
Appendix C Operational Analysis

Review of W Burnside Multimodal Synchro Model

Purpose: Modeling of a proposed protected bike lane concept by performing an analysis of the area and removing a vehicle lane from the existing geometry.

Review: Generally, no statistically significant delay observed on W Burnside or on the adjacent side streets shown in this model.

- Signal timing at W Burnside, Alder, and Morrison intersections was verified.
- Geometry changes at W Burnside and 19th Ave:
 - Remove SB right turn lane.
 - SB through lane becomes SB through/right turn lane.
 - SB through/left turn lane becomes SB left turn lane only.
- Geometry changes at NW Morrison and 19th/19th Ave:
 - Remove part of SB left turn lane for 50 ft storage lane for left turn.
- Geometry changes at Alder and 18th Ave:
 - Remove NB through/right turn lane.
 - NB through only lane becomes NB through/right turn lane.
 - Remove part of SEB through/left turn lane for 50 ft storage lane for left turn only.
- Geometry changes at W Burnside and 18th Ave:
 - Remove NB through/right turn lane.
 - NB through/left turn lane becomes through/right turn/left turn.
 - One receiving lane for NB vehicles.

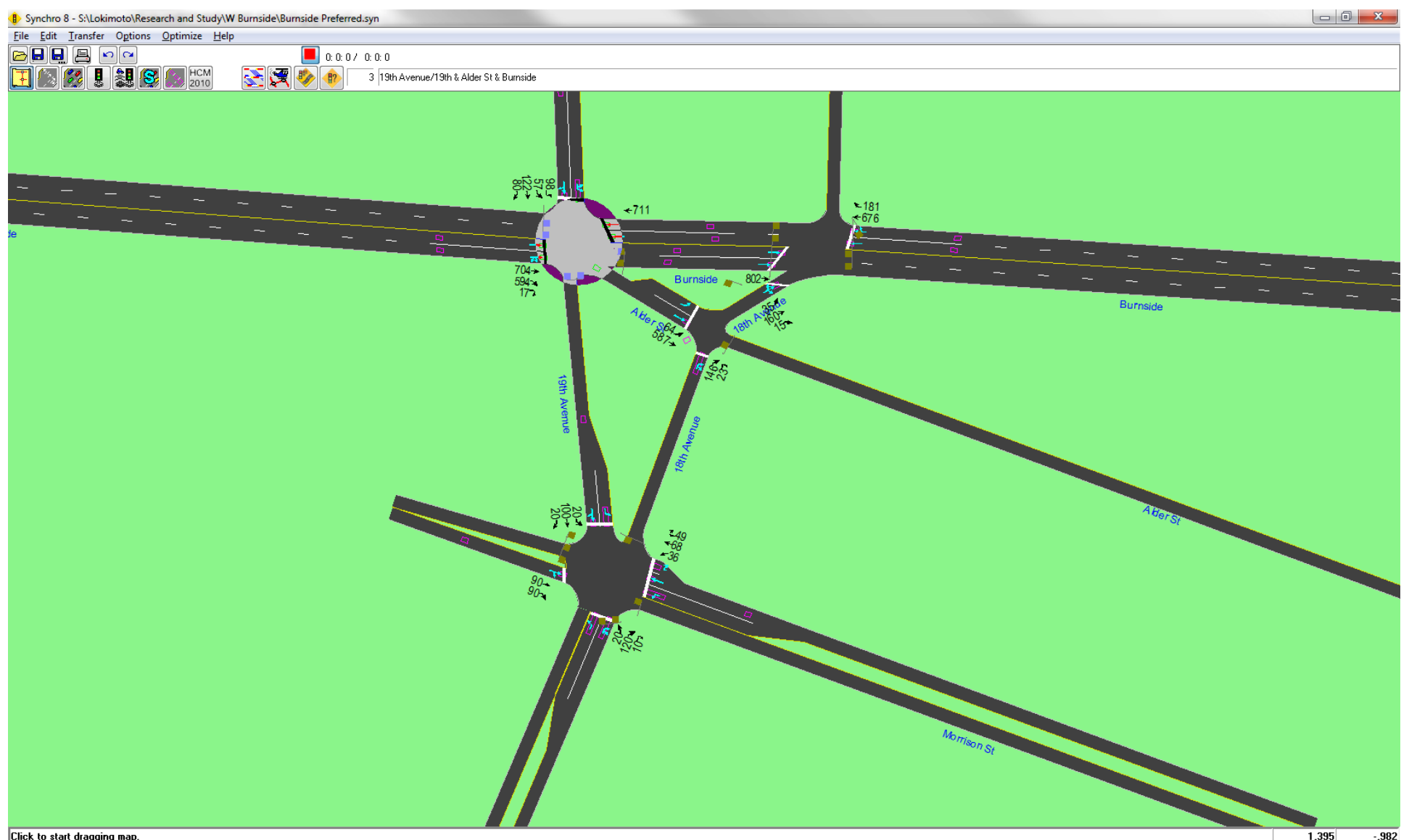
Limitations:

