	-43%	237,298	256,375	8%
	I-405	9,362	10,138	8%	10,605	6,192	-42%	152,730	144,723	-5%
	Total	**26,197**	**27,567**	**5%**	**29,393**	**16,899**	**-43%**	**390,029**	**401,099**	**3%**

Compared to the regional model results (listed previously in Table 5.1), the daily volumes across Lake Washington (part of Screenline 1) estimated by the TDM are acceptably matching the observed volumes at a difference of 5 percent. Similarly, the estimated volumes for the individual facilities in Screenline 1 also match the daily observed volumes.

In addition, the model-estimated versus observed SR 520 bridge volumes for the individual time periods during the morning peak, between-peak, and afternoon peak periods (11 hours in total from 7:00 am to 6:00 pm) are well within 10 percent. Overall, the TDM replicates the observed peaking patterns across Lake Washington reasonably well.

5.3.3 Post-Processing Adjustment Factors

Results from the TDM by travel direction, vehicle class, and time period were compared with FY 2018 transaction data from the Customer Service Center. Adjustment factors were developed from this relationship to post-process the TDM traffic estimates into a more finely tuned representation of FY 2018 toll transaction patterns for the purpose of revenue validation. These post-processing factors were applied universally to all model year results generated by the TDM, by travel direction, vehicle class and time period

6.0 TRAFFIC AND GROSS TOLL REVENUE POTENTIAL FORECAST

The traffic and revenue forecasts for the SR 520 bridge have been prepared using the actual data collected and analyzed (Chapter 3), the socio-economic and land use data (Chapter 4), and the modeling processes (Chapter 5). Using all of these data and the model, average weekday forecasts were prepared for 2025 and 2045. This chapter documents the future year modeling assumptions and the procedures that were used to convert the daily weekday traffic and revenue model results to an annual forecast for fiscal years 2019 through 2056.

6.1 ASSUMPTIONS FOR FUTURE YEARS

6.1.1 Toll Policy Assumptions

The future forecasts presented herein assume the current toll schedule on the SR 520 bridge (FY 2018, or as of July 1, 2017) will remain in effect over the entire forecast period. No future changes in toll rates were assumed, nor were any future changes assumed to the available payment options or fees. Because the future toll rates do not increase over time, the real toll cost to the customer decreases over time in comparison to inflationary increases in wages and the prices of other goods and services, thus making the toll route more attractive. Table 6.1 shows the toll rates assumed in our forecasts for all future years.

Table 6.1: Assumed Directional 2-axle Vehicle Toll Rates by Time Period and by Payment Type, FY 2018 Onwards

Time Period	FY 2018 and After			
	Good to Go!		Pay by Mail[1]	
	weekday	weekend	weekday	weekend
12-5 AM	$1.25	$1.25	$3.25	$3.25
5-6 AM	$2.00	$1.40	$4.00	$3.40
6-7 AM	$3.40	$1.40	$5.40	$3.40
7-8 AM	$4.30	$1.40	$6.30	$3.40
8-9 AM	$4.30	$2.05	$6.30	$4.05
9-10 AM	$3.40	$2.05	$5.40	$4.05
10AM - 11AM	$2.70	$2.05	$4.70	$4.05
11AM - 2PM	$2.70	$2.65	$4.70	$4.65
2-3 PM	$3.40	$2.65	$5.40	$4.65
3-6 PM	$4.30	$2.65	$6.30	$4.65
6-7 PM	$3.40	$2.05	$5.40	$4.05
7-9 PM	$2.70	$2.05	$4.70	$4.05
9-11 PM	$2.00	$1.40	$4.00	$3.40
11PM - 12AM	$1.25	$1.25	$3.25	$3.25

[1]Pay by Mail rates are equal to the *Good to Go!* toll rate plus a $2.00 increment.

6.1.2 Roadway Network Assumptions

6.1.2.1 SR 520 Improvements

As described in Chapter 2, the SR 520 bridge is part of the SR 520 Bridge Replacement and HOV Program. The future year construction schedule which shows the geometric assumptions by year is shown in Figure 2-3 on page 2-4.

6.1.2.2 Other Study Area Improvements

The forecasts assume that the highway network improvements in the regional model would be implemented as assumed by the Puget Sound Regional Council in their current regional plan and their regional model. The forecasts also assume that no new competing highway facilities or transportation projects or additional improvements to competing projects will be made during the forecast period.

6.1.3 Socioeconomic Assumptions

The future year socioeconomic assumptions are documented in Chapter 4 of this report.

6.1.4 Commercial Vehicle Assumptions

The forecast assumes that the heavy truck percentages using SR 520 remain low and fairly constant into the future. Table 6.2 summarizes the assumptions used within the TDM model for our forecasts.

Table 6.2: Assumed Weekday Heavy Vehicle Share by Time Period, FY 2025 and 2045

Year	5-6 AM	6-7 AM	7-9 AM	9-10 AM	10AM - 2PM	2-3PM	3-6PM	6-7PM	7-9PM	9-11PM	11PM - 5 AM	Daily
2025	0.7%	1.4%	1.6%	2.4%	3.1%	2.4%	1.3%	0.9%	0.7%	0.7%	0.7%	1.7%
2045	0.8%	1.4%	1.4%	2.5%	3.2%	2.5%	1.3%	0.9%	0.9%	0.8%	0.8%	1.8%

6.1.5 Payment Type Assumptions

Recent trends show that although the *Good to Go!* Market share continues to increase year over year, the percent of *Good to Go!* customers choosing to pay-by-plate has been increasing in the percentage share of total *Good to Go!* transactions. It was assumed that these trends would continue into the future.

6.1.6 Other Assumptions

Other assumptions integral to the forecast include:

- The SR 520 Project will continue to be maintained and efficiently operated.
- The tolls on other toll projects in the Central Puget Sound region shall be comparable to the rates currently envisioned during the forecast period through FY 2056.
- The average cost of owning and operating a personal vehicle will not increase at a rate greater than the general rate of inflation. Motor fuel will continue to be in plentiful supply at prices in line with the general rate of inflation.

- Economic conditions in the country and the Central Puget Sound region will be relatively stable and no major economic recession will occur during the forecast period through FY 2056.
- No material natural disaster or local, state, or national emergency will occur that would alter travel patterns and divert traffic from SR 520.

As for the long-term projections themselves, while they are stated year by year, they are intended to show the long-term trends that may be reasonably anticipated during the forecast period.

6.2 ANNUALIZATION

To convert the average weekday traffic and revenue results into an annual forecast, factors were developed from actual CSC data. Using FY 2018 data, the resulting factor to convert weekday traffic to annual traffic is 319 and the resulting factor to convert weekday revenue to annual revenue is 293. The annual revenue factor is lower than the annual traffic factor because the toll rates vary by weekday and weekend; weekend rates are lower than weekday rates. Also, toll rates vary by time of day, which also reduces the revenue factor, since overnight tolls are much lower than peak hour tolls.

6.2.1 Construction Closures

As part of the SR 520 Bridge Replacement and HOV Program, road closures due to construction are expected. WSDOT provided a schedule of these closures, as shown in Table 6.3. Traffic and revenue forecasts were adjusted to account for both the planned weekday and weekend day closures. Based on FY 18 CSC data, it was estimated that one weekend day represents around 0.20 percent of annual transactions and 0.14 percent of annual revenue, and that one weekday night represents less than 0.01 percent of both annual transactions and annual revenue.

