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March 12, 2019

**TO:** Miguel Gavino, PE  
Traffic Engineer, Snohomish/Mount Baker Area  
WSDOT Northwest Region

**FROM:** Andrew Bratlien, PE  
Senior Transportation Engineer

**SUBJECT:** Costco Lake Stevens Traffic Impact Analysis  
Simulation Analysis Findings

This memorandum describes the findings and recommendations associated with the supplemental simulation analysis performed for the Costco Lake Stevens Traffic Impact Analysis (TIA). This analysis was performed upon request from Washington State Department of Transportation (WSDOT) staff.

#### **METHODS AND ASSUMPTIONS**

A simulation analysis was performed in Vissim 10 software, using the calibrated 2018 PM peak hour simulation model developed for the SR 9 / 24<sup>th</sup> Street SE Intersection Control Evaluation (ICE). The development and calibration of the simulation model, including model inputs, methods, and assumptions, are described in detail in the ICE report.

This simulation analysis focused on Project impacts related to queueing interactions in the study area. Intersection Levels of Service and delay are described in the TIA report.

#### **SCENARIO DEVELOPMENT**

This analysis included one existing conditions (2018) scenario and three future (2025) scenarios, as described below.

- **Existing (2018)** travel demand and transportation network were modeled consistent with the inputs described in the ICE report.
- **2025 No Build** travel demand and transportation improvement project assumptions were modeled consistent with the 2025 Without-Project scenario described in the TIA report.
- **2025 Unimproved Build** travel demand was modeled consistent with 2025 With-Project volumes described in the TIA report. Unimproved Build transportation improvement projects included signal control at the west Costco 24<sup>th</sup> Street SE access. Per the TIA, signal control is not required for Project build-out, however the signal is anticipated to better support Project access and access to and from South Lake Stevens Road of 24<sup>th</sup> Street SE, with build-out of the 20<sup>th</sup> Street SE Corridor Subarea Plan which includes redevelopment and more traffic on 24<sup>th</sup> Street SE.

- **2025 Improved Build** travel demand was assumed to be identical to the Future Unimproved Build demand. Transportation improvement project recommendations were developed based on the results of the Unimproved Build scenario and are described later in this document.

## 2025 NO BUILD CONDITIONS

95<sup>th</sup> percentile queue results for all future scenarios are summarized in **Table 1**. Key results for the No Build scenario are summarized below.

- Bunk Foss Road westbound 95<sup>th</sup> percentile queue will extend 1,050 feet, through the SR 2 westbound off-ramp intersection located 500 feet to the east, impacting off-ramp operations.
- Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 48 minutes (80%) of the PM peak hour.
- SR 2 westbound off-ramp 95<sup>th</sup> percentile queue at Bunk Foss Road will extend approximately 3,675 feet, exceeding off-ramp storage by 2,825 feet and occupying the SR 2 westbound mainline.

## 2025 BUILD CONDITIONS

### Unimproved 2025 Build Conditions

Key results for the Unimproved Build scenario are summarized below.

- SR 9 & 24<sup>th</sup> Street SE roundabout
  - 24<sup>th</sup> Street SE eastbound 95<sup>th</sup> percentile queue at the SR 9 roundabout will extend 300 feet to the west and will not impact South Lake Stevens Road / Costco driveway.
- 24<sup>th</sup> Street SE Costco access
  - 24<sup>th</sup> Street SE westbound 95<sup>th</sup> percentile queue at the signalized South Lake Stevens Road / Costco driveway intersection will extend 225 feet and will not impact the SR 9 roundabout to the east.
- SR 9 & SR 2 westbound ramps
  - Bunk Foss Road westbound 95<sup>th</sup> percentile queue will extend 1,050 feet and through the SR 2 westbound off-ramp intersection 500 feet to the east, impacting off-ramp operations.
  - Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 51 minutes (85%) of the PM peak hour.
  - SR 2 westbound off-ramp 95<sup>th</sup> percentile queue will extend approximately 5,175 feet, including 4,325 feet of queue on the SR 2 westbound mainline.

### Mitigation Recommendations

In the 2025 Unimproved Build scenario, Project-generated trips resulted in an approximately 41 percent increase in 95<sup>th</sup> percentile queue length on the SR 2 westbound off-ramp at Bunk Foss Road. Westbound off-ramp queue consisted of two components: (1) queue stacking from the westbound approach of the SR 9 signalized intersection, and (2) queuing related to the minor approach stop-control on the northbound approach of the SR 2 westbound off-ramp.