- Depicting the “real-world” back up/delay that occurs on W Burnside, especially during the PM peak, and how that might affect these isolated intersections.
- Depicting delay due to turning vehicles yielding to bicyclists.
- Depicting “real-world” yielding behavior.

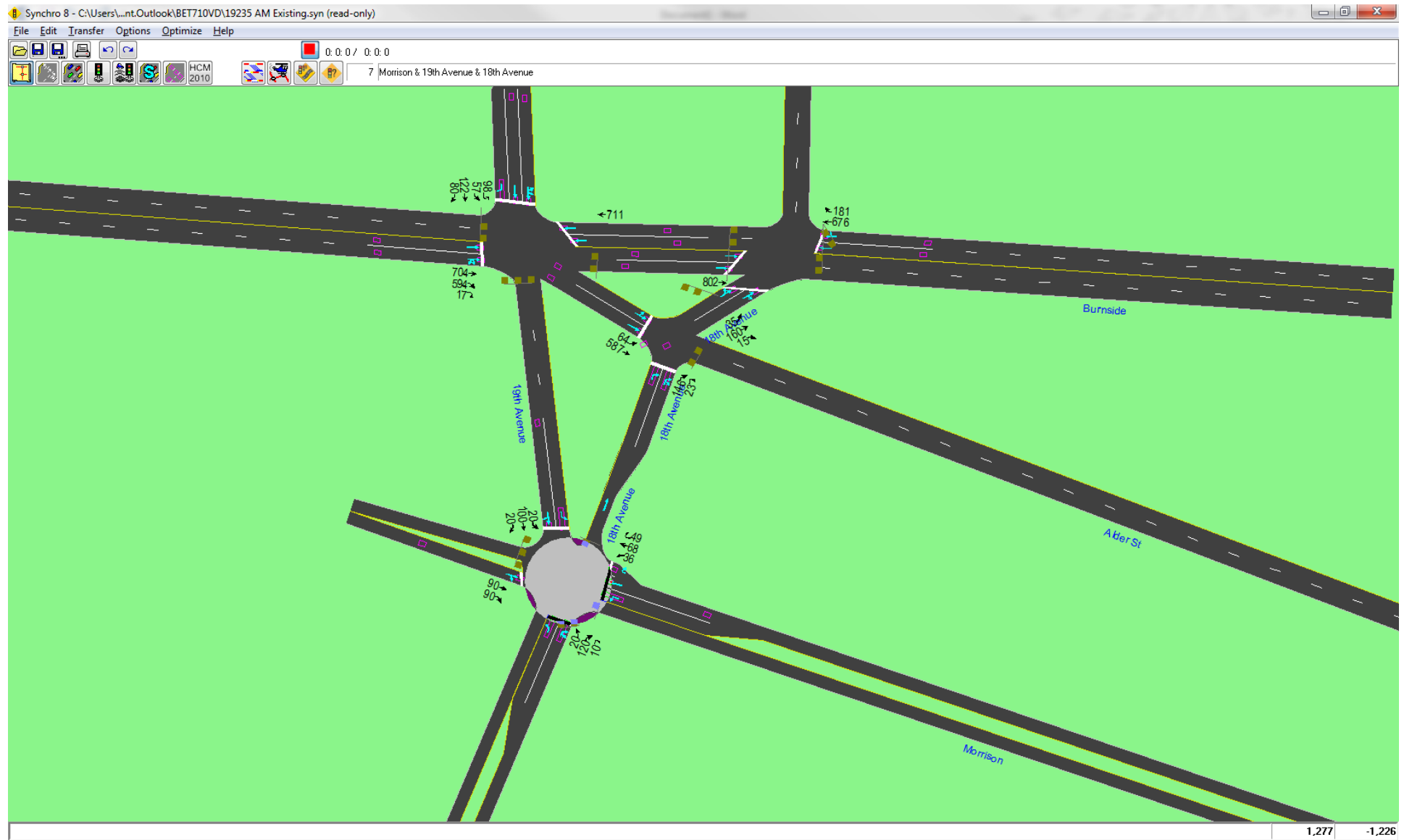
Questions to consider:

- Were peak hour traffic count volumes used?
- Peter mentioned a potential north/south pedestrian crossing on the east side of the intersection. Has this been confirmed (I inquired with Nelson about this and he did not know of this)? If so, will the model be modified to consider these conflicting pedestrians?

AM Peak: Preferred Alternative



AM Peak: Existing Conditions



AM Summary:	
19th Ave	
<i>Preferred</i>	<i>Existing</i>
EBT: 12.9 s	EBT: 15.0 s
WBT: 3.2 s	WBT: 3.9 s
18th Ave	
<i>Preferred</i>	<i>Existing</i>
EBT: 4.7 s	EBT: 7.5 s
WBT: 9.3 s	WBT: 11.8 s

Summary of All Intervals

Start Time	6:57
End Time	8:12
Total Time (min)	75
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	4393
Vehs Exited	4398
Starting Vehs	85
Ending Vehs	80
Travel Distance (mi)	1385
Travel Time (hr)	88.3
Total Delay (hr)	30.8
Total Stops	4113
Fuel Used (gal)	55.8

Interval #0 Information Seeding

Start Time	6:57
End Time	7:12
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	7:12
End Time	8:12
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	4393
Vehs Exited	4398
Starting Vehs	85
Ending Vehs	80
Travel Distance (mi)	1385
Travel Time (hr)	88.3
Total Delay (hr)	30.8
Total Stops	4113
Fuel Used (gal)	55.8

3: 19th Avenue/19th & Alder St & Burnside Performance by movement

Movement	EBT	EBR	EBR2	WBT	SBL2	SBL	SBT	SBR	All
Denied Delay (hr)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Denied Del/Veh (s)	0.4	0.5	0.8	0.0	0.3	0.3	0.0	0.0	0.3
Total Delay (hr)	2.5	3.6	0.1	0.7	0.7	0.5	1.1	0.6	9.8
Total Del/Veh (s)	12.9	21.8	25.6	3.2	26.1	31.5	29.6	20.1	14.2
Stop/Veh	0.48	0.65	0.82	0.11	0.65	0.84	0.82	0.80	0.45
Travel Time (hr)	7.9	8.2	0.3	2.1	1.2	0.9	1.7	1.1	23.4
Avg Speed (mph)	17	14	13	16	10	9	9	11	14
Density (ft/veh)									162
Occupancy (veh)	8	8	0	2	1	1	2	1	23

7: Morrison St & 19th Avenue & 18th Avenue Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR2	NBL	NBR	NBR2	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.3	0.2	3.9	0.4	4.0	3.7	0.2	0.6	0.0	0.0	0.0	0.8
Total Delay (hr)	0.3	0.2	0.3	0.1	0.1	0.1	0.5	0.0	0.2	0.4	0.0	2.2
Total Del/Veh (s)	10.0	5.6	26.2	7.9	4.8	19.6	15.0	7.2	24.1	13.1	8.6	12.0
Stop/Veh	0.52	0.58	0.95	0.47	0.55	0.88	0.77	0.64	1.04	0.67	0.79	0.67
Travel Time (hr)	0.4	0.4	0.6	0.5	0.3	0.2	1.1	0.1	0.2	0.6	0.1	4.4
Avg Speed (mph)	8	9	10	17	18	10	11	14	6	9	11	11
Density (ft/veh)												833
Occupancy (veh)	0	0	1	0	0	0	1	0	0	1	0	4