Table 6.3 : SR 520 Closure Assumptions, Weekday Night and Weekend Days, Amounts per Fiscal Year

FY	SR 520 Main Span		Portage Bay Bridge		Total	
	Weekday Night	Weekend	Weekday Night	Weekend	Weekday Night	Weekend
2018	1.6	4.0			1.6	4.0
2019		10.0			0.0	10.0
2020	29.5	17.0	6.0	3.5	35.5	20.5
2021	29.0	16.0	8.8	5.0	37.8	21.0
2022	29.5	17.0	8.8	5.0	38.3	22.0
2023	23.0	13.0	7.5	2.5	30.5	15.5
2024			10.0	3.0	10.0	3.0
2025			10.0	3.0	10.0	3.0
2026			12.0	7.0	12.0	7.0
Total	**112.6**	**77.0**	**63.1**	**29.0**	**175.7**	**106.0**

Source: WSDOT

6.2.2 Roadway Configuration / Construction Staging

To account for the geometric changes on SR 520 due to the construction staging, 2025 was modeled using three different configurations; the FY 2018 configuration, the FY 2024-2027 configuration, and the FY 2028-2056 configuration. The results indicated that the changes in configuration would have impacts in the annual traffic and revenue, and the traffic and revenue streams were adjusted to reflect construction phasing.

6.3 ANNUAL TRAFFIC AND GROSS TOLL REVENUE POTENTIAL FORECASTS

The annual actual and forecasted traffic and gross toll revenue potential is shown in Table 6.4, along with the average revenue per transaction and The *Good to Go!* transaction share. Transactions are expected to increase from 25.8 million transactions in FY 2018 to 43.2 million transactions in FY 2056, an average annual increase of 1.4 percent per year. Gross toll revenue potential is expected to increase from $90.3 million in FY 2018 to $148.5 million in FY 2056, an average annual increase of 1.3 percent per year. The average toll rate is expected to decrease slightly over time, from $3.50 to $3.44 as the *Good to Go!* share increases from 85.3 percent in FY 2018 to 88.4 percent by FY 2056. The annual transaction and gross toll revenue potential forecast is shown in Table 6.4 and in Figure 6-1.

Table 6.4: Annual Actual and Forecasted Traffic and Gross Toll Revenue Potential, FY 2012 to 2056

Fiscal Year	Annual Toll Transactions	Annual Gross Potential Revenue	Avg. Revenue per Transaction	Good to Go! Percentage Share
2012*[1]	9,600,000	$28,100,000	$2.93	
2013*	20,200,000	$61,300,000	$3.03	83.6%
2014*	20,959,573	$64,589,148	$3.08	84.4%
2015*	22,019,770	$69,383,209	$3.15	84.3%
2016*	23,217,000	$74,974,236	$3.23	84.5%
2017*	23,974,779	$81,913,285	$3.42	84.7%
2018*[2]	25,785,356	$90,349,101	$3.50	85.3%
2019	26,366,000	$92,575,000	$3.51	85.5%
2020	26,596,000	$94,093,000	$3.54	85.7%
2021	27,238,000	$96,257,000	$3.53	85.8%
2022	27,937,000	$98,656,000	$3.53	86.0%
2023	29,101,000	$102,187,000	$3.51	86.1%
2024	30,752,000	$106,788,000	$3.47	86.3%
2025	31,534,000	$109,523,000	$3.47	86.5%
2026	31,959,000	$111,192,000	$3.48	86.6%
2027	33,135,000	$114,680,000	$3.46	86.8%
2028	34,199,000	$118,311,000	$3.46	86.9%
2029	34,754,000	$120,028,000	$3.45	87.1%
2030	35,453,000	$122,355,000	$3.45	87.2%
2031	36,189,000	$124,914,000	$3.45	87.4%
2032	37,001,000	$127,660,000	$3.45	87.5%
2033	37,236,000	$128,400,000	$3.45	87.6%
2034	37,585,000	$129,562,000	$3.45	87.7%
2035	37,892,000	$130,474,000	$3.44	87.7%
2036	38,359,000	$132,068,000	$3.44	87.8%
2037	38,633,000	$133,039,000	$3.44	87.9%
2038	38,982,000	$134,197,000	$3.44	88.0%
2039	39,331,000	$135,354,000	$3.44	88.0%
2040	39,758,000	$136,703,000	$3.44	88.1%
2041	39,984,000	$137,405,000	$3.44	88.2%
2042	40,378,000	$138,820,000	$3.44	88.3%
2043	40,726,000	$139,974,000	$3.44	88.3%
2044	41,202,000	$141,594,000	$3.44	88.4%
2045	41,442,000	$142,348,000	$3.43	88.5%
2046	41,673,000	$143,040,000	$3.43	88.5%
2047	41,882,000	$143,767,000	$3.43	88.5%
2048	42,216,000	$145,069,000	$3.44	88.5%
2049	42,204,000	$145,008,000	$3.44	88.5%
2050	42,323,000	$145,425,000	$3.44	88.5%
2051	42,442,000	$145,846,000	$3.44	88.5%
2052	42,600,000	$146,198,000	$3.43	88.5%
2053	42,682,000	$146,689,000	$3.44	88.5%
2054	42,802,000	$147,112,000	$3.44	88.5%
2055	42,922,000	$147,536,000	$3.44	88.5%
2056	43,176,000	$148,452,000	$3.44	88.5%

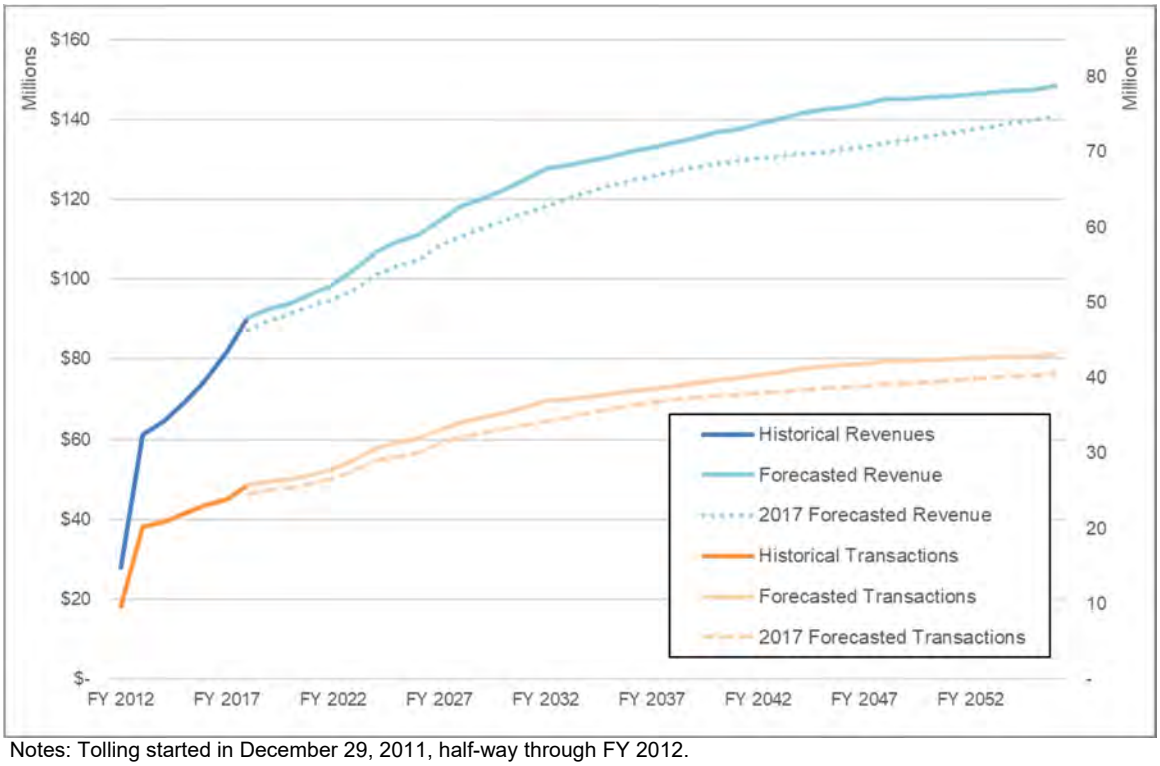
* Actual toll transactions and estimated actual potential gross toll revenue, Transportation Revenue Forecast Council, Transportation Economic and Revenue Forecasts

