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Technical Memorandum

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SUBJECT: SEDGWICK-BETHEL CORRIDOR STUDY PRELIMINARY LOS AND QUEUING FORECASTS REVISED 12/21/2017

Ms. Wooton:

The purpose of this technical memorandum is to document the preliminary travel demand forecasts and Level of Service results generated by TSI's analysis of the Sedgwick Road and Bethel Road corridors for the Sedgwick Road and Bethel Road Corridor Study.

Analysis Methodology

The travel demand model used in this analysis was based upon the Port Orchard citywide planning model. Land use forecasts were based upon Port Orchard Comprehensive Plan policy with local revisions along the study corridors based on direction from City staff. External trips in the model were linked to trip forecasts generated by the SR 16 corridor model used in the WSDOT SR 16 Congestion Study.

The travel demand model is based on a 2040 year of analysis and a PM peak hour period. The model was calibrated using counts collected in January 2017 by CH2M which were also used in the SR 16 corridor model. Trip generation rates, connector loading points and shares, and link/node capacities were refined to improve calibration result for the study corridors.

Intersection Levels of Service (LOS) were calculated using Highway Capacity Manual 2010 (HCM2010) methodologies. Signalized and stop-controlled intersections were analyzed using Synchro 9 software. Roundabouts were analyzed using Sidra Intersection 7.0 software with analysis parameters consistent with Washington State Department of Transportation (WSDOT) Sidra Policy Guidance.

Transportation Improvement Scenarios

Three 2040 network improvement scenarios were considered in this preliminary analysis, as described below. Improvement assumptions for each of the scenarios are summarized in **Table 1.**

Table 1. Modeled Network Improvements

Analysis Scenario			TIP ID	Project Name	Location	Description
Base	A	B				
X	X	X	1.1	Tremont St Widening	SR 16 – PO Blvd	Widen to 4 lanes w/ median, sidewalks, bike lanes, & 2 roundabouts
X	X	X	1.5	Anderson Hill & Old Clifton Rd Intersection Improvements		New roundabout
X	X	X	1.6	Old Clifton Rd & Campus Pkwy Intersection Improvements		New roundabout
X	X	X	1.7	Arnold Creek Crossing	Bay Street	Replace wooden span w/ concrete box culvert
X	X	X	1.8	Bay St. Ped. Pathway Construction	PO Shoreline	14-ft multi-modal pathway
X	X	X	2.4[1]	SR 160 Roundabout #1	Sedgwick & Bravo Terrace	New roundabout
X	X	X	2.5[1]	SR 160 Roundabout #2	Sedgwick e/o Geiger Rd	New roundabout
X	X	X	n/a[1]	Sedgwick Rd & Geiger Rd Intersection Improvements		New signal or roundabout
X	X	X	n/a[1]	Bethel Rd & Salmonberry Rd Intersection Improvements		New signal or roundabout
X	X	X	n/a[1]	Bethel Rd & Blueberry Rd Intersection Improvements		New signal or roundabout
X	X	X	n/a[1]	Walmart Connector	North of Salmonberry to signal @ Bethel Rd	Extend and dedicate to City
	X	X	2.2	Sedgwick Rd West Construction	SR 16 – Sidney Ave	Widen to 3 ln w/ TWLTL, bike lanes and sidewalks
	X	X	2.3	Bethel Corridor ROW & Construction	Mile Hill Dr – 1,000 ft s/o Sedgwick	(TBD) Assume 3 ln w/ TWLTL, bike lanes, and sidewalks
	X	X	2.7	Sedgwick Rd Corridor Construction	SR 16 – Bethel	(TBD) Assume 5 ln w/ TWLTL, bike lanes, and sidewalks
	X	X	2.8	Sidney Ave Widening	SR 16 – Sedgwick Rd	Widen to 3 ln w/TWLTL, bike lanes and sidewalks
	X	X	2.9	Pottery Ave Widening	Tremont – Melcher	Widen to urban standard
	X	X	2.10	Old Clifton Shoulder & Pedestrian Impr.	SR 16 - western city limits	Shldr widening & grade-separated pedestrian path
	X	X	2.11	Old Clifton Rd & McCormick Woods Dr Intersection Improvements		New roundabout
	X	X	2.12	Melcher St Widening	Pottery – Sherman	Widen to urban standard
	X	X	3.3	Fireweed Rd Widening	Sidney – S Flower Ave	Widen to urban standard
	X	X	3.4	Sedgwick Rd W to Glenwood	SR 16 – Glenwood	Complete streets impr.
	X	X	3.5a	Sherman Ave Widening	Fireweed Rd – terminus	Widen to urban standard
	X	X	3.6a	Port Orchard Blvd Widening	Tremont – Bay St	New roundabouts at Tremont and Bay St; curb; gutter; bike lanes; sidewalks
	X	X	3.5b	Pottery Ave Widening	Tremont – SR 16	Widen to 4 lanes w/ sidewalks
	X	X	3.6b	Old Clifton Rd & Berry Lake Rd Intersection Improvements		New roundabout or signal
	X	X	3.7	Ramsey Rd Widening	Sedgwick – Salmonberry	Widen to urban standard
	X	X	3.8	Blueberry Rd Widening	Geiger – Bethel	Widen to urban standard
	X	X	3.9	Geiger Rd Widening	Sedgwick – Blueberry	Widen to urban standard
	X	X	3.10	Salmonberry Rd Widening	Ramsey – Bethel	Widen to urban standard
	X	X	3.11	New Collector	Geiger – Ramsey	New east-west collector road
		X	n/a	Connector A: Ives Mill Rd terminus – Bravo Terrace		New roadway
		X	n/a	Connector B: Sherman Ave terminus – Sedgwick @ Bravo Terr		New roadway
		X	n/a	Connector C: Lund 450 ft w/o Bethel – Bethel @ Walmart DW		New roadway

[1]Project is necessary to provide access to major developments and is assumed to be constructed concurrent with development

Baseline (2040): 2018-2023 Six-Year TIP

The 2040 Baseline scenario assumed construction of all projects identified in the Port Orchard 2018-2023 Six-Year Transportation Improvement Program (TIP) and any anticipated developer-funded improvements.

Baseline improvements not identified in the 2018-2023 Six-Year TIP included a new traffic signal at Bethel & Blueberry Rd and new roundabouts at Sedgwick & Bravo Terrace and Sedgwick east of Geiger Road. The intersection of Bethel Rd & Salmonberry Rd was modeled under both roundabout and traffic signal control. Intersection control for non-TIP intersections was selected based on preliminary MUTCD warrant analyses and proximity of nearby intersections. Final selection of intersection control treatments along the study corridor should also consider right-of-way, topography, and safety.

Baseline developer-funded improvement projects were also assumed to include a new connector roadway extending from the Walmart frontage to the south to serve an anticipated big-box retail site to the east of Bethel Road. This connector roadway will access Bethel Road at the Walmart driveway signal and will access Mile Hill Dr to the north via internal access roads. The connector roadway is shown in **Figure 1**. All Baseline improvement projects are identified in **Table 1.**

This analysis assumed phased construction of corridor improvements along Sedgwick Rd and Bethel Rd, with the first phase including minor signal phasing improvements at the intersections of Bethel Road & Sedgwick Road and Bethel Road & Lund Avenue. The addition of protected-permitted left-turn treatments at these locations would represent a low-cost preliminary phase of the Bethel Road and Sedgwick Road corridor improvements and was included in the baseline scenario.

Conceptual drawings of all proposed roundabouts are provided in **Attachment A**.

Alternative A: 20-Year TIP with Sedgwick & Bethel Corridor Improvements

Alternative A included all projects identified in the Port Orchard 20-year (Tier 2) Transportation Improvement Program and all baseline improvement projects. Tier 2 TIP projects include construction of Sedgwick Road and Bethel Road corridor improvements.

This analysis assumed Sedgwick Road widening will include a four-lane access-controlled section with a raised median from SR 16 to Bethel Road. Left turns will be prohibited at stop-controlled driveways and intersections along Sedgwick Road. Left-run access to access-restricted driveways along Sedgwick Road will be available via U-turn movements at new roundabouts at Bravo Terrace and east of Geiger Road.

Bethel Road widening will include a two-lane access-controlled section with a raised from Mile Hill Drive to 1,000 feet south of Sedgwick Road. Left turns will be prohibited at stop-controlled driveways and intersections along Bethel Road. Left-turn access to access-restricted driveways along Sedgwick Road will be available via U-turn movements at the intersections of Lund Avenue and Salmonberry Road along Bethel Road.

A conceptual drawing showing recommended lane channelization at the intersection of Sedgwick Road and Bethel Road is provided in **Attachment B**.

These planning-level assumptions are consistent with the Port Orchard Comprehensive Plan and were confirmed by City staff.