8: 18th Avenue & Alder St Performance by movement

Movement	EBL	EBT	NBR	NBR2	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.6	1.2	0.2	2.0
Total Del/Veh (s)	3.7	3.5	30.2	29.7	8.9
Stop/Veh	0.21	0.15	0.79	0.77	0.28
Travel Time (hr)	0.1	1.2	1.6	0.3	3.3
Avg Speed (mph)	12	13	4	4	8
Density (ft/veh)					138
Occupancy (veh)	0	1	2	0	3

9: 18th Avenue & Burnside Performance by movement

Movement	EBT	WBT	WBR	NBL	NBT	NBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.2	0.3	0.0	0.0	0.0	0.1
Total Delay (hr)	1.0	1.9	0.3	0.1	0.3	0.0	3.6
Total Del/Veh (s)	4.7	9.3	5.8	6.8	7.1	3.5	6.8
Stop/Veh	0.17	0.40	0.35	0.46	0.26	0.56	0.29
Travel Time (hr)	2.4	4.9	1.1	0.2	0.4	0.0	9.0
Avg Speed (mph)	13	15	17	5	6	9	14
Density (ft/veh)							175
Occupancy (veh)	2	5	1	0	0	0	9

Total Zone Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	0.5
Total Delay (hr)	17.6
Total Del/Veh (s)	2112.6
Stop/Veh	78.40
Travel Time (hr)	40.0
Avg Speed (mph)	13
Density (ft/veh)	234
Occupancy (veh)	40

Summary of All Intervals

Start Time	6:57
End Time	8:12
Total Time (min)	75
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	4376
Vehs Exited	4364
Starting Vehs	74
Ending Vehs	86
Travel Distance (mi)	1380
Travel Time (hr)	89.6
Total Delay (hr)	32.0
Total Stops	4282
Fuel Used (gal)	56.1

Interval #0 Information Seeding

Start Time	6:57
End Time	7:12
Total Time (min)	15
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	7:12
End Time	8:12
Total Time (min)	60
Volumes adjusted by Growth Factors.	
Vehs Entered	4376
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Travel Time (hr)	89.6
Total Delay (hr)	32.0
Total Stops	4282
Fuel Used (gal)	56.1

3: 19th Avenue & Burnside Performance by movement

Movement	EBT	EBR	EBR2	WBT	SBL2	SBL	SBT	SBR	All
Denied Delay (hr)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Denied Del/Veh (s)	0.4	0.4	0.3	0.0	0.1	0.0	0.0	0.3	0.2
Total Delay (hr)	3.2	3.2	0.1	0.8	0.8	0.5	0.8	0.2	9.5
Total Del/Veh (s)	15.0	19.6	16.3	3.9	24.4	26.6	23.2	7.3	13.7
Stop/Veh	0.57	0.63	0.61	0.12	0.68	0.81	0.71	0.71	0.47
Travel Time (hr)	8.9	7.7	0.2	2.1	1.4	0.8	1.5	0.7	23.2
Avg Speed (mph)	16	14	15	15	10	10	11	16	14
Density (ft/veh)									191
Occupancy (veh)	9	8	0	2	1	1	1	1	23

7: Morrison & 19th Avenue & 18th Avenue Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR2	NBL	NBR	NBR2	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.4	0.3	3.8	0.6	3.9	4.0	0.5	0.1	0.0	0.0	0.0	0.8
Total Delay (hr)	0.3	0.1	0.2	0.2	0.1	0.2	1.1	0.0	0.2	0.4	0.0	2.8
Total Del/Veh (s)	11.0	5.7	25.6	9.3	8.6	32.5	26.5	25.9	33.9	12.8	10.0	15.7
Stop/Veh	0.55	0.63	0.89	0.46	0.80	1.00	0.85	0.80	1.00	0.53	0.57	0.68
Travel Time (hr)	0.4	0.3	0.4	0.7	0.4	0.3	1.7	0.1	0.2	0.6	0.1	5.2
Avg Speed (mph)	7	9	11	17	16	7	8	8	5	9	10	10
Density (ft/veh)												772
Occupancy (veh)	0	0	0	1	0	0	2	0	0	1	0	5