[1] Tolling started in December 29, 2011, half-way through FY 2012.

[2] Overnight tolling between the hours of 12am-5am began in July FY 2018

Source: Stantec's 2018 November Forecast

Figure 6-1: Annual Actual and Forecasted Traffic and Gross Toll Revenue Potential, 2018 vs. 2017 Forecasts, FY 2012 to 2056



Notes: Tolling started in December 29, 2011, half-way through FY 2012.
Prior to FY 2018, untolled trips between 11PM and 5AM were not included in the transaction total

Figure 6-1 also shows a comparison of the current 2018 forecast to the prior forecast presented in November 2017. The current forecast is slightly higher than the prior forecast, largely due to slightly higher than expected growth that actually occurred in FY 2018. One reason for this growth is due to the amount of toll transactions that were captured by the introduction of overnight tolling. Additionally, the revised land use estimates discussed in Chapter 4.0 contribute to higher growth over time versus those for the November 2017 Forecast. Table 6.5 presents a side by side comparison of the current forecast versus the November 2017 Forecast. As noted by the first line of data, the volume of transactions in FY 2018 was 4.8 percent higher than anticipated. FY 2018 potential revenues came in roughly 3.5 percent higher than the November 2017 Forecast. This higher starting point sets the forecasts up to maintain these positive differences into the future. Combined with the updated land use assumptions, this difference grows over time.

Table 6.5: Annual Actual and Forecasted Traffic and Gross Toll Revenue Potential, 2018 vs. 2017 Forecasts, FY 2012 to 2056

Fiscal Year	Transactions (millions)			Revenue (millions)		
	November 2017	November 2018	Change	November 2017	November 2018	Change
2018*	24.6	25.8	4.8%	$87.3	$90.3	3.5%
2019	25.2	26.4	4.7%	$89.7	$92.6	3.2%
2020	25.4	26.6	4.7%	$91.3	$94.1	3.0%
2021	26.1	27.2	4.3%	$93.5	$96.3	2.9%
2022	26.7	27.9	4.5%	$95.0	$98.7	3.8%
2023	27.7	29.1	5.1%	$97.4	$102.2	5.0%
2024	29.1	30.8	5.8%	$101.1	$106.8	5.6%
2025	29.6	31.5	6.4%	$103.2	$109.5	6.1%
2026	30.1	32.0	6.3%	$104.7	$111.2	6.2%
2027	31.4	33.1	5.6%	$108.4	$114.7	5.8%
2028	32.1	34.2	6.6%	$110.6	$118.3	7.0%
2029	32.7	34.8	6.2%	$112.8	$120.0	6.4%
2030	33.3	35.5	6.5%	$114.8	$122.4	6.6%
2031	33.8	36.2	7.1%	$116.5	$124.9	7.2%
2032	34.3	37.0	7.8%	$118.2	$127.7	8.0%
2033	34.8	37.2	6.9%	$120.0	$128.4	7.0%
2034	35.4	37.6	6.3%	$121.8	$129.6	6.4%
2035	35.9	37.9	5.6%	$123.3	$130.5	5.8%
2036	36.4	38.4	5.3%	$124.6	$132.1	6.0%
2037	36.8	38.6	5.0%	$125.8	$133.0	5.7%
2038	37.2	39.0	4.9%	$127.1	$134.2	5.6%
2039	37.5	39.3	5.0%	$128.0	$135.4	5.7%
2040	37.6	39.8	5.6%	$129.0	$136.7	6.0%
2041	37.8	40.0	5.7%	$129.6	$137.4	6.0%
2042	38.0	40.4	6.2%	$130.3	$138.8	6.6%
2043	38.2	40.7	6.6%	$130.9	$140.0	6.9%
2044	38.4	41.2	7.3%	$131.3	$141.6	7.9%
2045	38.6	41.4	7.2%	$131.7	$142.3	8.1%
2046	38.8	41.7	7.4%	$132.5	$143.0	8.0%
2047	39.0	41.9	7.4%	$133.3	$143.8	7.9%
2048	39.2	42.2	7.8%	$134.1	$145.1	8.2%
2049	39.3	42.2	7.3%	$134.9	$145.0	7.5%
2050	39.5	42.3	7.1%	$135.7	$145.4	7.1%
2051	39.7	42.4	7.0%	$136.6	$145.8	6.8%
2052	39.9	42.6	6.9%	$137.4	$146.2	6.4%
2053	40.0	42.7	6.6%	$138.3	$146.7	6.1%
2054	40.2	42.8	6.4%	$139.1	$147.1	5.8%
2055	40.4	42.9	6.3%	$139.9	$147.5	5.4%
2056	40.6	43.2	6.4%	$140.8	$148.5	5.4%

* November 2018 forecasts show actual toll transactions and estimated actual potential gross toll revenue, Transportation Revenue Forecast Council, Transportation Economic and Revenue Forecasts

APPENDIX A:
LAND USE FORECAST

Central Puget Sound Region Independent Land Use Forecast Review and Adjustments

November 13, 2018

BERK Consulting

Central Puget Sound Region Independent Land Use Forecast Review and Adjustments

Draft: November 13, 2018

Prepared by BERK Consulting

Study Overview and Approach

BERK Consulting (BERK) conducted an independent review of available population and employment forecast products for the Central Puget Sound Region of Washington State, which includes King, Kitsap, Pierce, and Snohomish Counties. The purpose of this review was to inform the preparation of a new land use forecast product to be used in a SR 520 toll revenue forecasting study. The forecast years for this product are 2018, 2025 and 2045.

BERK used a top-down process to prepare an adjusted land use forecast product. We first reviewed the latest available regional macroeconomic forecast and selected regional targets for population, households, and employment. We then reviewed historic growth trends by county as well as available forecast products to determine the likely distribution of regional growth by county. To determine the allocation of growth to cities and transportation analysis zones (TAZ), we analyzed permitted and pipeline development, historic growth patterns, major investments such as light rail station openings, capacity for growth, and planning for growth at the jurisdictional scale. This report provides an overview of that analysis and its findings.