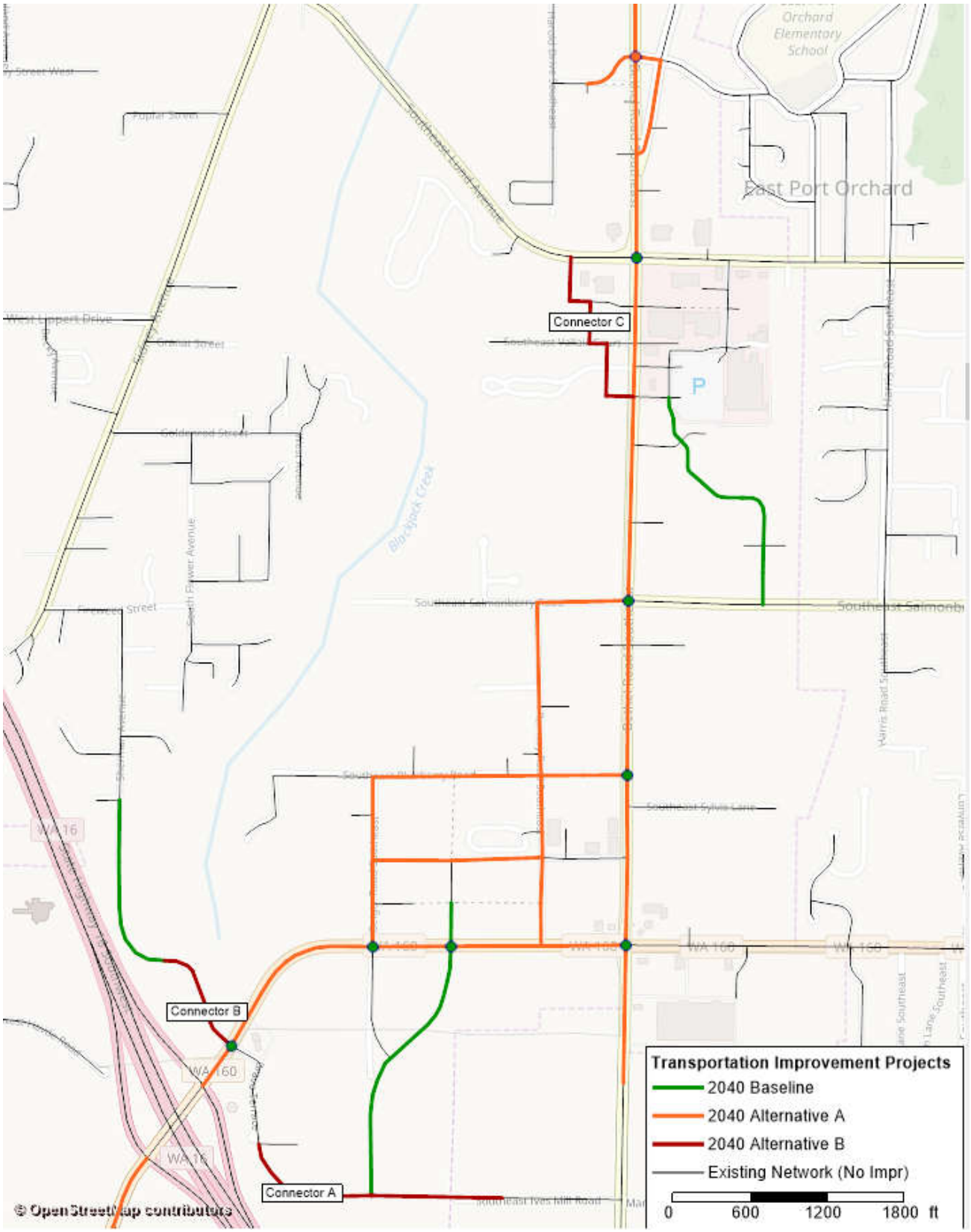


Figure 1. Future (2040) Proposed Connectors

Mitchel Road – Lundberg Road – Lincoln Avenue Reconfiguration

Alternative A assumes realignment of SE Lundberg Road and Lincoln Avenue SE concurrent with the Bethel Corridor project to create a new four-leg roundabout on Bethel Road, as shown in **Figure 2**. The new intersection will improve access to development parcels to the west of Bethel Road and to Mitchel Avenue and South Kitsap High School to the east of Bethel Road.

Alternative A also assumes Mitchell Road we be reconfigured as a northbound one-way street between Bethel Road and Lincoln Avenue SE. The new one-way will relieve right-turn demand from the new roundabout to the north.

Figure 2. Alternative A (2040) Mitchell Road – Lundberg Road – Lincoln Avenue Reconfiguration

<u>Alternative B: Expanded Roadway Network</u>

Alternative B included all projects which were modeled in Alternative A with the addition of three new local street connections, as shown below and in **Figure 1:**

- Connector A: Ives Mill Road from existing terminus west of Bethel to Bravo Terrace
- Connector B: Sherman Avenue from existing terminus north of Sedgwick to intersect Bethel at Bravo Terrace.
- Connector C: New roadway from SE Lund Ave 450 west of Bethel Rd to intersect with Bethel Rd at existing signalized intersection opposite Walmart driveway

Level of Service Standards

Minimum street and intersection LOS requirements are defined in the Port Orchard 2014 Transportation Element as LOS D for all segments and intersections on the City's arterial street system.

The City's Level of Service standard does not apply to State facilities within the City of Port Orchard. Minimum LOS for State facilities are set by the Washington State Department of Transportation (WSDOT). SR 16 is designated by WSDOT as a Highway of Statewide Significance (HSS) and is assigned minimum LOS D. SR 160 is designated a Tier 2 non-HSS also with minimum LOS D.

Level of Service Definition

Intersection LOS is based on the average delay experienced by a vehicle traveling through an intersection. Delay at a signalized intersection can be caused by waiting for the signal or waiting for the queue ahead to clear the signal. Delay at unsignalized intersections is caused by waiting for a gap in traffic or waiting for a queue to clear the intersection.

Table 2 identifies the delay thresholds used to determine intersection LOS. For the purposes of this analysis and to maintain consistency with WSDOT practice, roundabouts were analyzed using signalized LOS thresholds.

Delay is defined differently for signalized and all-way stop controlled intersections than for two-way stop controlled (i.e. stop control on minor approach) intersections. For signalized and all-way stop controlled intersections, level of service thresholds are based upon average control delay for all vehicles using the intersection. For two-way stop controlled intersections, delay is reported for the movement with the worst (highest) delay.

Table 2. Intersection Level of Service Thresholds

LOS	Signalized & Roundabout Delay (sec/veh)	Stop-Controlled Delay (sec/veh)
A	≤10	≤10
B	>10 – 20	>10 – 15
C	>20 – 35	>15 – 25
D	>35 – 55	>25 – 35
E	>55 – 80	>35 – 50
F	>80	>50

Results

Baseline (2040): 2018-2023 Six-Year TIP

Baseline intersection LOS results for key intersections along the study corridors are summarized in **Table 3**.

Table 3. Baseline Intersection Levels of Service

ID	Intersection	2017 PM				2040 PM Baseline			
		Control Type[1]	TEV[2]	Delay[3] (sec/veh)	LOS	Control Type[1]	TEV[2]	Delay[3] (s/veh)	LOS
39	Sedgwick Rd & SR 16 EB ramps	Signal	2175	30.4	C	Signal	3050	48.8	D
40	Sedgwick Rd & SR 16 WB ramps	Signal	2280	17.6	B	Signal	2701	20.7	C
109	Sedgwick Rd & Bravo Terrace	TWSC	2006	29.5	D	RAB	2429	5.2	A
110	Sedgwick Rd & Geiger Rd	TWSC	1959	67.5	F	RIRO	2332	18.6	C
121	Sedgwick Rd & New Roundabout	-	-	-	-	RAB	2514	6.1	A
41	Sedgwick Rd & Bethel Rd	Signal	2935	42.8	D	Signal	3970	63.7	E
129	Bethel Rd & Blueberry Rd	TWSC	1448	49.9	E	Signal	1909	4.2	A
84	Bethel Rd & Salmonberry Rd	TWSC	1566	48.8	E	RAB Signal	2482	8.3 12.1	A B
108	Bethel Rd & Walmart	Signal	1749	6.4	A	Signal	2132	6.4	A
30	Bethel Rd & Lund Ave	Signal	3135	35.5	D	Signal	4323	48.4	D
47	Bethel Rd & Mitchell Rd SE	TWSC	1483	17.5	C	TWSC	2181	49.8	E
132	Bethel Rd & SE Lundberg Rd	TWSC	1100	13.8	B	TWSC	1586	22.2	C
29	Bethel Rd & Lincoln Ave SE	TWSC	1134	15.8	C	TWSC	1492	23.2	C
133	Mitchell Ave & Lincoln Ave	TWSC	176	9.5	A	TWSC	315	10.7	B
46	Bethel Rd & Mile Hill Dr	RAB	1913	13.4	B	RAB	2647	51.6	D

[1]TWSC = two-way stop control; AWSC = all-way stop control; RAB = roundabout; Signal = signalized; RIRO= right-in right-out access
[2]Total Entering Volume, PM peak hour
[3]Two-way stop controlled intersection delay is expressed as average worst (i.e. highest delay) movement delay

The intersections of Sedgwick Rd & Bethel Rd and Bethel Rd & Mitchell Rd will operate below minimum LOS standards at LOS E by 2040.

Baseline signal phasing improvements at the intersection of Bethel Rd & Lund Ave will allow the intersection to operate at LOS D through 2040, satisfying minimum LOS standards. The intersection would operate with 104.5 seconds per vehicle delay (LOS F) without signal improvements.

The intersection of Bethel Rd & Salmonberry Rd will operate with LOS B under signal control or LOS A under roundabout control. This analysis indicated that a two-lane roundabout with flared entries will be necessary to maintain minimum LOS standards at the intersection. A roundabout will result in control delay of 8.3 seconds per vehicle while a traffic signal will result in control delay of 12.1 seconds per vehicle.