8: 18th Avenue & Alder St Performance by movement

Movement	EBL	EBT	NBR	NBR2	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.0	0.5	1.3	0.3	2.1
Total Del/Veh (s)	2.5	2.8	29.6	36.0	9.0
Stop/Veh	0.13	0.13	0.81	0.92	0.29
Travel Time (hr)	0.1	1.2	1.5	0.3	3.1
Avg Speed (mph)	14	15	3	2	8
Density (ft/veh)					187
Occupancy (veh)	0	1	1	0	3

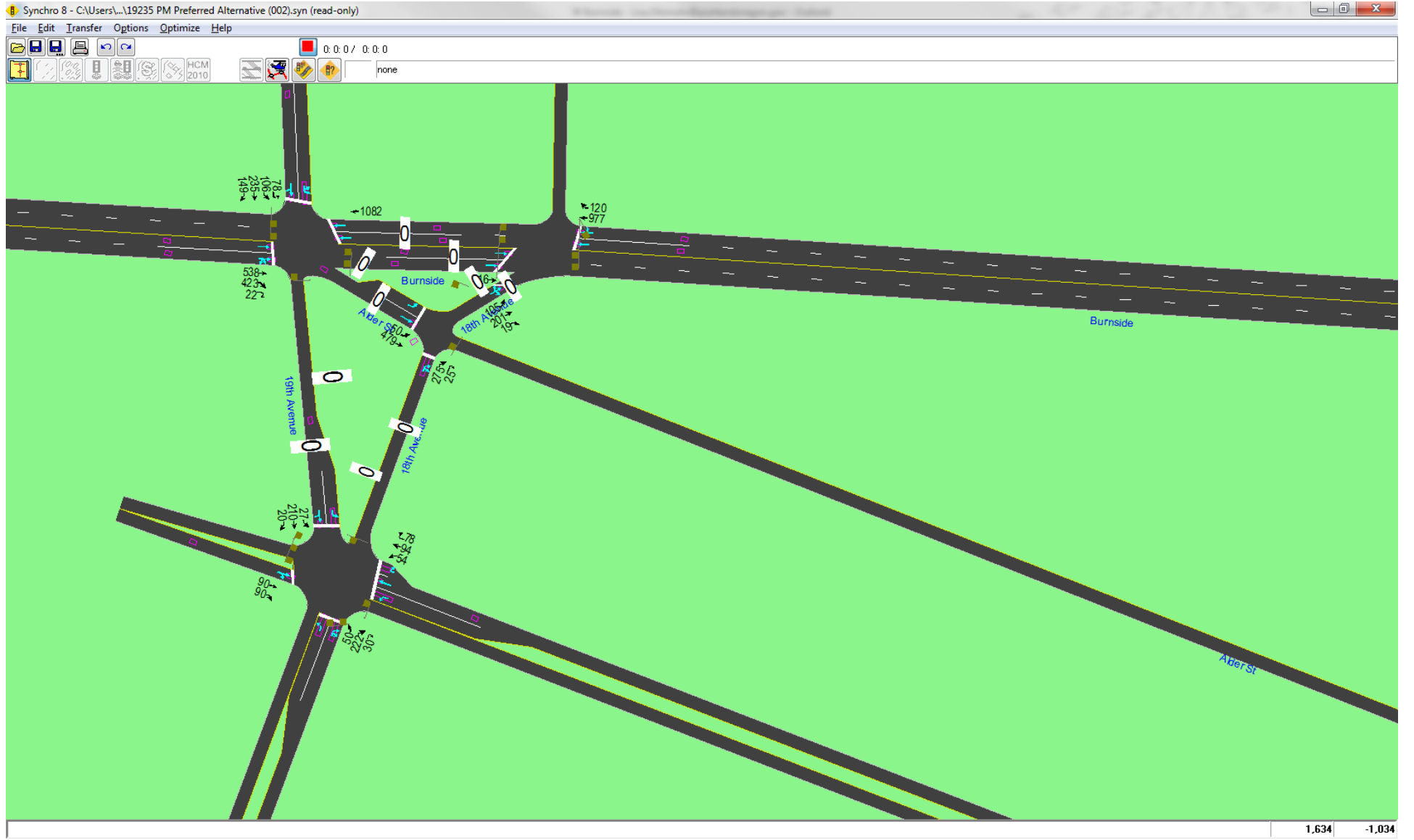
9: 18th Avenue & Burnside Performance by movement