Mitigation of westbound off-ramp queuing must ultimately address both components of the queue. In this analysis, the following improvement projects were shown to mitigate queuing impacts:

1. **Rechannelize westbound Bunk Foss Road at SR 9:** Rechannelize Bunk Foss Road by narrowing the existing shoulders to provide three westbound lanes, including exclusive left-turn, through, and right-turn lanes. With shoulder narrowing, the three westbound lanes appear to fit within the existing pavement section. This improvement would allow right-turn-on-red (RTOR) movements to clear the SR 9 / Bunk Foss Road intersection.

2. **Mini-roundabout at Bunk Foss Road and SR 2 westbound off-ramp:** A single-lane 90-foot Inscribed Circle Diameter (ICD), as shown in **Figure 1**. A 90-foot ICD mini-roundabout would fit within the existing pavement. The single-lane westbound roundabout exit leg would transition into a 3-lane westbound entry leg at the SR 9 intersection to the west.



**Figure 1. Conceptual Diagram of Bunk Foss Road Mitigation Projects**

Improved 2025 Build Conditions

Key results for the Improved Build scenario are summarized below.

- Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 15 minutes (25 percent) of the PM peak hour, a reduction of 67 percent from the No Build scenario.
- Roundabout control at the intersection of Bunk Foss Road and SR 2 westbound off-ramp will eliminate queue stacking on the SR 2 westbound mainline, reducing queue from 3,675 feet in the No Build condition to 700 feet in the Improved Build condition, a reduction of approximately 81 percent from the No Build condition.

These improvements prevent 95<sup>th</sup> percentile queuing from impacting the SR 2 mainline, including removing the existing 2,825 feet of mainline queuing which occurs in the 2025 No Build scenario.

Table 1. 95<sup>th</sup> Percentile Queue in feet

Intersection	Movement	2025 No Build		2025 Build (Unimproved)		2025 Build (Improved)	
		Storage (ft)	95 <sup>th</sup> % Queue	Storage (ft)	95 <sup>th</sup> % Queue	Storage (ft)	95 <sup>th</sup> % Queue
8. SR 9 & 24th St	NB	2,500	75	2,500	300	2,500	300
	SB	1,100	275	1,100	450	1,100	450
	EB	400	100	400	300	400	375
	WB	900	75	900	125	900	125
10. SR 9 & US 2 WB on-ramp	NBL	425	50	425	50	425	50
	NBT	875	750	875	850	<b>875</b>	<b>950</b>
	NBR	175	100	175	100	175	100
	SBL	200	50	200	25	200	25
	SBT	5,280	750	5,280	850	5,280	925
	SBR	175	25	175	25	175	25
	WBL	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,050</b>	500	450
	WBT					500	125
	WBR	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,625</b>
11. Bunk Foss Rd & US 2 WB off-ramp	NBL	<b>850</b>	<b>3,675</b>	<b>850</b>	<b>5,175</b>	825	600
	NBR	200	75	200	75		
	EB	500	-	500	-	500	175
	WB	-	25	-	25	-	1,000
12. SR 9 & US 2 EB ramps	NBT	<b>1,725</b>	<b>8,975</b>	<b>1,725</b>	<b>10,000</b>	<b>1,725</b>	<b>10,025</b>
	NBR	150	25	150	25	150	25
	SBL	350	175	350	200	350	225
	SBT	850	500	850	475	850	500
	EBL	1,200	475	1,200	475	1,200	475
	EBR	1,200	125	1,200	125	1,200	125
18. S Lk Stevens Rd & 24th St	NBL			100	25	100	25
	NBTR	425	<25	425	75	425	75
	SBL	-	-	100	175	100	175
	SBTR	-	-	-	<25	-	<25
	EBL	-	-	100	25	100	25
	EBTR	-	-	-	50	-	50
	WBL	100	-	100	75	100	75
	WBT			400	50	400	50
WBR			100	200	100	200	

## FINDINGS AND RECOMMENDATIONS

The key findings of this analysis are summarized below.