Queue results are summarized in **Table 4.**

Table 4: Baseline Queue at Key Locations

	Intersection	Control Type[1]	Mvmt	Storage (feet)	Average Q[2] (feet)	95th Q[3] (feet)
39	Sedgwick Rd & SR 16 EB ramps	Signal	WBL	250	232	376
			WBT	600	185	261
			SBLT	1600	304	501
			SBR	600	189	402
40	Sedgwick Rd & SR 16 WB ramps	Signal	EBL	240	0[4]	0[4]
			EBT	575	0[4]	0[4]
			WB	270	288	441
			NBLT	1500	188	340
			NBR	430	101	242
109	Sedgwick & Bravo Terrace	RAB	EBT	270	24	58
			EBR	200	5	12
			WBT	1250	21	53
41	Sedgwick Rd & Bethel Rd	Signal	EBL	500	165	286
			EBT	570	758	1006
			EBR	90	98	170
			WBL	260	40	122
			WBT	1650	277	393
			WBR	60	0	38
			NBL	250	169	341
			NBT	1910	348	525
			NBR	800	1	48
			SBL	200	139	297
			SBT	600	412	635
			SBR	110	118	213
84A	Bethel Rd & Salmonberry Rd (Signal)	Signal	NBL	200	1	4
			NBT	1280	108	190
			NBR	200	0	28
			SBL	300	5	17
			SBT	1160	151	290
			SBR	200	0	21
84B	Bethel Rd & Salmonberry Rd (Roundabout)	RAB	NBLT	1280	37	91
			NBR	200	19	47
			SBLT	1160	58	144
			SBR	200	16	40
29	Bethel Rd & Lincoln Ave	TWSC	WB	150	-	45
133	Mitchell Ave & Lincoln Ave	TWSC	EB	150	-	5

1. AWSC = All-way stop control; RAB = Roundabout; RIRO = Two-way stop control with right-in-right-out access restriction; Signal = Signalized; TWSC = Two-way stop control
2. Average (50th percentile) queue, in feet (HCM 2010 methodology does not calculate for TWSC intersections
3. 95th percentile queue, in feet
4. Volume is metered by upstream signal

Queue exceeds storage capacity

Westbound queue at the Sedgwick Rd & SR 16 WB ramps will stack to Bravo Terrace and impact roundabout operations, assuming the existing intersection spacing of 270 feet is maintained.

The intersection of Sedgwick Rd & Bethel Rd will operate with queue exceeding storage capacity for eastbound right, northbound left, southbound left, and southbound right turn lanes. Queuing on the westbound through movement will block the 60-foot westbound right turn lane for the majority of the PM peak hour, limiting the effectiveness of the right-turn lane.

Alternative A: 20-Year TIP with Sedgwick & Bethel Corridor Improvements

Geiger-Blueberry-Ramsey-Salmonberry Bypass Route

Alternative A includes planned widening projects along Geiger Road, Blueberry Road, Ramsey Road, and Salmonberry Road. The combination of these widening and improvement projects, in addition to intersection capacity improvements at Sedgwick Rd & Bethel Rd and Bethel Rd & Salmonberry Rd, create a bypass route to the northwest of the Sedgwick Rd & Bethel Rd intersection. The northwest bypass route will serve approximately 167 vehicles during the 2040 PM peak hour, as shown in **Figure 3.**

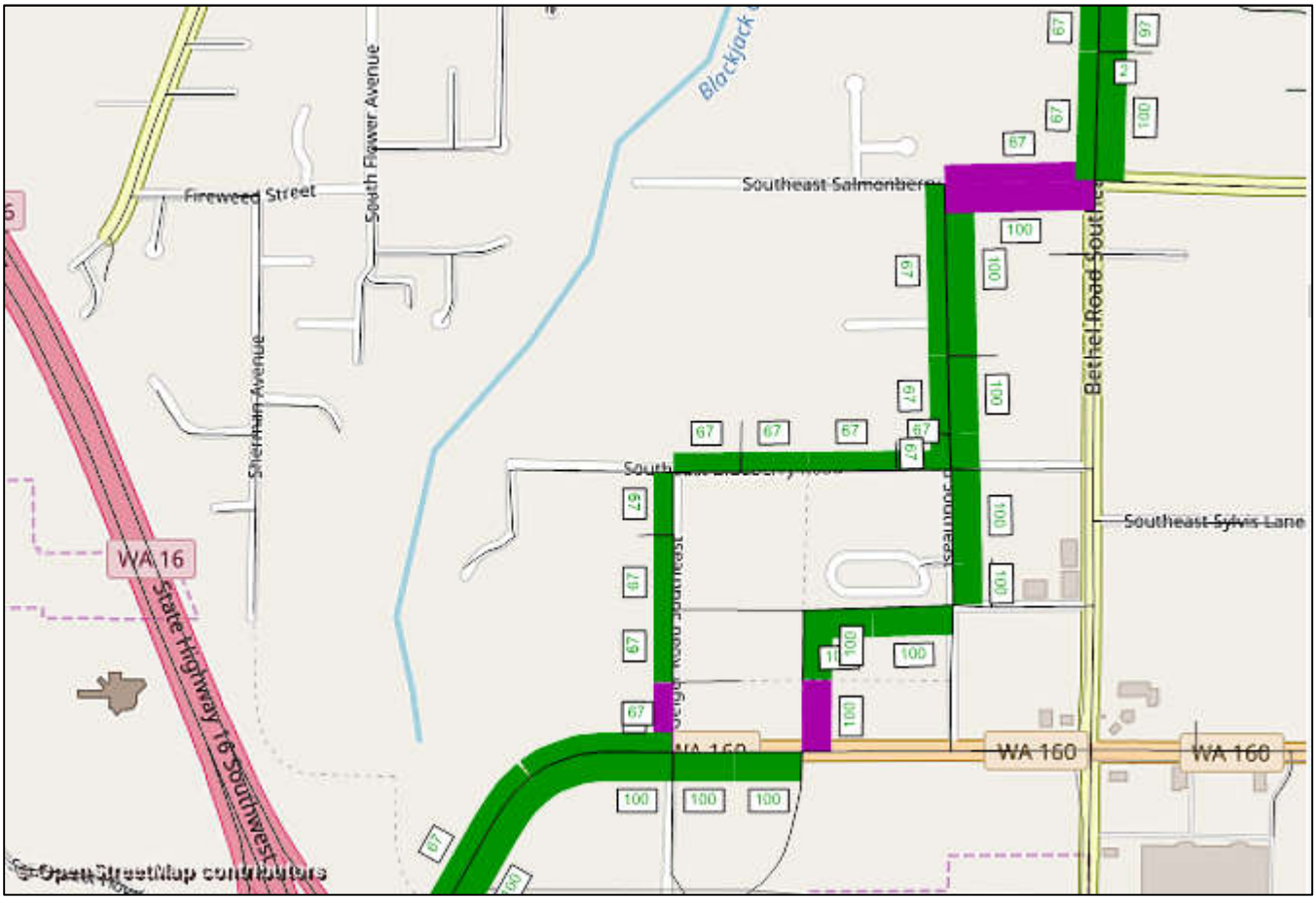


Figure 3. Alternative A (2040) Geiger-Blueberry-Ramsey-Salmonberry Bypass Demand

Level of Service (LOS) and Queuing

Alternative A (2040) intersection LOS results are summarized in **Table 5**.

Table 5. Alternative A Intersection Levels of Service

ID	Intersection	Baseline (2040)				Alternative A (2040)			
		Control Type[1]	TEV[2]	Delay[3] (sec/veh)	LOS	Control Type[1]	TEV[2]	Delay[3] (s/veh)	LOS
39	Sedgwick Rd & SR 16 EB ramps	Signal	3050	48.8	D	Signal	3087	52.6	D
40	Sedgwick Rd & SR 16 WB ramps	Signal	2701	20.7	C	Signal	3069	22.2	C
109	Sedgwick Rd & Bravo Terrace	RAB	2429	5.2	A	RAB	3021	5.2	A
110	Sedgwick Rd & Geiger Rd	RIRO	2332	18.6	C	RIRO	2874	16.0	C
121	Sedgwick Rd & New Roundabout	RAB	2514	6.1	A	RAB	3143	7.2	A
41	Sedgwick Rd & Bethel Rd	Signal	3970	63.7	E	Signal	4455	42.6	D
129	Bethel Rd & Blueberry Rd	Signal	1909	4.2	A	Signal	2353	6.4	A
84	Bethel Rd & Salmonberry Rd	RAB Signal	2482	8.3 12.1	A B	RAB Signal	3038	14.9 21.9	B C
108	Bethel Rd & Walmart	Signal	2132	6.4	A	Signal	3001	16.6	C
30	Bethel Rd & Lund Ave	Signal	4323	48.4	D	Signal	4837	53.1	D
47	Bethel Rd & Mitchell Rd SE	TWSC	2181	49.8	E	Removed			
132	Bethel Rd & SE Lundberg Rd	TWSC	1586	22.2	C	RAB	1980	8.1	A
29	Bethel Rd & Lincoln Ave SE	TWSC	1492	23.2	C				
133	Mitchell Ave & Lincoln Ave	TWSC	315	10.7	B	TWSC	405	10.2	B
46	Bethel Rd & Mile Hill Dr	RAB	2647	51.6	D	RAB	2535	37.9	D

[1]TWSC = Two-way stop control; AWSC = All-way stop control; RAB = Roundabout; Signal = Signalized
[2]Total Entering Volume, PM peak hour
[3]Two-way stop controlled intersection delay is expressed as average worst (i.e. highest delay) movement delay

The Mitchell Road – Lundberg Road – Lincoln Avenue reconfiguration will mitigate an LOS deficiency at Bethel Road & Mitchell Road, with the new roundabout operating at LOS A through 2040.

The widening of Sedgwick Road to include a two through lanes in each direction will allow the Sedgwick Rd & Bethel Rd intersection to operate at LOS D through 2040. This analysis also assumed revised turn bay storage capacities, as described above, to allow turn bays to operate effectively.

This analysis assumed widening of Sedgwick Road to a point east of the Bethel Road intersection in order to allow two westbound through lanes at the intersection. This extension of the Sedgwick Road widening project would be necessary to maintain intersection LOS standards at the intersection, as the intersection will operate at LOS E with 65 seconds average delay with a one-lane westbound approach.

A two-lane roundabout at the intersection of Bethel Road & Salmonberry Road will allow slightly lower delay (14.9 sec/veh) than signal control (21.9 sec/veh) at the same location. Roundabout

Intersection operations at Bethel Rd and Mile Hill Dr (SR 166) are improved by demand redistribution and rebalancing associated with the Port Orchard Boulevard improvements and the Bethel Road widening.