Movement	EBT	WBT	WBR	NBL	NBT	NBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.2	0.3	0.0	0.0	0.0	0.1
Total Delay (hr)	1.8	2.3	0.4	0.0	0.3	0.0	4.9
Total Del/Veh (s)	7.5	11.8	8.1	3.7	7.4	2.3	8.9
Stop/Veh	0.28	0.45	0.47	0.16	0.25	0.31	0.36
Travel Time (hr)	3.4	5.1	1.3	0.1	0.5	0.0	10.3
Avg Speed (mph)	11	14	14	9	7	10	12
Density (ft/veh)							160
Occupancy (veh)	3	5	1	0	0	0	10

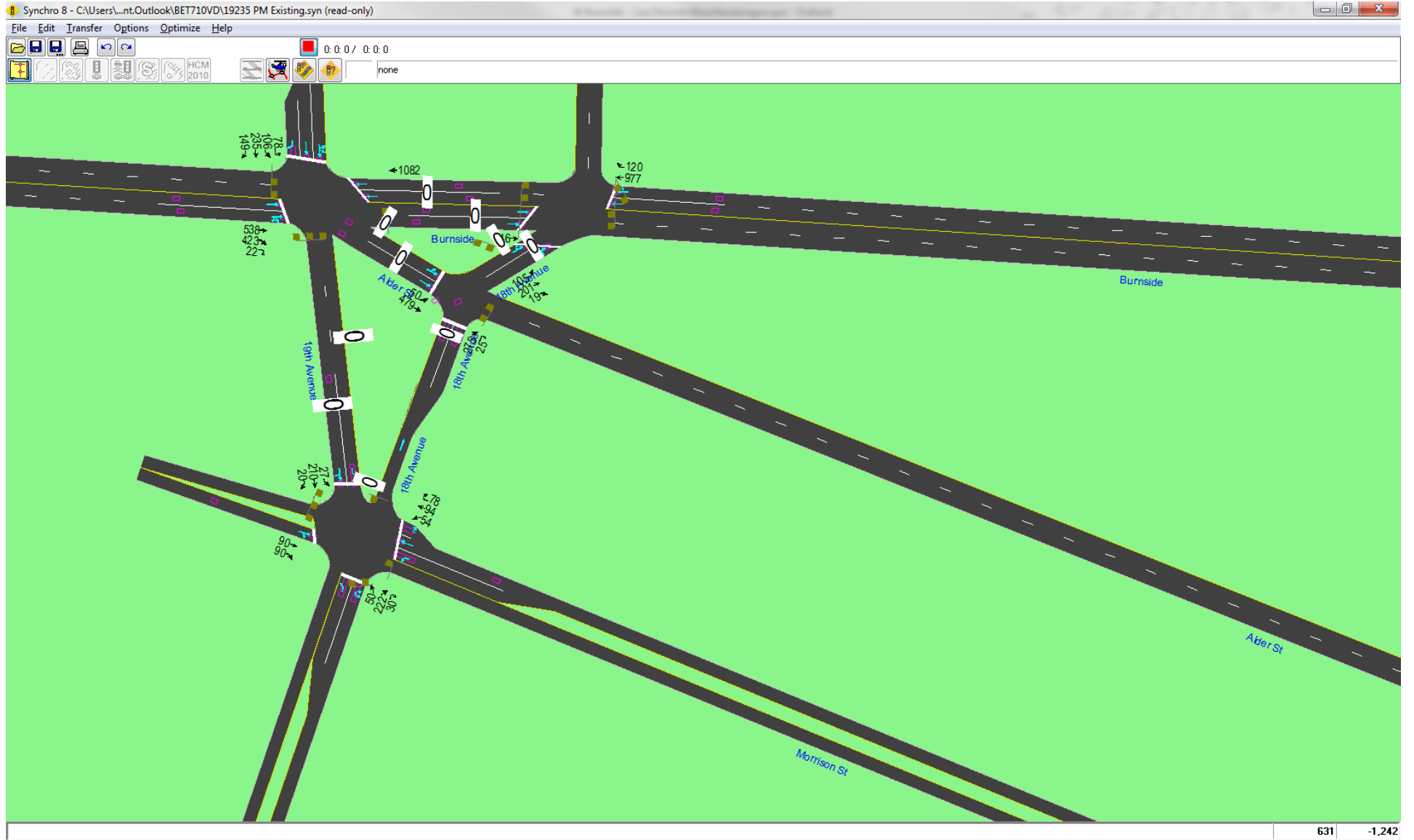
Total Zone Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	0.5
Total Delay (hr)	19.3
Total Del/Veh (s)	2240.8
Stop/Veh	82.52
Travel Time (hr)	41.9
Avg Speed (mph)	13
Density (ft/veh)	254
Occupancy (veh)	41