Data Products Obtained and Reviewed for this Study

FORECAST DATA PRODUCTS

PSRC Macroeconomic Forecast

The Puget Sound Regional Council (PSRC) publishes a macroeconomic forecast for the Central Puget Sound region, including King, Kitsap, Pierce, and Snohomish Counties. The latest forecast, released in 2018, provides annual regional totals of households, total population, household population, group quarter population, and jobs broken down into nine employment categories through the year 2050.[1] A previous release of this forecast (from 2015) was used as a key input for PSRC's land use forecast, Land Use Vision.

PSRC Land Use Vision (LUV)

PSRC's latest land use forecast product, LUV version 2.0 was last updated in April 2017.[2] This product forecasts population, households, and employment sector breakdowns for 2010, 2015, 2025, 2030, 2035, and 2040. It summarizes these forecasts by county, city, and census tract. To support this project, PSRC also provided BERK with LUV household and population forecast summaries for 2015, 2025, and 2040 by TAZ. The smallest available geography for employment forecasts is census tract, and the forecast provided includes significant data suppression at the sectoral level as well as, in some cases, total employment.

[1] See https://www.psrc.org/regional-macroeconomic-forecast

[2] See https://www.psrc.org/projections-cities-and-other-places for details on PSRC's land use forecasting program. Generic references to LUV in this report refer to the LUV version 2.0.

Washington State Employment Security Department (ESD) Employment Projections

ESD releases annual short-term (2-year), medium-term (5-year), and long-term (10-year) employment projections by sector for counties and regions across Washington State. BERK reviewed forecasts for King County, Snohomish County, Pierce County, and the Olympic Region which combines Kitsap, Clallam, and Jefferson Counties.

Office of Financial Management (OFM) Growth Management Act County Projections

In 2017, the Washington State OFM released low, medium, and high population projections for each of the four counties in the Central Puget Sound Region. These projections are prepared by state demographers as directed by state statute. County officials are required to select 20-year comprehensive plan targets from within the range of growth projected by OFM, as directed by the Growth Management Act.

BASELINE EMPLOYMENT

PSRC Total Employment Estimates by Census Tract, 2017

BERK obtained total employment estimates by census tract and county for the year 2017. These estimates reflect PSRC's analysis of Quarterly Census of Employment and Wages (QCEW) data along with more detailed surveys of Boeing, Office of Washington Superintendent of Education of Public Instruction (OSPI) and governmental units throughout the Puget Sound Region, including uniformed military employment. Additionally, PSRC estimates self-employed individuals not covered in QCEW estimates. This dataset reflects some data suppression at the sector level as well as, in some cases, tract totals.

Census LEHD Origin-Destination Employment Statistics (LODES)

BERK obtained estimated employment counts by census block for 2015 broken down by NAICS sector from the U.S. Census Longitudinal Employment Household Dynamics (LEHD) program. These data are developed from the same primary source as PSRC employment estimates. These data have not undergone the same level of review and refinement as PSRC employment estimates, and there are known reliability issues associated with LODES data regarding some workplace locations. However, unlike PSRC employment estimates, there is no suppression of employment counts in LODES data.

DEVELOPMENT PIPELINE

PSRC Pipeline and Master Planned Development Inventory

PSRC surveys counties and cities regarding master planned development (MPD) and other pipeline development expected to be built during the next 10-15 years, following a baseline year of 2014. Raw data was provided to BERK for review and analysis.

Permitted Development in Seattle, Bellevue, Kirkland, and Redmond

BERK obtained development permit data from the Cities of Seattle, Bellevue, Kirkland, and Redmond. We then conducted additional analysis to isolate and summarize nonredundant pipeline residential and nonresidential development by land use category. We worked with local planning and permitting officials to interpret the status of all active building permits and differentiate development in the permitting pipeline based on its relative level of certainty of occurring. Approved projects with high

certainty permitted for completion after April 1, 2018 are assumed to be constructed by 2025. Permits that are not as far along in the pipeline are assumed to result in some development during the 2025 to 2045 forecast period.

LAND CAPACITY

PSRC Land Capacity

PSRC estimates residential and nonresidential growth capacity for all parcels throughout the four-county region. These capacity estimates are used in the PSRC land use forecasting model as one input to help determine the location and amount of future growth to allocate at the parcel scale during the preparation of LUV. Capacity is determined based on PSRC's future land use assumptions, including allowed uses, allowed development density, and expected residential/nonresidential split for mixed-use areas. PSRC staff responsible for land use forecasting indicated that, in most cases, local jurisdictions were consulted during the development of these assumptions and many jurisdictions provided direct input.

PSRC provided raw land capacity data to BERK for review and analysis. Additionally, PSRC provided assumed employment density per square foot by building type and TAZ. BERK conducted additional analysis to estimate buildable land capacity for housing and employment by TAZ for a 2018 baseline.

City of Seattle 2018 and Proposed Land Capacity

Following the development of PSRC's land capacity estimates, the City of Seattle passed new legislation to expand zoning in several neighborhoods in the greater downtown area as well as the University District. Furthermore, the City is currently proposing to increase zoned capacity in many more areas of the city, including all urban villages and centers, as well as many additional areas zoned for commercial development. BERK obtained parcel level data about newly zoned or proposed zoned capacity and summarized capacity on vacant and redevelopable parcels by TAZ as of 2018. This analysis superseded the capacity estimates provided by PSRC in BERK's TAZ level forecast data preparation.

OTHER DATA SETS

Washington State OFM Small Area Estimates

OFM provides annual estimates of population and housing units for the years 2000 through 2018 by county and jurisdiction, as well as estimates through 2017 for small area geographies down to the census block group scale. These estimates are based upon an analysis of best available data for the county in question, including residential building permits, assessor records, postal delivery statistics, and federal census data.[3] BERK reviewed these data for baseline population and housing counts as well as historic growth trends.

Local Jurisdictions' Comprehensive Plans

BERK leveraged reviews of local jurisdiction comprehensive plans conducted previously for the I-405 and Puget Sound Gateway projects. These reviews included all jurisdictions within approximately eight miles of the I-405, SR-167, and the Puget Sound Gateway Program Area and focused on adopted population

[3] For more information, see http://www.ofm.wa.gov/pop/april1/ and http://ofm.wa.gov/pop/smallarea/default.asp.

and employment growth targets as well as the kinds of land use activity being planned for. Local growth targets are set by counties in consultation with cities as part of the process of setting countywide planning policies. Cities then adopt projections consistent with their growth targets in their Comprehensive Plans. BERK reviewed these growth targets for consistency with historic growth trends and PSRC growth forecasts, as discussed in more detail below.

Methodology

2018 BASELINE PREPARATION

Population and Households

BERK obtained OFM small area estimates by census block group for the year 2017 and used GIS analysis to reaggregate housing unit estimates by TAZ.[4] We then compared the results to PSRC's 2015 housing and population estimates by TAZ and adjusted the 2017 totals upwards to reflect OFM 2018 housing estimates for counties. OFM small area assumptions about housing occupancy rates and average household size were then used to derive household and household population estimates. We used a similar process to allocate group quarter population estimates from OFM to TAZ and adjust upward to reflect 2018 estimates by county. To determine the breakdown of households by income level, BERK applied assumed percentage splits in the PSRC LUV forecast, interpolating for the year 2018. Finally, we compared the results of this analysis at the county scale to OFM estimates for consistency.