Queuing results are summarized in **Table 6.**

Table 6: Alternative A Queuing at Key Locations

Intersection		Control Type[1]	Mvmt	Storage (feet)	Average Q[2] (feet)	95th Q[3] (feet)
39	Sedgwick Rd & SR 16 EB ramps	Signal	WBL	250	226	424
			WBT	600	173	284
			SBLT	1600	344	541
			SBR	600	141	311
40	Sedgwick Rd & SR 16 WB ramps	Signal	EBL	240	1[1]	1[1]
			EBT	575	188	188[1]
			WB	270	228	338
			NBLT	1500	154	251
			NBR	430	196	390
109	Sedgwick & Bravo Terrace	RAB	EBT	270	35	88
			EBR	200	4	11
			WBT	1250	34	85
41	Sedgwick Rd & Bethel Rd	Signal	EBL	500	288	489
			EBT	570	238	311
			EBR	**150**	14	74
			WBL	260	33	63
			WBT	1650	126	177
			WBR	**200**	0	54
			NBL	**300**	137	298
			NBT	1910	264	445
			NBR	800	0	19
			SBL	**350**	132	301
			SBT	600	312	523
			SBR	**200**	110	178
84A	Bethel Rd & Salmonberry Rd (Signal)	Signal	NBL	200	1	4
			NBT	1280	427	697
			NBR	200	8	35
			SBL	300	95	249
			SBT	1160	306	705
			SBR	200	11	47
84B	Bethel Rd & Salmonberry Rd (Roundabout)	RAB	NBLT	1280	113	281
			NBR	200	22	54
			SBLT	1160	168	417
			SBR	200	25	62
29	Bethel Rd & Lincoln Ave	RAB	WB	150	22	54
133	Mitchell Ave & Lincoln Ave	TWSC	EB	150	-	5

1. AWSC = All-way stop control; RAB = Roundabout; RIRO = Two-way stop control with right-in-right-out access restriction; Signal = Signalized; TWSC = Two-way stop control
2. Average (50th percentile) queue, in feet (HCM 2010 methodology does not calculate for TWSC intersections
3. 95th percentile queue, in feet
4. Volume is metered by upstream signal

Queue exceeds storage capacity

Westbound 95th percentile queue at the intersection of Sedgwick Rd & SR 16 WB ramps will extend 338 feet and through the Bravo Terrace roundabout. Eastbound 95th percentile queue at Bravo Terrace will extend 88 feet and will not stack to the ramp intersection.

Roadway improvements under Alternative A included increased turn bay storage at the intersection of Sedgwick Rd & Bethel Rd. Turn bay storage capacities identified in **Table 6** at the Sedgwick & Bethel intersection were defined based on 95th percentile queue results.

Alternative B: Expanded Roadway Network

Connector A, as shown in **Figure 1**, will operate as a cut-through route to the southwest of the intersection of Sedgwick Rd and Bethel Rd. It will serve approximately 490 vehicles per hour in the 2040 PM peak hour condition, some of which include vehicles which would otherwise travel through the Sedgwick & Bethel intersection.

Connector B will create an alternate north-south route east of SR 16 from Sedgwick Road to Sidney Avenue, which continues north to Tremont Street. The connector will serve anticipated development in the vicinity but will also serve cut-through demand. Connector B will serve up to 530 vehicles per hour by 2040.

Connector C as defined by City staff will provide internal connectivity to commercial developments southwest of the intersection of Bethel Road and Lund Avenue. the route will also function as a bypass route during the PM peak hour, serving approximately 170 vehicles per hour which would otherwise use the intersection of Bethel & Lund. Consideration should be given to the intended purpose of this connector. If the route is intended to serve as a collector roadway, alignment and intersection control along the corridor should be designed to provide capacity to through movements.

Alternative B intersection LOS results are summarized in **Table 7**.

Table 7. Alternative B Intersection Levels of Service

ID	Intersection	Baseline (2040)				Alternative B (2040)			
		Control Type[1]	TEV[2]	Delay[3] (sec/veh)	LOS	Control Type[1]	TEV[2]	Delay[3] (s/veh)	LOS
39	Sedgwick Rd & SR 16 EB ramps	Signal	3050	48.8	D	Signal	3138	54.5	D
40	Sedgwick Rd & SR 16 WB ramps	Signal	2701	20.7	C	Signal	3226	32.1	C
109	Sedgwick Rd & Bravo Terrace	RAB	2429	5.2	A	RAB	3604	7.7	A
110	Sedgwick Rd & Geiger Rd	RIRO	2332	18.6	C	RIRO	2806	14.2	B
121	Sedgwick Rd & New Roundabout	RAB	2514	6.1	A	RAB	3002	6.9	A
41	Sedgwick Rd & Bethel Rd	Signal	3970	63.7	E	Signal	4087	37.3	D
129	Bethel Rd & Blueberry Rd	Signal	1909	4.2	A	Signal	2293	8.1	A
84	Bethel Rd & Salmonberry Rd	RAB Signal	2482	8.3 12.1	A B	RAB Signal	3034	15.7 22.0	B C
108	Bethel Rd & Walmart	Signal	2132	6.4	A	Signal	2875	10.0	B
30	Bethel Rd & Lund Ave	Signal	4323	48.4	D	Signal	4526	44.2	D
47	Bethel Rd & Mitchell Rd SE	TWSC	2181	49.8	E	Removed			
132	Bethel Rd & SE Lundberg Rd	TWSC	1586	22.2	C	RAB	1876	8.1	A
29	Bethel Rd & Lincoln Ave SE	TWSC	1492	23.2	C				
46	Bethel Rd & Mile Hill Dr	TWSC	315	10.7	B	RAB	2457	32.6	C

[1]TWSC = Two-way stop control; AWSC = All-way stop control; RAB = Roundabout; Signal = Signalized
[2]Total Entering Volume, PM peak hour
[3]Two-way stop controlled intersection delay is expressed as average worst (i.e. highest delay) movement delay

The intersection of Sedgwick Road with the SR 16 WB ramps will operate at LOS D, satisfying WSDOT LOS standards but within 0.5 seconds of LOS E and failure threshold. An increase in delay at the Sedgwick Rd & SR 16 WB ramp intersection is a result of increased northbound right-turn demand which will exit SR 16 to use Connector B.

A two-lane roundabout at the intersection of Bethel Road & Salmonberry Road will allow slightly lower delay (15.7 sec/veh) than signal control (22.0 sec/veh) at the same location.

Queuing results are summarized in **Table 8.**

Table 8: Alternative B Queuing at Key Locations

Intersection		Control Type[1]	Mvmt	Storage (feet)	Average Q[2] (feet)	95th Q[3] (feet)
39	Sedgwick Rd & SR 16 EB ramps	Signal	WBL	250	282	482
			WBT	600	238	341
			SBLT	1600	376	580
			SBR	600	155	313
40	Sedgwick Rd & SR 16 WB ramps	Signal	EBL	240	1	6
			EBT	575	820	1154
			WB	270	371	523
			NBLT	1500	157	239
			NBR	430	410	627
109	Sedgwick & Bravo Terrace	RAB	EBT	270	45	112
			EBR	200	11	28
			WBT	1250	51	126
41	Sedgwick Rd & Bethel Rd	Signal	EBL	500	295	498
			EBT	570	225	293
			EBR	**150**	0	12
			WBL	260	29	56
			WBT	1650	145	201
			WBR	**200**	0	24
			NBL	**300**	44	105
			NBT	1910	253	444
			NBR	800	0	0
			SBL	**350**	133	302
			SBT	600	259	421
			SBR	**200**	92	151
84A	Bethel Rd & Salmonberry Rd (Signal)	Signal	NBL	200	3	8
			NBT	1280	435	704
			NBR	200	9	38
			SBL	300	143	194
			SBT	1160	307	438
			SBR	200	19	33
84B	Bethel Rd & Salmonberry Rd (Roundabout)	RAB	NBLT	1280	128	319
			NBR	200	23	58
			SBLT	1160	181	451
			SBR	200	25	63
29	Bethel Rd & Lincoln Ave	RAB	WB	150	20	49
133	Mitchell Ave & Lincoln Ave	TWSC	EB	150	-	

1. AWSC = All-way stop control; RAB = Roundabout; RIRO = Two-way stop control with right-in-right-out access restriction; Signal = Signalized; TWSC = Two-way stop control
2. Average (50th percentile) queue, in feet (HCM 2010 methodology does not calculate for TWSC intersections
3. 95th percentile queue, in feet
4. Volume is metered by upstream signal

Queue exceeds storage capacity

Westbound 95th percentile queue at the intersection of Sedgwick Rd & SR 16 WB ramps will extend 523 feet and through the Bravo Terrace roundabout. Eastbound 95th percentile queue at Bravo Terrace will extend 112 feet and will not stack to the ramp intersection.

Eastbound 95th percentile queue will extend 1,154 feet, well beyond the SR 16 eastbound ramp intersection, impacting operations on the SR 16 eastbound off-ramp. Queue mitigation would require widening of the Sedgwick overpass to provide two eastbound through lanes at the SR 16 westbound ramps.

Eastbound 95th percentile queue at the intersection of Sedgwick Road and Bravo Terrace will extend 112 feet and will not reach the SR 16 WB ramp intersection.

As PM peak hour demand on SR 16 approaches or exceeds capacity in 2040, regional demand may begin to spill over to the Port Orchard street network. This analysis did not consider capacity improvements to SR 16, which are currently being evaluated as part of the WSDOT SR 16 Congestion Study. As a result, this analysis reflects a "worst case" scenario with regional demand potentially using the Port Orchard street network to bypass freeway congestion. This analysis should be updated as WSDOT identifies potential SR 16 improvement strategies.

Conclusion

This preliminary analysis indicates that minimum LOS standards along the Sedgwick Road and Bethel Road corridors can be maintained through 2040 with a combination of signal phasing improvements, developer-funded project improvements, and widening of Sedgwick Road and Bethel Road.