PM Peak: Preferred Alternative



PM Peak: Existing Conditions



PM Summary:	
19th Ave	
<i>Preferred</i>	<i>Existing</i>
EBT: 13.3 s	EBT: 15.2 s
WBT: 2.7 s	WBT: 9.5 s
18th Ave	
<i>Preferred</i>	<i>Existing</i>
EBT: 4.7 s	EBT: 5.2 s
WBT: 8.2 s	WBT: 12.8 s

Summary of All Intervals

Start Time	6:57
End Time	8:12
Total Time (min)	75
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	4348
Vehs Exited	4352
Starting Vehs	85
Ending Vehs	81
Travel Distance (mi)	1361
Travel Time (hr)	86.1
Total Delay (hr)	29.8
Total Stops	3955
Fuel Used (gal)	54.7

Interval #0 Information Seeding

Start Time	6:57
End Time	7:12
Total Time (min)	15
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	7:12
End Time	8:12
Total Time (min)	60
Volumes adjusted by Growth Factors.	
Vehs Entered	4348
Vehs Exited	4352
Starting Vehs	85
Ending Vehs	81
Travel Distance (mi)	1361
Travel Time (hr)	86.1
Total Delay (hr)	29.8
Total Stops	3955
Fuel Used (gal)	54.7

3: 19th Avenue/19th & Alder St & Burnside Performance by movement

Movement	EBT	EBR	EBR2	WBT	SBL2	SBL	SBT	SBR	All
Denied Delay (hr)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Denied Del/Veh (s)	0.3	0.5	0.4	0.0	0.2	0.1	0.4	0.0	0.3
Total Delay (hr)	2.7	3.8	0.1	0.5	0.7	0.5	0.9	0.5	9.6
Total Del/Veh (s)	13.3	21.0	17.5	2.7	25.7	29.5	26.8	21.8	14.2
Stop/Veh	0.50	0.59	0.54	0.09	0.74	0.74	0.78	0.82	0.45
Travel Time (hr)	8.2	8.8	0.3	1.7	1.3	0.8	1.5	0.9	23.4
Avg Speed (mph)	17	14	15	17	10	10	10	11	14
Density (ft/veh)									162
Occupancy (veh)	8	9	0	2	1	1	1	1	23

7: Morrison St & 19th Avenue & 18th Avenue Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR2	NBL	NBR	NBR2	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Denied Del/Veh (s)	0.2	0.2	4.1	0.4	3.7	4.2	0.2	0.1	0.0	0.0	0.0	0.9
Total Delay (hr)	0.3	0.2	0.3	0.1	0.1	0.2	0.4	0.0	0.1	0.4	0.0	2.1
Total Del/Veh (s)	10.8	5.7	26.0	7.1	4.1	28.3	10.8	6.8	28.3	13.5	10.5	11.3
Stop/Veh	0.56	0.55	0.97	0.53	0.70	0.93	0.64	0.57	1.00	0.64	0.87	0.65
Travel Time (hr)	0.4	0.4	0.5	0.5	0.4	0.4	0.8	0.0	0.1	0.6	0.1	4.3
Avg Speed (mph)	7	9	10	18	18	8	12	15	5	9	10	11
Density (ft/veh)												846
Occupancy (veh)	0	0	0	1	0	0	1	0	0	1	0	4

8: 18th Avenue & Alder St Performance by movement

Movement	EBL	EBT	NBR	NBR2	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.6	1.2	0.2	2.1
Total Del/Veh (s)	4.5	3.2	31.5	29.5	8.7
Stop/Veh	0.30	0.13	0.82	0.88	0.28
Travel Time (hr)	0.2	1.3	1.7	0.3	3.4
Avg Speed (mph)	11	14	4	4	8
Density (ft/veh)					133
Occupancy (veh)	0	1	2	0	3