Employment

Our starting point for baseline employment is PSRC's total employment estimates for 2017. The first step was to develop estimates for suppressed data values at the tract scale. To do this we utilized LODES data for the year 2015 to estimate percentage shares of employment to place in suppressed job sector categories. These preliminary proportional shares were refined to address known limitations in the LODES data with regards to K-12 Education jobs.[5] BERK mapped school locations in Snohomish, King, and Pierce Counties and used this information to help inform estimates of K-12 Education jobs in cases of suppressed values. Our model controlled for PSRC's 2017 county level total employment by sector. Finally, we reaggregated the estimated employment to TAZ using GIS analysis of LODES data to determine the relative shares of employment by TAZ part.

To increase the 2017 employment estimates to 2018, we began by using the PSRC Macroeconomic Forecast for a regional control total. Next, we analyzed ESD's short-term employment forecasts by county/region and sector to determine the relative rates of growth among the four counties. Then we grew employment at the TAZ scale based on historic growth patterns up to the 2018 county control totals. Finally, minor sectoral adjustments were necessary at the TAZ scale to match PSRC's forecasted sector breakdowns.

[4] This reaggregation process eliminated parks, protected areas, and water areas where housing is unlikely to be located.

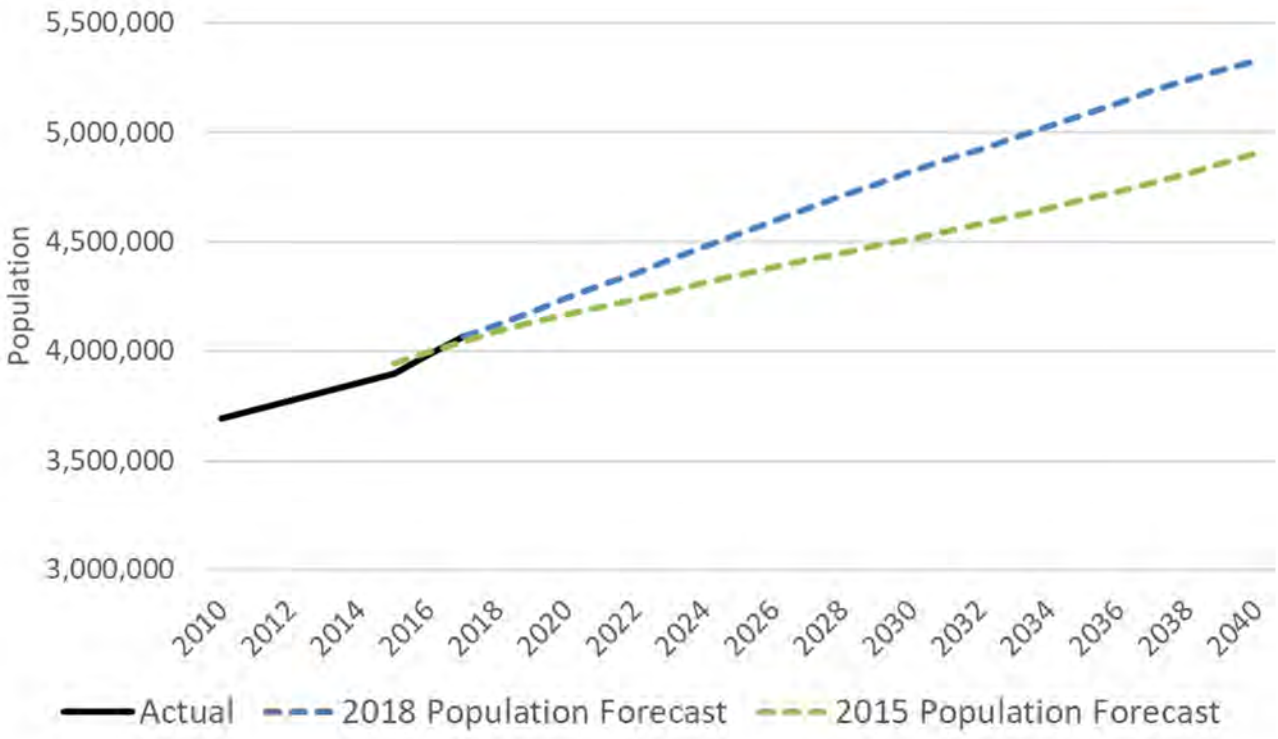
[5] LODES data commonly places educational workers at school district headquarters rather than school locations.

LAND USE FORECAST PREPARATION

We started by reviewing and accepting the total population and employment forecasts for 2025 and 2045 available in the 2018 PSRC Macroeconomic Forecast. PSRC's LUV forecast is based on a previous (2015) release of the PSRC Macroeconomic Forecast. The 2018 forecast shows a significantly higher rate of population growth, as shown in Exhibit 1. It also includes a faster rate of employment growth through 2025, as shown in

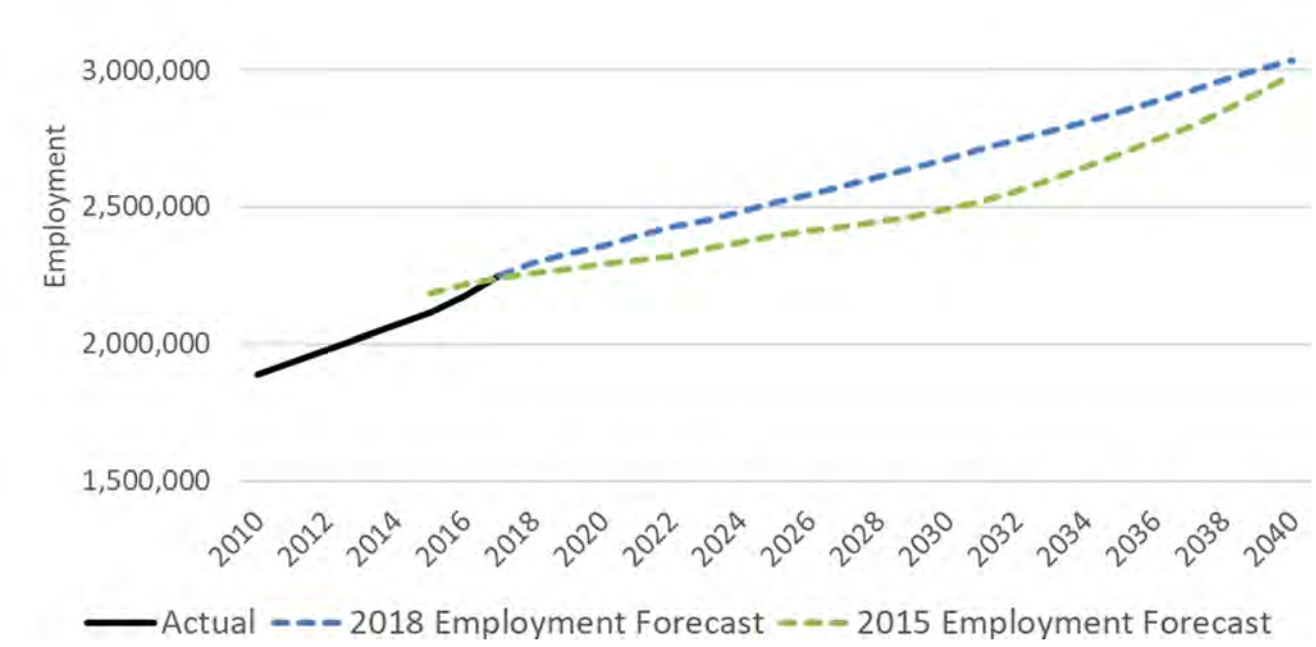
Exhibit 2, and that rate remains steady through 2045.