Several developer-funded project improvements will be necessary to provide access to anticipated commercial and residential development sites along the study corridor.

Sedgwick Road widening is recommended to include a five-lane section extending to the east of Bethel Road in order to satisfy intersection LOS at the intersection of Sedgwick Road & Bethel Road.

A two-lane roundabout will provide the greatest operational benefit at the intersection of Bethel Road and Salmonberry Road. In addition to providing delay and queuing benefits over signal control, roundabout control will allow the northbound and southbound U-turn movements which will be necessary given the proposed access restrictions along the Bethel Road corridor. Roundabout control also offers safety and traffic calming benefits for the Bethel & Salmonberry intersection.

Realignment of the Bethel Road & Lundberg Road and Bethel Road & Lincoln Avenue intersections, in combination with one-way channelization of Mitchell Road between Bethel Road and Lincoln Avenue, will mitigate intersection LOS deficiency on the westbound stop-controlled approach of Mitchell Road at Bethel Road.

The proposed connector roadways in Alternative B will provide alternate routes to Sedgwick Road and Bethel Road. These routes will not be necessary to maintain minimum intersection LOS in the 2040 analysis horizon but will improve network connectivity and access to anticipated commercial and residential development.

Future analyses should consider the impacts of potential improvement strategies along the SR 16 corridor through Port Orchard, pending WSDOT SR 16 corridor study results.

This document summarizes the preliminary findings of TSI's Sedgwick-Bethel corridor travel demand and LOS forecasts. If you have any questions about the analysis or findings presented above, please contact me at your convenience.

Sincerely,

Transportation Solutions, Inc.

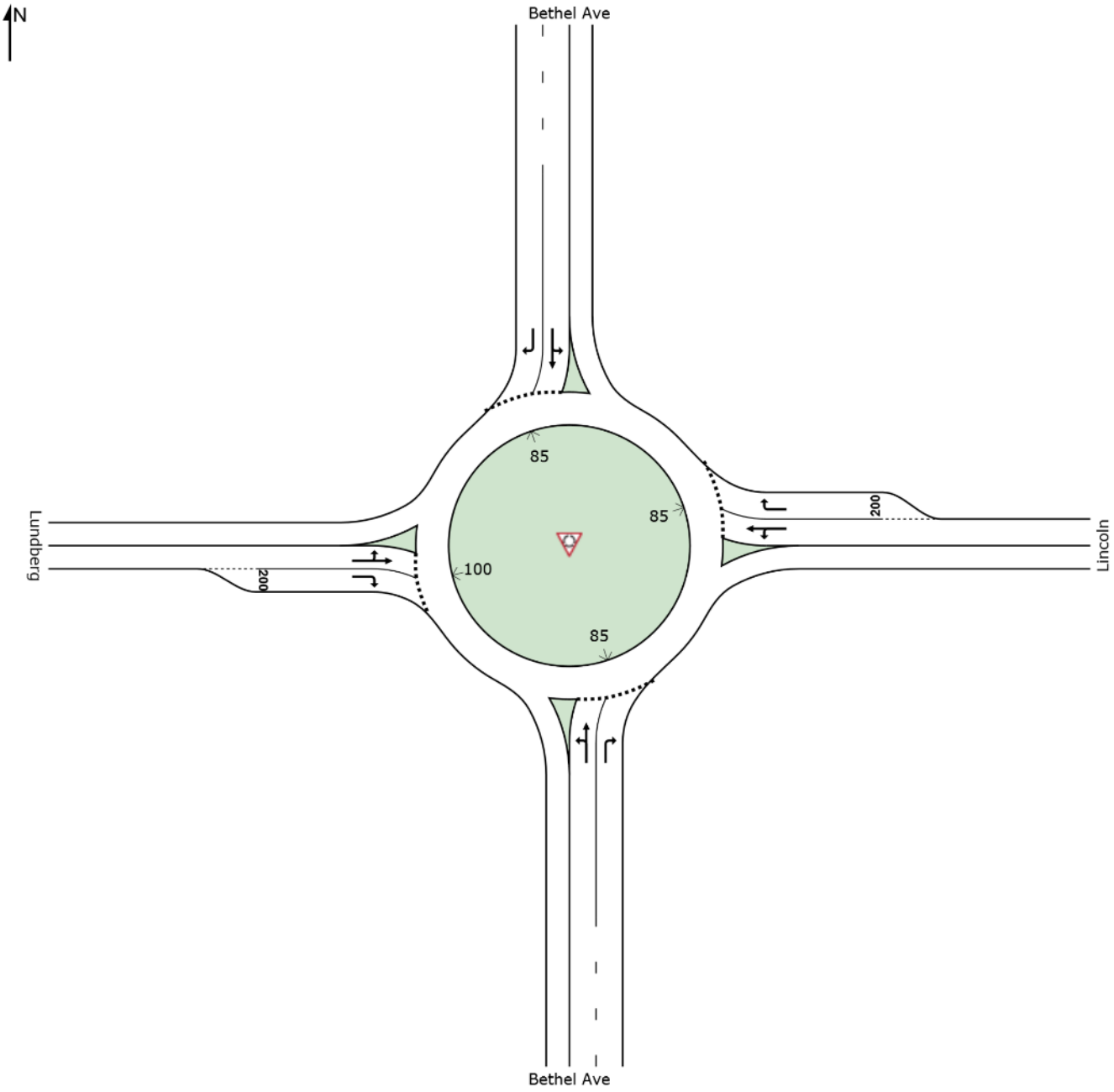
Andrew L. Bratlien, PE
Senior Transportation Engineer

Attachment A: Roundabout Concepts
Attachment B: Sedgwick & Bethel Intersection Channelization Concept
Attachment B: 2040 Baseline Network Volume Plot
Attachment C: Alternative A Network Volume Plot
Attachment D: Alternative B Network Volume Plot

SITE LAYOUT

Site: [29_Bethel & Lincoln]

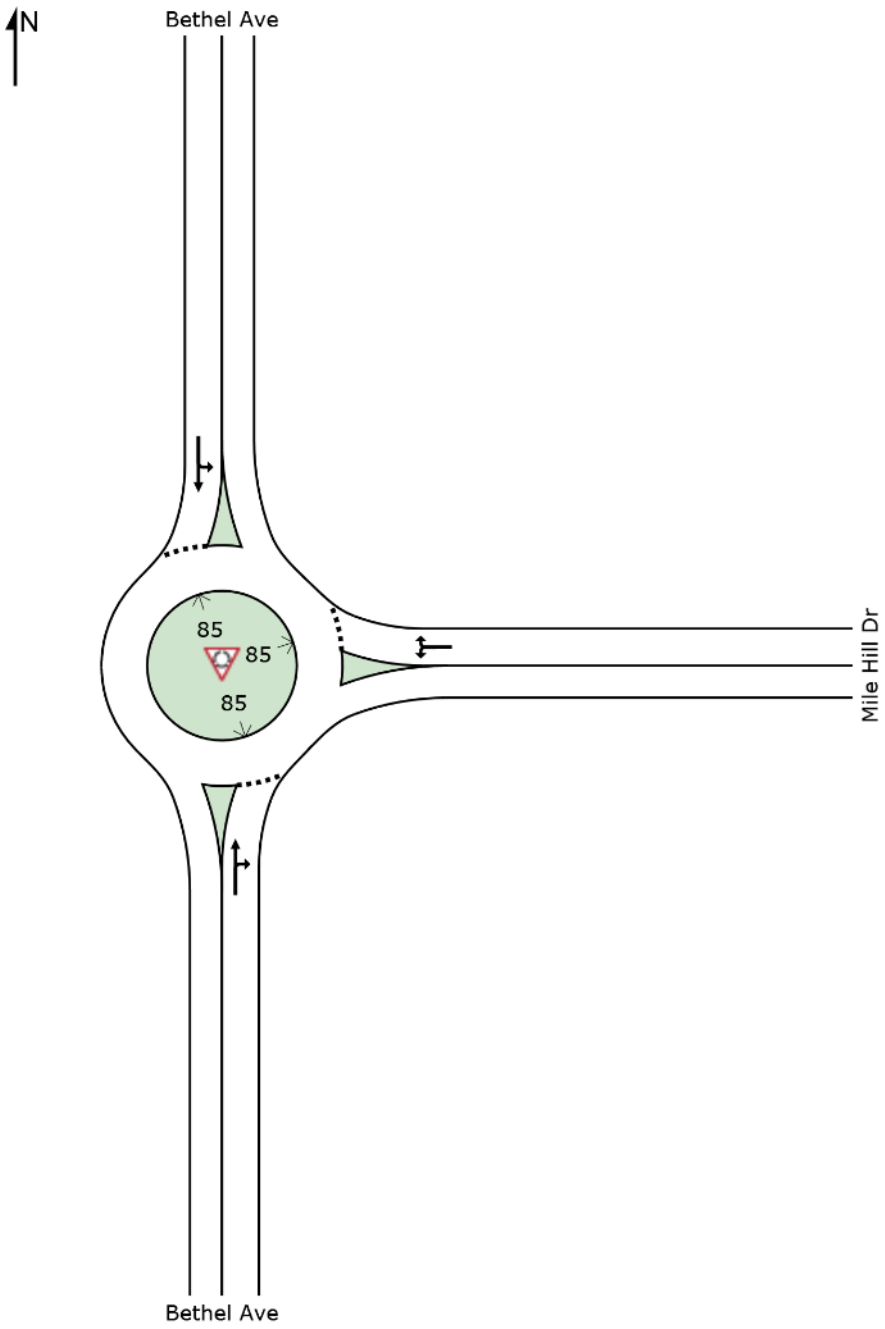
Sedgwick & Bethel Corridor Study - 2040 Alternative A
Roundabout



SITE LAYOUT

Site: [46_Bethel & Mile Hill]