- **SR 9 & 24<sup>th</sup> Street SE:** Eastbound 95<sup>th</sup> percentile queue at the SR 9 roundabout will not impact the Costco driveway / South Lake Stevens Road intersection.
- **24<sup>th</sup> Street SE Costco access:** Westbound 95<sup>th</sup> percentile queue at the signalized South Lake Stevens Road / Costco driveway intersection will not impact the SR 9 roundabout to the east.
- **SR 9 & SR 2 westbound ramps:**
  - SR 2 westbound off-ramp 95<sup>th</sup> percentile queue will extend beyond its 850-foot storage and onto the SR 2 westbound mainline in both No Build and Unimproved Build scenarios, including a queue of 3,675 feet in the No Build and 5,175 feet in the Unimproved Build scenario. The No Build queue will extend 2,825 feet onto the SR 2 westbound mainline, and the Unimproved Build queue will extend 4,325 feet onto the SR 2 westbound mainline.
  - The addition of Project-generated trips will cause SR 2 westbound off-ramp 95<sup>th</sup> percentile queue to extend 4,325 feet onto the SR 2 westbound mainline, an increase of 1,500 feet from the No Build condition.
  - Mitigation recommendations include two projects related to SR 2 westbound ramps:
    - Rechannelization of westbound Bunk Foss Road within the existing pavement section at SR 9 to provide exclusive left-turn, through, and right-turn lanes.
    - Construction of a 90-foot ICD mini-roundabout at the Bunk Foss Road & US 2 westbound off-ramp intersection
  - The recommended mitigation projects will have the following effects on queueing:
    - Reduce the duration of Bunk Foss Road westbound queuing interaction between SR 9 and SR 2 westbound off-ramp by 67 percent from the No Build condition.
    - Reduce SR 2 westbound off-ramp 95<sup>th</sup> percentile queue by approximately 81 percent from the No Build condition.

The identified improvements correct existing and future queuing on the SR 2 mainline in addition to fully mitigating the impacts of 37 new Costco trips. Costco's share of the improvement cost should be proportional to the impacts created by Costco.

Costco's estimated share of the improvements is 35 percent, based on mitigating Costco's 1,500-foot share of the total 4,325-foot 95<sup>th</sup> percentile queue on the SR 2 westbound mainline in the 2025 Unimproved Build scenario.

Costco could meet its contribution to the improvement by providing design documentation and plans, specifications, and estimates for the improvements such that WSDOT and or other partner agencies could program construction.



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- **2025 Improved Build** travel demand was assumed to be identical to the Future Unimproved Build demand. Transportation improvement project recommendations were developed based on the results of the Unimproved Build scenario and are described later in this document.

## 2025 NO BUILD CONDITIONS

95<sup>th</sup> percentile queue results for all future scenarios are summarized in **Table 1**. Key results for the No Build scenario are summarized below.

- Bunk Foss Road westbound 95<sup>th</sup> percentile queue will extend 1,050 feet, through the SR 2 westbound off-ramp intersection located 500 feet to the east, impacting off-ramp operations.
- Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 48 minutes (80%) of the PM peak hour.
- SR 2 westbound off-ramp 95<sup>th</sup> percentile queue at Bunk Foss Road will extend approximately 3,675 feet, exceeding off-ramp storage by 2,825 feet and occupying the SR 2 westbound mainline.

## 2025 BUILD CONDITIONS

### Unimproved 2025 Build Conditions

Key results for the Unimproved Build scenario are summarized below.

- SR 9 & 24<sup>th</sup> Street SE roundabout
  - 24<sup>th</sup> Street SE eastbound 95<sup>th</sup> percentile queue at the SR 9 roundabout will extend 300 feet to the west and will not impact South Lake Stevens Road / Costco driveway.
- 24<sup>th</sup> Street SE Costco access
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- SR 9 & SR 2 westbound ramps
  - Bunk Foss Road westbound 95<sup>th</sup> percentile queue will extend 1,050 feet and through the SR 2 westbound off-ramp intersection 500 feet to the east, impacting off-ramp operations.
  - Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 51 minutes (85%) of the PM peak hour.
  - SR 2 westbound off-ramp 95<sup>th</sup> percentile queue will extend approximately 5,175 feet, including 4,325 feet of queue on the SR 2 westbound mainline.

### Mitigation Recommendations

In the 2025 Unimproved Build scenario, Project-generated trips resulted in an approximately 41 percent increase in 95<sup>th</sup> percentile queue length on the SR 2 westbound off-ramp at Bunk Foss Road. Westbound off-ramp queue consisted of two components: (1) queue stacking from the westbound approach of the SR 9 signalized intersection, and (2) queuing related to the minor approach stop-control on the northbound approach of the SR 2 westbound off-ramp.