Exhibit 1. PSRC Macroeconomic Forecast Comparison: Population (2018 release vs. 2015 release)



Source: PSRC 2015 and 2018; BERK 2018.

Exhibit 2. PSRC Macroeconomic Forecast Comparison: Employment (2018 release vs. 2015 release)



Source: PSRC 2015 and 2018; BERK 2018.

Next, we conducted additional analysis to determine the likely allocation of regional population and employment growth at the county, city, and TAZ scale. This work is described in the sections that follow.

County Population Forecasts

Exhibit 3 shows a comparison of population growth rates for each county in the PSRC region. Since 2010, King County has grown most rapidly among the four counties. Looking forward to 2025, the LUV forecast shows a significant slowdown in rate of growth for King County, as well as a slower rate for King County when compared to the other counties. After 2025, LUV shows an even more significant slowing of growth in King County relative to the other counties.

To evaluate PSRC's county-scale forecast, BERK reviewed planned transportation projects and other investments that have potential to shape real estate market dynamics and the shares of future household and employment growth that may be expected by each of the counties in the Puget Sound region. The most significant change expected before 2025 is the opening of Sound Transit's Link light rail extensions to Northgate and Bellevue/Overlake in King County. These extensions are expected to create significant demand for housing and employment near both current and future light rail stations as well as neighboring communities that are accessible to the light rail stations.

BERK identified no other demographic or real estate trends that indicate King County's growth rate will slow compared to neighboring counties during the 2018-2025 forecast period. As mentioned above, this study assumes the total rate of regional growth from 2015-2025 will increase compared to the PSRC LUV forecast, while decreasing compared to trends during the past three years. BERK's 2018-2025 rates of growth by county shows a significant increase in rate of growth for King County, more moderate increases in rate of growth for Pierce and Snohomish Counties and a lower rate of growth for Kitsap County.

For the later 2025-2045 period, BERK's rate of growth for the four-county region is slightly higher than assumed in the PSRC LUV forecast (0.96% vs. 0.83%). During this period relative rates of growth between counties more closely conform to PSRC's LUV forecast. BERK's forecast shows both King and Snohomish County growing somewhat faster than predicted in LUV 2.0, due in part to the expected introduction of new light rail service following 2025.

Exhibit 3. Comparison of Historic and Forecasted Population, Compound Annual Rates of Growth (CAGR)

	Historic Growth		PSRC LUV Forecast		BERK Adjusted Forecast		
	2010-2015	2015-2018	2015-2025	2025-2040	2015-2025	2018-2025	2025-2045
King	1.23%	2.18%	0.95%	0.55%	1.81%	1.65%	0.71%
Kitsap	0.56%	1.14%	1.64%	1.44%	0.98%	0.91%	1.42%
Pierce	0.86%	1.66%	1.27%	0.94%	1.39%	1.28%	0.96%
Snohomish	1.21%	2.05%	1.48%	1.17%	1.92%	1.86%	1.42%
Total	1.10%	1.98%	1.17%	0.83%	1.69%	1.57%	0.96%

Source: OFM, 2018; PSRC, 2017; BERK, 2018.

Exhibit 4 compares total population by county in each forecast. BERK forecasts that regionwide population will be 5.3% higher in 2025. Much of that difference is due to a higher population forecast for King County and to a lesser extent Snohomish County.

Exhibit 4. Comparison of County Population Forecasts

	PSRC LUV Forecast		BERK Adjusted Forecast		Percent Difference
	2025	2040	2025	2045	2025
King	2,255,388	2,449,065	2,456,418	2,832,326	8.9%
Kitsap	303,749	376,362	284,571	377,498	-6.3%
Pierce	941,915	1,083,980	953,260	1,153,089	1.2%
Snohomish	877,328	1,044,543	916,200	1,214,892	4.4%
Total	4,378,380	4,953,950	4,610,449	5,577,805	5.3%

Source: PSRC, 2017; BERK, 2018.

Finally, we also compared adjusted forecast results to OFM population forecasts to confirm consistency. All county forecasts fall within the middle of OFM's forecast range for 2025 and 2045.

County Employment Forecasts

Employment has grown rapidly since 2010. But that growth has been unevenly distributed across the region. As shown in Exhibit 5, between 2010 and 2017 King County has grown at a 3% compound annual rate, while Snohomish County has been growing at 2.3%. Kitsap and Pierce Counties have been growing at somewhat slower rates. PSRC's LUV Forecast shows a significant slowdown in growth rates across the region as well as much less variation in rates of growth. ESD's total employment forecast, on the other hand, indicates that King County will continue to grow at a significantly faster rate than the other counties.

Our adjusted 2025 total employment forecast reflects the regionwide rate of growth expected in the PSRC Macroeconomic Forecast which is slightly lower than ESD's forecast. Our forecast also reflects the

relative differences in growth rates observed in recent historic trends and the ESD forecast. As noted above, the most significant infrastructure change during this period which would could impact the distribution of employment growth will be the introduction of new light rail stations in Seattle, Mercer Island, and Bellevue.

As shown above in

Exhibit 2, the newest PSRC Macroeconomic Forecast predicts a somewhat slower rate of growth from 2025 to 2045 than was assumed in the previous forecast on which PSRC's LUV is based. However total employment in 2045 is expected to be slightly higher than assumed in the previous forecast. BERK's adjusted forecast products also reflect these new assumptions. With regards to the distribution of growth by county, BERK assumes the same relative rates as the LUV 2025-2040 forecast, adjusted downward to reflect expected macroeconomic conditions.

Exhibit 5. Comparison of Historic and Forecasted Employment CAGR

	HISTORIC GROWTH	PSRC LUV FORECAST		ESD FORECAST*	BERK ADJUSTED FORECAST	
	2010-2017	2015-2025	2025-2040	2018-2026	2018-2025	2025-2045
King	3.03%	0.98%	1.30%	1.75%	1.52%	1.20%
Kitsap	0.99%	1.10%	1.29%	1.28%*	1.08%	1.15%
Pierce	1.70%	0.98%	1.18%	1.12%	1.09%	1.07%
Snohomish	2.33%	1.12%	1.75%	1.13%	1.36%	1.65%
Total	2.61%	1.01%	1.35%	1.56%	1.41%	1.24%

* ESD does not provide a forecast for Kitsap County. This tables shows the Olympic Region forecasted rate of growth, which includes Kitsap County.
Source: PSRC, 2017; PSRC, 2018; ESD, 2018; BERK, 2018.

Exhibit 6 compares the LUV and BERK Adjusted county employment forecasts.

Exhibit 6. Comparison of County Employment Forecasts

	PSRC LUV FORECAST		BERK ADJUSTED FORECAST		PERCENT DIFFERENCE
	2025	2040	2025	2045	2025
King	1,544,032	1,875,067	1,653,571	2,097,259	7.1%
Kitsap	115,369	149,408	114,565	144,137	-0.7%
Pierce	386,148	498,086	393,647	487,155	1.9%
Snohomish	347,770	458,937	353,164	490,154	1.6%
Total	2,393,319	2,981,498	2,514,947	3,218,706	5.1%

Source: PSRC, 2017; BERK, 2018.