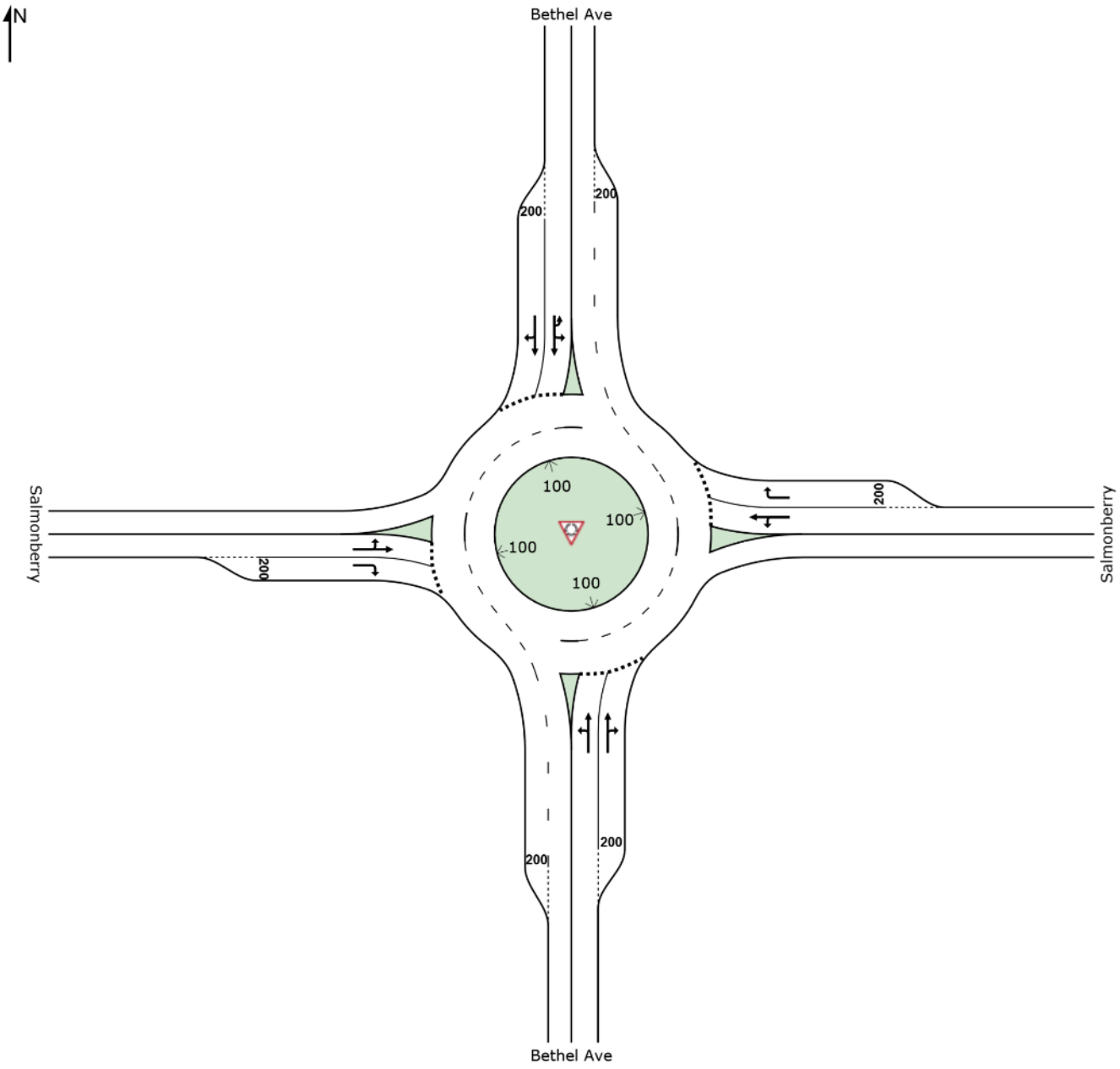
Sedgwick & Bethel Corridor Study - 2040 Alternative A
Roundabout



SITE LAYOUT

Site: [84_Bethel & Salmonberry]

Sedgwick & Bethel Corridor Study - 2040 Alternative A
Roundabout



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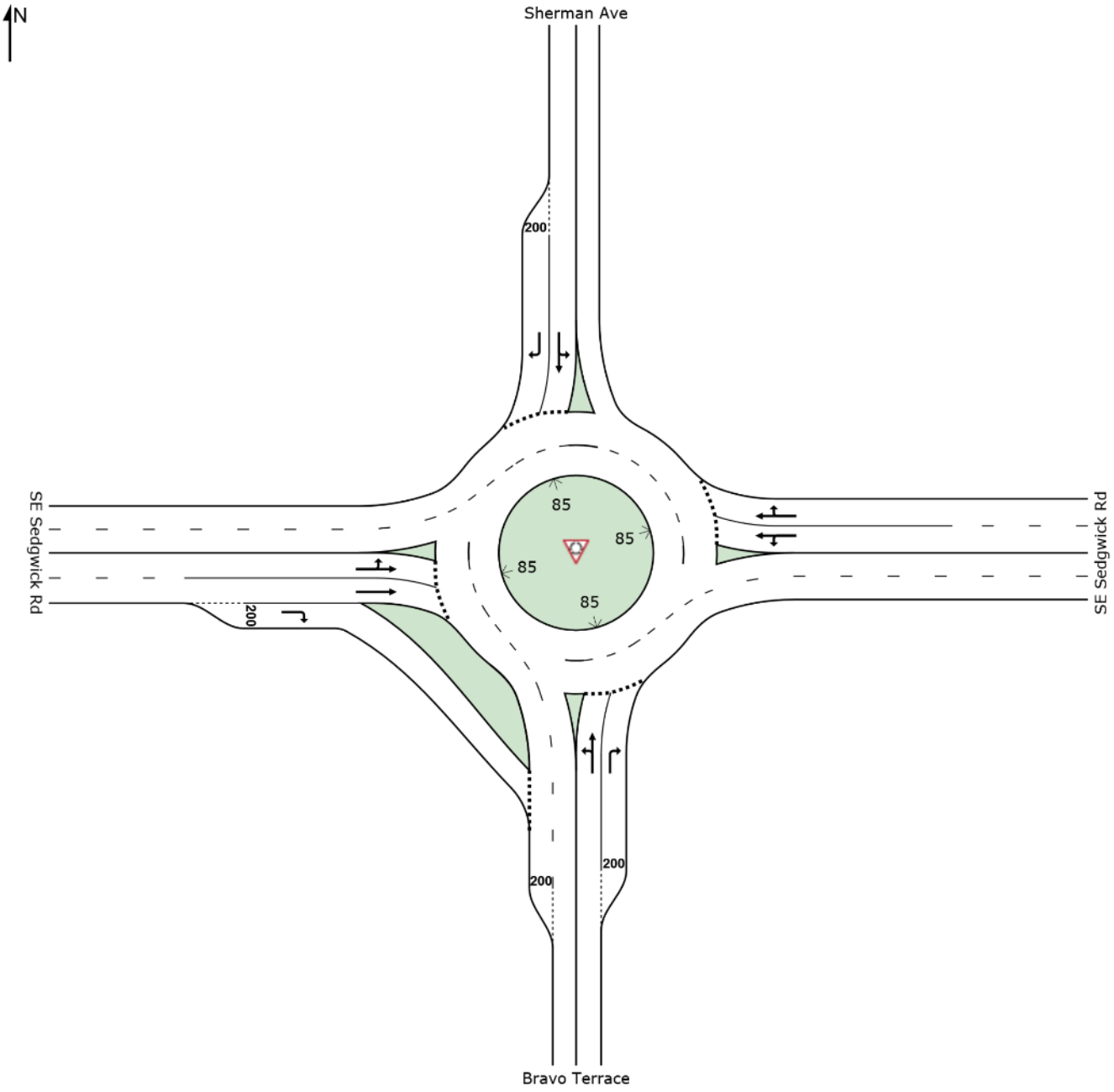
SITE LAYOUT

Site: [109_Sedgwick & Bravo Terrace]