Mitigation of westbound off-ramp queuing must ultimately address both components of the queue. In this analysis, the following improvement projects were shown to mitigate queuing impacts:

1. **Rechannelize westbound Bunk Foss Road at SR 9:** Rechannelize Bunk Foss Road by narrowing the existing shoulders to provide three westbound lanes, including exclusive left-turn, through, and right-turn lanes. With shoulder narrowing, the three westbound lanes appear to fit within the existing pavement section. The traffic signal pole in the northeast quadrant of the intersection will likely need to be relocated to provide adequate clearance for right turning trucks. This

improvement would allow right-turn-on-red (RTOR) movements to clear the SR 9 / Bunk Foss Road intersection.

2. **Compact roundabout at Bunk Foss Road and SR 2 westbound off-ramp:** A single-lane 90-foot Inscribed Circle Diameter (ICD), compact roundabout with fully traversable central island as shown in **Figure 1**. A 90-foot ICD mini-roundabout would fit within the existing pavement. The single-lane westbound roundabout exit leg would transition into a 3-lane westbound entry leg at the SR 9 intersection to the west.



**Figure 1. Conceptual Diagram of Bunk Foss Road Mitigation Projects**

Improved 2025 Build Conditions

Key results for the Improved Build scenario are summarized below.

- Bunk Foss Road westbound queue will extend through the SR 2 westbound off-ramp intersection for approximately 15 minutes (25 percent) of the PM peak hour, a reduction of 67 percent from the No Build scenario.
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These improvements prevent 95<sup>th</sup> percentile queuing from impacting the SR 2 mainline, including removing the existing 2,825 feet of mainline queuing which occurs in the 2025 No Build scenario.

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	WBT	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,050</b>	500	125
WBR	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,050</b>	<b>500</b>	<b>1,625</b>	
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	NBTR			425	75	425	75
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	EBL	-	-	100	25	100	25
	EBTR	-	-	-	50	-	50
	WBL	100	-	100	75	100	75
	WBT	-	-	400	50	400	50
WBR			100	200	100	200	

## FINDINGS AND RECOMMENDATIONS

The key findings of this analysis are summarized below.

- **SR 9 & 24<sup>th</sup> Street SE:** Eastbound 95<sup>th</sup> percentile queue at the SR 9 roundabout will not impact the Costco driveway / South Lake Stevens Road intersection.
- **24<sup>th</sup> Street SE Costco access:** Westbound 95<sup>th</sup> percentile queue at the signalized South Lake Stevens Road / Costco driveway intersection will not impact the SR 9 roundabout to the east.
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  - SR 2 westbound off-ramp 95<sup>th</sup> percentile queue will extend beyond its 850-foot storage and onto the SR 2 westbound mainline in both No Build and Unimproved Build scenarios, including a queue of 3,675 feet in the No Build and 5,175 feet in the Unimproved Build scenario. The No Build queue will extend 2,825 feet onto the SR 2 westbound mainline, and the Unimproved Build queue will extend 4,325 feet onto the SR 2 westbound mainline.
  - The addition of Project-generated trips will cause SR 2 westbound off-ramp 95<sup>th</sup> percentile queue to extend 4,325 feet onto the SR 2 westbound mainline, an increase of 1,500 feet from the No Build condition.
  - Mitigation recommendations include two projects related to SR 2 westbound ramps:
    - Rechannelization of westbound Bunk Foss Road within the existing pavement section at SR 9 to provide exclusive left-turn, through, and right-turn lanes.
    - Construction of a 90-foot ICD mini-roundabout at the Bunk Foss Road & US 2 westbound off-ramp intersection
  - The recommended mitigation projects will have the following effects on queueing:
    - Reduce the duration of Bunk Foss Road westbound queuing interaction between SR 9 and SR 2 westbound off-ramp by 67 percent from the No Build condition.
    - Reduce SR 2 westbound off-ramp 95<sup>th</sup> percentile queue by approximately 81 percent from the No Build condition.

The identified improvements correct existing and future queuing on the SR 2 mainline in addition to fully mitigating the impacts of 37 new Costco trips. The improvements should be constructed concurrently with the SR9/SE24th Street improvements proposed to support Costco and the City of Lake Stevens SE 20th Subarea Plan

Costco's share of the improvement cost should be proportional to the impacts created by Costco. Costco's estimated share of the improvements is 35 percent, based on mitigating Costco's 1,500-foot share of the total 4,325-foot 95<sup>th</sup> percentile queue on the SR 2 westbound mainline in the 2025 Unimproved Build scenario. Costco and the City of Lake Stevens should enter into a cost sharing agreement to fund these improvements.