JURISDICTION FORECAST REVIEW AND ADJUSTMENTS

Population

BERK's review of PSRC's jurisdiction-level population forecasts focused primarily on cities located within 10 miles of the SR 520 corridor. To evaluate these growth forecasts for the 2018 to 2025 period, BERK compared them to actual growth trends between the years 2010 and 2018[6]. Where LUV projections

[6] Population growth estimates for cities were obtained from Washington State Office of Financial Management (OFM). To measure actual population growth rather than growth due to annexation, BERK calculated growth rates for cities based on consistent geographic boundaries using OFM's small area estimates at the census block group scale.

were consistent or close to historic trends, BERK assumes a future rate of growth consistent with the historic trend. Where discrepancies occurred, BERK used supporting information from discussions with local planners, local comprehensive plans[7], and subsequent city planning efforts that may impact the capacity and rate of growth within a city. Our underlying default assumption is that as long as there is capacity for new growth, the factors driving population growth are unlikely to change before 2025.

There are a few exceptions to these default assumptions. First, BERK considered local factors that resulted in an uncommonly high growth rate for the 2010-2018 period, such as a large master planned development. Secondly, some jurisdictions are actively planning for increased growth in the future based on anticipated improvement in transit accessibility. The introduction of light rail, and to a much lesser extent transit-oriented development planned around bus rapid transit, represent a major change in factors supporting growth. Communities that are planning now for these changes will likely see higher rates of growth over the next 10 years than the historic trend. In these cases, a higher rate consistent with PSRC forecasted growth is assumed. The results of this analysis for cities and urban growth areas in King County is summarized in Exhibit 7.[8] Details about BERK's research and outreach to individual cities is available in the final section of this report.

BERK's adjustments also consider known development pipeline projects summarized by jurisdiction as well as limitations to buildable land capacity for new growth[9]. As discussed above, BERK obtained and analyzed all active building permits in Seattle, Bellevue, Kirkland, and Redmond as of August 2018 to support this analysis.

A similar process was used to review and adjust growth during the 2025 to 2045 forecast period. However, during this period more deference was given to rates of growth expected in PSRC's LUV forecast, after accounting for BERK's adjustment to countywide rates of growth. Total growth by jurisdiction was then compared to available land capacity. In situations where anticipated growth exceeds PSRC's estimated capacity, BERK reviewed comprehensive plans and reached out to selected city planning officials to further review land capacity estimations. Following any relevant land capacity adjustments, BERK reallocated growth exceeding capacity to jurisdictions with excess capacity in proportion to expected shares of forecasted county growth. Finally, we compared the results to LUV, historic trends, and adjusted rates of growth during the 2015 to 2025 period for reasonableness.

---

[7] Jurisdictional population growth targets are set by counties in consultation with cities as part of the process of setting countywide planning policies. Cities then adopt projections consistent with their growth targets in their Comprehensive Plans.

[8] PSRC forecasts household and population growth by city and unincorporated urban growth areas (one forecast zone for each county) based on 2014 geographic boundaries. It maintains these geographic boundaries in future years for the purpose of consistency in forecasting. BERK used the same assumptions in adjusted forecasts. BERK's calculated historic growth rates (2010 – 2018) account for annexations to avoid counting annexed population as actual population growth.

[9] Total population growth allocations were limited by available capacity minus a standard 25% market factor deduction. This deduction is common in land capacity studies and reflects the fact that not every available parcel in a jurisdiction with additional zoned capacity is expected to become available for development or redevelopment within the forecast period. In BERK's forecast calculations, any growth in excess of capacity was reallocated to other jurisdictions with excess capacity, proportional to their total forecasted growth.

Employment

BERK applied a similar method for reviewing and adjusting the PSRC LUV forecasted employment growth rates by jurisdiction. Exhibit 8 compares historic, PSRC forecasted, and BERK's adjusted employment growth rates by selected jurisdiction in King County. The review of historic trends revealed that, in many communities, some of the employment growth from 2010-2017 reflects recovery from the economic recession rather than new development. Details about BERK's research and outreach to individual cities are available in the final section of this report.

Exhibit 7. Comparison of PSRC and BERK Population Growth CAGR, select King County Jurisdictions*

JURISDICTION	2010 – 2018	LUV 2015 - 2025	BERK 2018 - 2025	LUV 2025 - 2040	BERK 2025 - 2045
Auburn	1.49%	1.13%	1.23%	0.77%	0.74%
Bellevue	1.34%	1.12%	2.50%	0.69%	1.13%
Bothell	1.75%	1.12%	1.44%	0.50%	0.69%
Burien	1.09%	0.96%	0.90%	0.49%	0.51%
Clyde Hill	0.25%	0.07%	0.21%	0.18%	0.15%
Hunts Point	0.80%	0.39%	0.66%	0.17%	0.29%
Issaquah	2.51%	0.75%	0.48%	0.76%	0.49%
Kenmore	1.43%	1.41%	1.11%	1.01%	0.81%
Kent	1.13%	0.64%	0.94%	0.31%	0.45%
Kirkland	1.05%	0.73%	1.20%	0.37%	0.56%
Lake Forest Park	0.48%	0.56%	0.39%	0.35%	0.28%
Medina	1.12%	0.49%	0.92%	0.14%	0.37%
Mercer Island	0.84%	0.65%	0.97%	0.43%	0.51%
Newcastle	2.26%	0.79%	1.87%	0.25%	0.73%
Normandy Park	0.50%	0.42%	0.41%	0.28%	0.26%
Redmond	2.04%	1.38%	2.13%	0.96%	1.12%
Renton	1.59%	1.21%	1.31%	0.59%	0.69%
Sammamish	1.28%	0.43%	0.55%	0.32%	0.32%
SeaTac	1.00%	1.56%	0.82%	1.42%	0.89%
Seattle	2.31%	1.01%	1.91%	0.57%	0.88%
Shoreline	0.63%	0.76%	1.42%	0.52%	0.70%
Tukwila	0.45%	1.68%	1.22%	1.56%	1.08%
Woodinville	0.98%	1.97%	0.81%	1.67%	1.00%
Yarrow Point	0.78%	0.45%	0.64%	0.21%	0.30%
Unincorporated Urban Growth Areas	1.53%**	0.55%	1.63%	0.29%	0.67%

* All rates based on growth in constant geography to avoid influence of annexations.
** Historic CAGR based on 2010-2015 period for unincorporated UGAs only.
Source: OFM, 2018; PSRC, 2017; BERK, 2018.