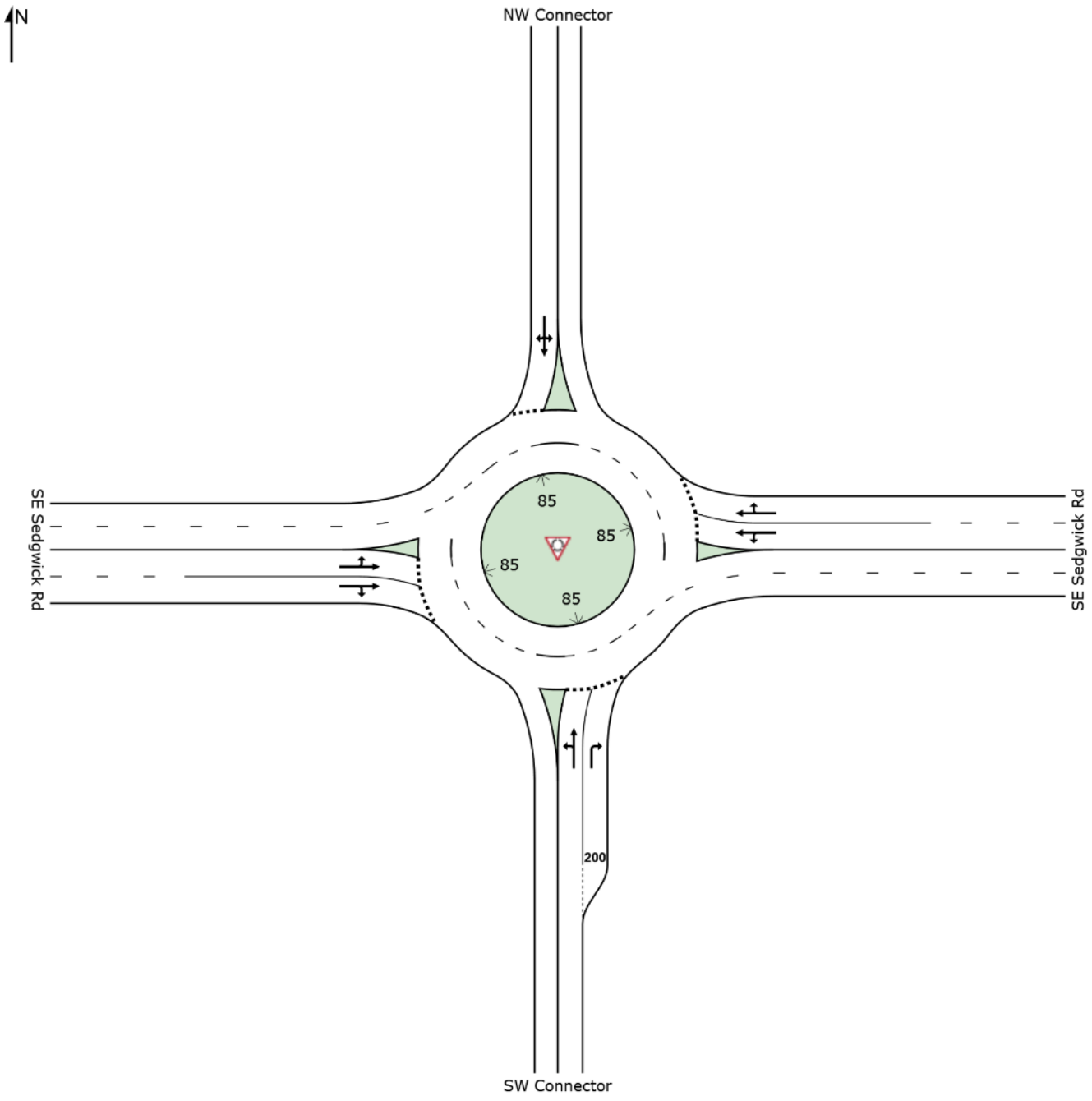
Sedgwick & Bethel Corridor Study - 2040 Alternative A
Roundabout

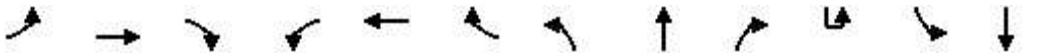


SITE LAYOUT

Site: [121_Sedgwick & NW Connector]

Sedgwick & Bethel Corridor Study - 2040 Alternative A
Roundabout





Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Lane Width (ft)	12	12	12	12	12	12	12	12	12	12	12	12
Grade (%)		0%			0%			0%				0%
Storage Length (ft)	500		150	260		200	300		800		350	
Storage Lanes	1		1	1		1	1		1		1	
Taper Length (ft)	0			0			0				0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Ped Bike Factor									0.97			
Frt			0.850			0.850			0.850			
Flt Protected	0.950			0.950			0.950				0.950	
Satd. Flow (prot)	1787	3574	1599	1805	3610	1615	1787	1881	1599	0	1803	1900
Flt Permitted	0.218			0.286			0.154				0.148	
Satd. Flow (perm)	410	3574	1599	543	3610	1615	290	1881	1552	0	281	1900
Right Turn on Red			Yes			Yes			Yes			
Satd. Flow (RTOR)			285			176			158			
Link Speed (mph)		35			35			35				35
Link Distance (ft)		682			2613			839				1107
Travel Time (s)		13.3			50.9			16.3				21.6

Intersection Summary	
Area Type:	Other

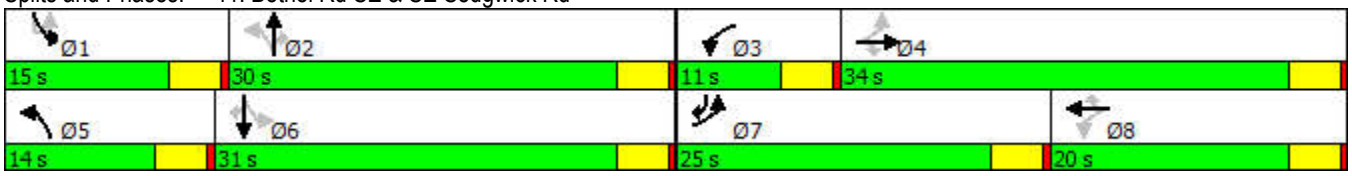
Lane Group	SBR
Lane Configurations	
Ideal Flow (vphpl)	1900
Lane Width (ft)	12
Grade (%)	
Storage Length (ft)	200
Storage Lanes	1
Taper Length (ft)	
Lane Util. Factor	1.00
Ped Bike Factor	
Frt	0.850
Flt Protected	
Satd. Flow (prot)	1615
Flt Permitted	
Satd. Flow (perm)	1615
Right Turn on Red	Yes
Satd. Flow (RTOR)	61
Link Speed (mph)	
Link Distance (ft)	
Travel Time (s)	

Intersection Summary

Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBU	SBL	SBT
Lane Configurations												
Traffic Volume (vph)	515	858	306	98	423	167	284	462	108	15	279	529
Future Volume (vph)	515	858	306	98	423	167	284	462	108	15	279	529
Turn Type	pm+pt	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm	custom	pm+pt	NA
Protected Phases	7	4		3	8		5	2			1	6
Permitted Phases	4		4	8		8	2		2	1	6	
Detector Phase	7	4	4	3	8	8	5	2	2	1	1	6
Switch Phase												
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	8.0	20.0	20.0	8.0	20.0	20.0	8.0	20.0	20.0	8.0	8.0	20.0
Total Split (s)	25.0	34.0	34.0	11.0	20.0	20.0	14.0	30.0	30.0	15.0	15.0	31.0
Total Split (%)	27.8%	37.8%	37.8%	12.2%	22.2%	22.2%	15.6%	33.3%	33.3%	16.7%	16.7%	34.4%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
All-Red Time (s)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lost Time Adjust (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0
Total Lost Time (s)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0		4.0	4.0
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lag	Lag	Lead	Lead	Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	None	None	None	None	None	None	Max	Max	None	None	Max
Act Effct Green (s)	40.0	31.3	31.3	21.8	15.0	15.0	36.0	26.0	26.0		38.0	27.0
Actuated g/C Ratio	0.45	0.35	0.35	0.24	0.17	0.17	0.40	0.29	0.29		0.43	0.30
v/c Ratio	1.06	0.72	0.43	0.45	0.73	0.42	1.05	0.89	0.20		1.01	0.97
Control Delay	83.0	29.7	6.2	23.2	43.0	8.7	90.7	50.4	2.6		78.5	62.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0
Total Delay	83.0	29.7	6.2	23.2	43.0	8.7	90.7	50.4	2.6		78.5	62.7
LOS	F	C	A	C	D	A	F	D	A		E	E
Approach Delay		41.8			31.8			57.7				49.2
Approach LOS		D			C			E				D

Intersection Summary	
Cycle Length: 90	
Actuated Cycle Length: 89	
Natural Cycle: 90	
Control Type: Actuated-Uncoordinated	
Maximum v/c Ratio: 1.06	
Intersection Signal Delay: 45.4	Intersection LOS: D
Intersection Capacity Utilization 97.1%	ICU Level of Service F
Analysis Period (min) 15	

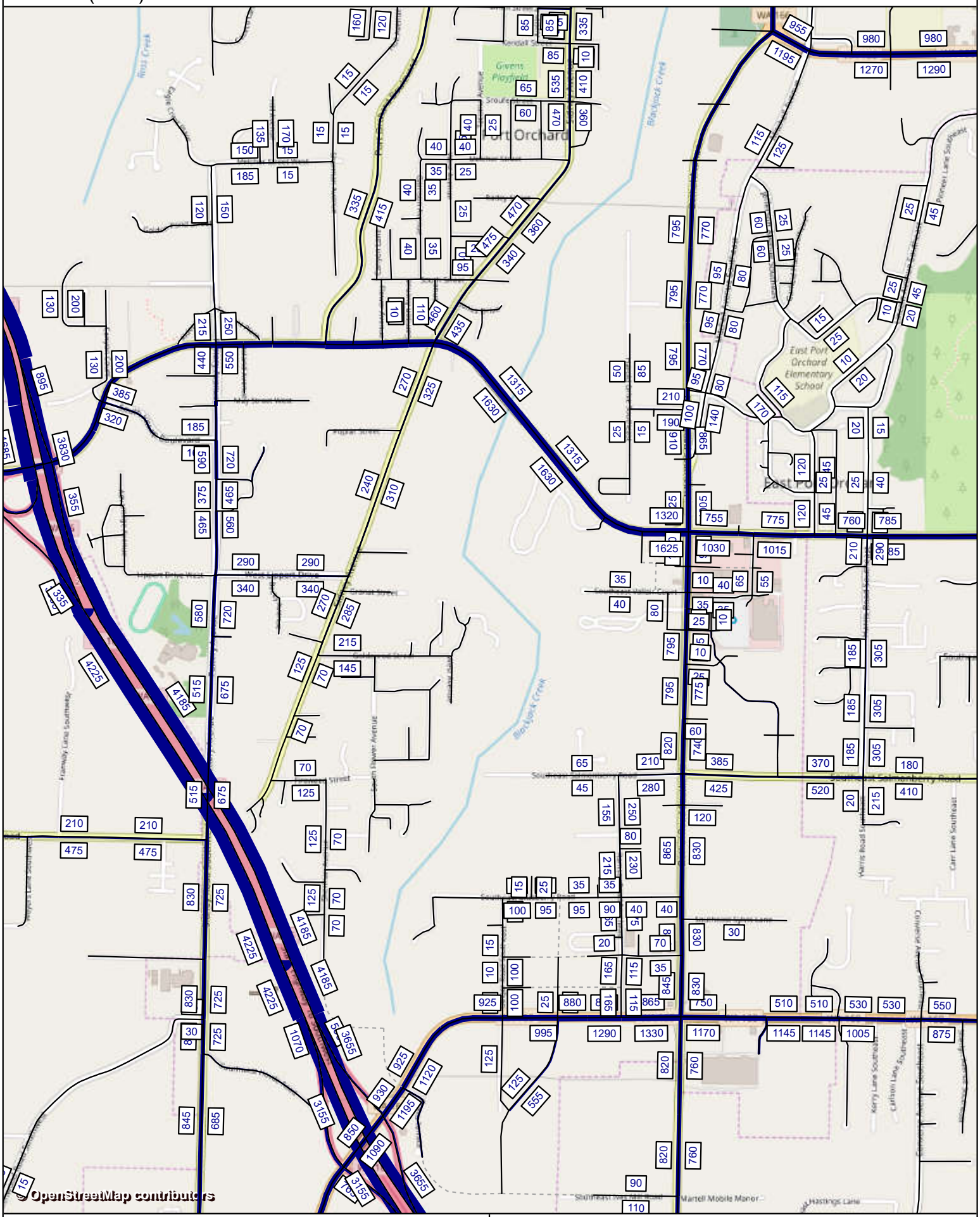
Splits and Phases: 41: Bethel Rd SE & SE Sedgwick Rd



Lane Group	SBR
Lane Configurations	
Traffic Volume (vph)	411
Future Volume (vph)	411
Turn Type	pm+ov
Protected Phases	7
Permitted Phases	6
Detector Phase	7
Switch Phase	
Minimum Initial (s)	4.0
Minimum Split (s)	8.0
Total Split (s)	25.0
Total Split (%)	27.8%
Yellow Time (s)	3.5
All-Red Time (s)	0.5
Lost Time Adjust (s)	0.0
Total Lost Time (s)	4.0
Lead/Lag	Lead
Lead-Lag Optimize?	Yes
Recall Mode	None
Act Effct Green (s)	52.0
Actuated g/C Ratio	0.58
v/c Ratio	0.45
Control Delay	10.7
Queue Delay	0.0
Total Delay	10.7
LOS	B
Approach Delay	
Approach LOS	

Intersection Summary

Baseline (2040) Volume



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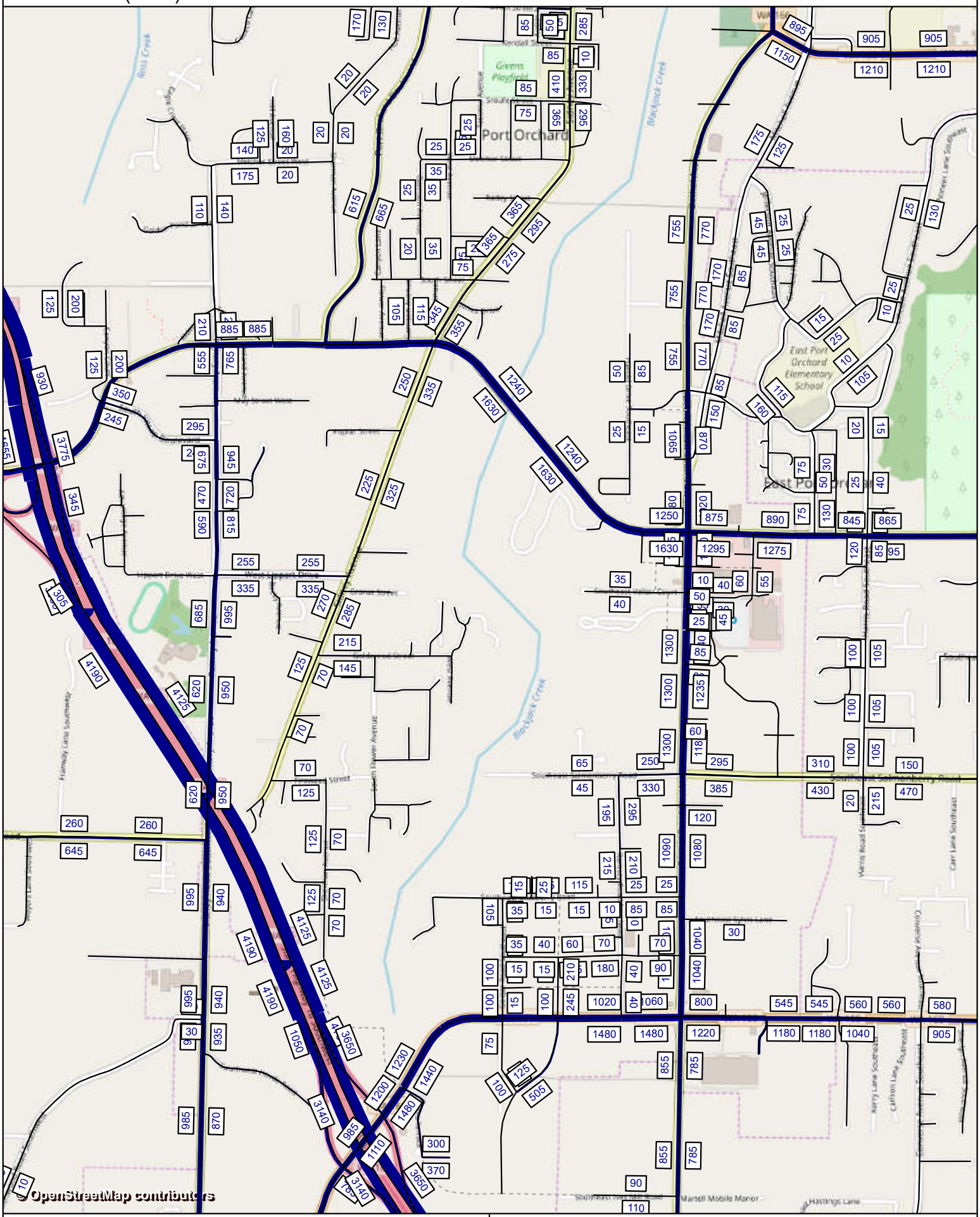
Alternative A (2040) Volume



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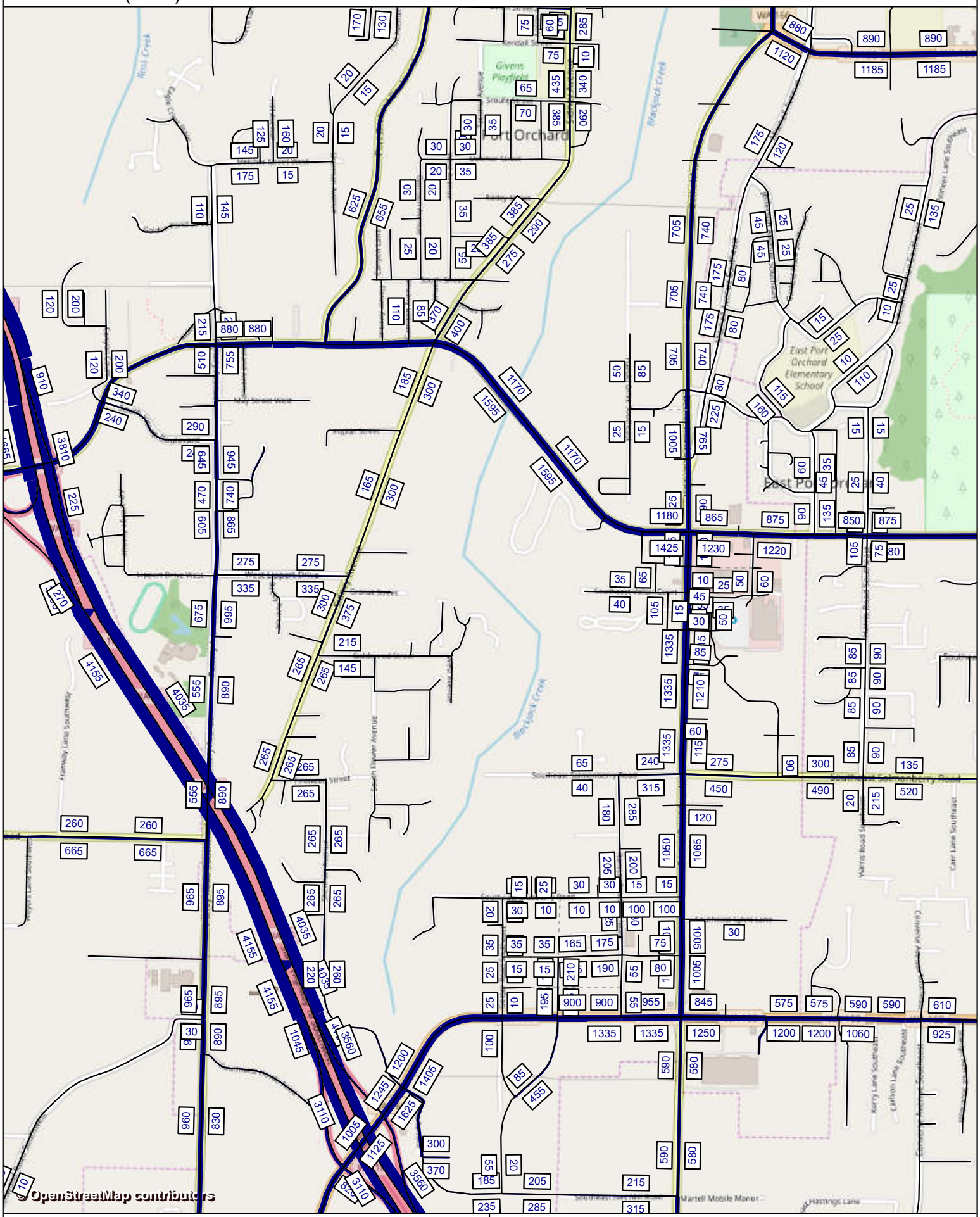
Alternative B (2040) Volume



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