Exhibit 8. Comparison of PSRC and BERK Employment Growth CAGR, select King County Jurisdictions*

JURISDICTION	2010 – 2017**	LUV 2015 - 2025	BERK 2018 - 2025	LUV 2025 - 2040	BERK 2025 - 2045
Auburn	2.92%	1.49%	1.36%	1.71%	1.51%
Bellevue	2.05%	0.98%	1.86%	1.49%	1.39%
Bothell	4.17%	0.66%	1.60%	1.24%	1.09%
Burien	2.38%	1.88%	0.95%	1.47%	1.29%
Clyde Hill	1.95%	1.88%	0.22%	-0.09%	0.04%
Covington	1.03%	0.44%	0.52%	0.90%	0.79%
Issaquah	4.11%	2.24%	1.72%	2.59%	2.29%
Kenmore	0.49%	3.96%	1.90%	2.49%	2.19%
Kent	3.05%	0.58%	1.11%	0.76%	0.67%
Kirkland	6.03%	1.24%	2.05%	1.72%	1.52%
Lake Forest Park	-0.90%	0.26%	1.78%	0.61%	0.53%
Medina	1.40%	0.16%	0.00%	-0.09%	-0.08%
Mercer Island	0.50%	0.76%	0.60%	0.80%	0.70%
Newcastle	4.98%	0.19%	0.75%	1.27%	1.11%
Normandy Park	3.75%	0.95%	2.51%	0.64%	-0.03%
Redmond	3.03%	1.02%	1.41%	1.08%	1.56%
Renton	1.96%	1.26%	1.03%	1.73%	1.52%
Sammamish	5.65%	0.66%	1.65%	0.94%	0.83%
SeaTac	4.16%	2.93%	1.99%	2.58%	2.27%
Seattle	3.32%	0.63%	1.54%	1.07%	0.98%
Shoreline	0.10%	1.16%	0.88%	1.17%	1.02%
Tukwila	1.42%	0.93%	4.36%	1.30%	1.14%
Woodinville	2.81%	2.46%	1.09%	1.70%	1.49%
Unincorporated Urban Growth Areas	6.71%	1.96%	3.65%	0.72%	0.63%

* All rates based on growth in constant geography to avoid influence of annexations.
** Historic CAGR based on PSRC covered employment estimates by City. UGA estimated based on Census LEHD employment estimates, 2010-2014.
Source: PSRC, 2017 & 2018; Census LEHD, 2017; BERK, 2018.

ALLOCATION OF JURISDICTION GROWTH TO TAZ

Housing and Employment Growth Capacity

BERK used data about future land use assumptions from PSRC to calculate housing unit and total employment capacity on vacant and redevelopable parcels by TAZ. Within the City of Seattle, BERK used updated parcel-based land capacity calculations based on newly passed and proposed zoning changes. This analysis assumes 25 percent of total aggregate capacity in vacant and underutilized parcels will remain unavailable for development. In cases where the known development pipeline exceeds calculated capacity, the capacity estimates were modified to accommodate all planned growth.

Population and Household Allocation

Beginning with the 2025 forecast period, BERK allocated the adjusted population forecasts for each jurisdiction to households within TAZ. First, group quarter population forecasted in LUV at the jurisdictional scale was subtracted from BERK's adjusted population forecasts and assigned to TAZ consistently with the LUV forecast. Next, BERK allocated population growth to housing units in development pipeline projects expected to build out before 2025. Remaining population growth was then allocated to households[10] in TAZ proportionally to the amount of growth each TAZ was expected to receive in the LUV forecast. If a TAZ is limited by housing capacity, then overflow growth is allocated to other TAZ in the same jurisdiction proportional to their remaining capacity. Within each separate county, unincorporated UGAs and rural areas were each treated as a distinct jurisdiction using this same method.

Employment

The process for allocating total employment growth/loss to TAZ was similar to the approach used for population and households. However, additional work was required to address significant data suppression in the PSRC census tract forecast. In most cases the suppression was limited to the two or more sector totals, while in other cases total employment was also suppressed. Key steps in this process are described below.

Estimating Suppressed Values in LUV TAZ Forecast

To address data suppression in the 2025 LUV forecast, BERK's model first inserted the estimated 2018 values then made adjustments to accommodate all county-level growth or loss of employment by sector to match PSRC's LUV county level sector totals. Adjustments were controlled for total forecasted employment by TAZ and employment capacity in TAZ with suppressed totals. An identical process was used to estimate suppressed values for the 2040 LUV forecast products. Finally, BERK reaggregated census tract data by TAZ based on total employment capacity.

Review and Adjustment to LUV TAZ Forecast

Next, BERK's unsuppressed LUV forecast by TAZ was used as a key input for developing and reviewing

[10] BERK's review of LUV found that PSRC's forecasted rate of reduction in average household sizes by TAZ are faster than demographic trends and PSRC's regional macroeconomic forecast. Therefore, BERK's forecast includes adjusted assumptions about the rate of reduction in average household size by TAZ. In all cases, allocated population to households by TAZ reflect average household size reflect TAZ level conditions and trends.

the adjusted forecast product. To allocate BERK's adjusted jurisdictional total employment growth to TAZ, BERK began by placing development pipeline projects expected to build out before 2025. Remaining employment growth was then allocated to TAZ proportional to the amount of growth each TAZ was expected to receive in the unsuppressed LUV forecast, limited by BERK's calculated capacity. Growth exceeding capacity was then reallocated to other TAZ in the same jurisdiction proportional to their remaining capacity. For each TAZ, preliminary breakdowns by employment sector were based on proportions in the unsuppressed LUV forecast, controlling for consistency with building types in the development pipeline as well as BERK's countywide control totals by employment sector.

REVIEW AND ADJUSTMENT NOTES BY JURISDICTION

This section describes adjustments made to the LUV forecast for individual jurisdictions that diverge from the general assumptions and methodology described above, with a focus on King County jurisdictions. Cases where the general assumptions for jurisdictional review and adjustment were confirmed by further research are not discussed here.

Bellevue

Bellevue worked closely with PSRC to explain and refine their growth projections and land capacity exceptions during the development of Land Use Vision. Light rail will be operative in 2023 and Bellevue has done extensive planning work to create transit-oriented development around future stations and to create a secondary urban center in the Bel-Red area. The city expects that with light rail coming online there will be more growth in the period before 2025 than in the following 10 years. Master planned development of the Spring District is significant and already in the pipeline, likely to peak by 2025. The city also has two growth areas that are still waiting on land use planning and zoning changes that will increase capacity – the Eastgate Corridor, which is primarily employment capacity with some mixed use, and the Wilburton subarea which is likely to increase both employment and population capacity. Those are also expected to occur before 2025.

For both the 2025 and 2045 forecasts, BERK's growth rate adjustments reflect this large pipeline of expected development activity.

Issaquah

During recent years, Issaquah has experienced significant growth, Much of this growth was related to large master planned developments that are expected to reach capacity by 2025. Future growth is mainly expected to occur in the commercial core, as guided by the Central Issaquah Plan. However, in 2016 Issaquah enacted a moratorium on development in the commercial core, with the intent to rework portions of the plan in response to community concerns about land use intensity. The moratorium concluded in 2018 after council adopted several new development regulations, including an inclusionary zoning requirement. BERK expects that the impacts of the moratorium period and changes to regulations will slow future growth in Issaquah compared to historic trends and the LUV forecast.

Redmond

BERK's analysis of city permit data revealed an excess of 4,000 residential units in the short-term pipeline that were not reflected in PSRC's development pipeline database. BERK's forecast assumptions reflect this additional expected growth before 2025, resulting in a rate of residential growth higher than LUV and historic trends.

Seattle

BERK's analysis of city permit data revealed a large amount of new residential and employment pipeline development in both the short and long term which are not reflected in LUV. This includes commercial and industrial development with capacity over 38,000 jobs by 2025, as well as over 21,000 housing units. The availability of this permit data provides more certainty around the expected pattern of growth in Seattle, particularly in the 2025 forecast period.

Based on this known pipeline, as well as the high rate of growth in recent years, BERK forecasts show continued strong growth in Seattle compared to many other King County jurisdictions, and higher than the LUV forecast. However, the rate of employment growth is expected to slow somewhat from the very rapid recent trends due in part to Amazon's decision to locate a second headquarters outside of Seattle.