9: 18th Avenue & Burnside Performance by movement

Movement	EBT	WBT	WBR	NBL	NBT	NBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.2	0.3	0.0	0.0	0.0	0.1
Total Delay (hr)	1.1	1.5	0.3	0.1	0.3	0.0	3.3
Total Del/Veh (s)	4.7	8.2	5.7	8.4	7.4	3.6	6.3
Stop/Veh	0.18	0.37	0.33	0.47	0.26	0.53	0.27
Travel Time (hr)	2.4	4.2	1.0	0.1	0.5	0.0	8.3
Avg Speed (mph)	13	16	17	5	6	9	15
Density (ft/veh)							189
Occupancy (veh)	2	4	1	0	0	0	8

Total Zone Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	0.5
Total Delay (hr)	17.1
Total Del/Veh (s)	1617.5
Stop/Veh	59.84
Travel Time (hr)	39.4
Avg Speed (mph)	14
Density (ft/veh)	238
Occupancy (veh)	39

Summary of All Intervals

Start Time	6:57
End Time	8:12
Total Time (min)	75
Time Recorded (min)	60
# of Intervals	2
# of Recorded Intervals	1
Vehs Entered	5062
Vehs Exited	5050
Starting Vehs	92
Ending Vehs	104
Travel Distance (mi)	1659
Travel Time (hr)	110.4
Total Delay (hr)	41.6
Total Stops	5282
Fuel Used (gal)	68.3

Interval #0 Information Seeding

Start Time	6:57
End Time	7:12
Total Time (min)	15

Volumes adjusted by Growth Factors.
No data recorded this interval.

Interval #1 Information Recording

Start Time	7:12
End Time	8:12
Total Time (min)	60

Volumes adjusted by Growth Factors.

Vehs Entered	5062
Vehs Exited	5050
Starting Vehs	92
Ending Vehs	104
Travel Distance (mi)	1659
Travel Time (hr)	110.4
Total Delay (hr)	41.6
Total Stops	5282
Fuel Used (gal)	68.3

3: 19th Avenue & Alder St & Burnside Performance by movement

Movement	EBT	EBR	EBR2	WBT	SBL2	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.2	0.2	0.4	0.0	0.0	0.0	0.1	0.5	0.1
Total Delay (hr)	2.3	2.3	0.1	3.0	0.4	0.5	1.1	0.6	10.4
Total Del/Veh (s)	15.2	18.9	12.8	9.5	17.1	18.5	19.2	15.1	13.8
Stop/Veh	0.52	0.60	0.45	0.35	0.56	0.61	0.60	0.86	0.49
Travel Time (hr)	5.7	5.1	0.2	5.1	0.9	1.1	2.2	1.4	21.7
Avg Speed (mph)	15	13	15	10	12	12	12	13	13
Density (ft/veh)									188
Occupancy (veh)	6	5	0	5	1	1	2	1	22

7: Morrison St & 19th Avenue & 18th Avenue Performance by movement

Movement	EBT	EBR	WBL	WBT	WBR2	NBL	NBR	NBR2	SBL	SBT	SBR	All
Denied Delay (hr)	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.2
Denied Del/Veh (s)	0.2	0.2	3.7	0.4	3.4	3.6	0.5	0.5	0.0	0.0	0.0	0.9
Total Delay (hr)	0.4	0.2	0.4	0.3	0.2	0.4	1.2	0.2	0.2	0.8	0.1	4.4
Total Del/Veh (s)	14.1	6.9	28.8	10.8	7.7	28.7	19.7	23.1	27.2	17.3	11.4	16.7
Stop/Veh	0.58	0.66	0.90	0.52	0.76	1.05	0.70	0.83	1.00	0.72	0.65	0.72
Travel Time (hr)	0.5	0.4	0.8	0.9	0.8	0.7	1.7	0.3	0.3	1.2	0.2	7.8
Avg Speed (mph)	6	8	11	17	17	6	8	7	5	8	9	10
Density (ft/veh)												522
Occupancy (veh)	1	0	1	1	1	1	2	0	0	1	0	8

8: 18th Avenue & Alder St Performance by movement

Movement	EBL	EBT	NBT	NBR	NBR2	All
Denied Delay (hr)	0.0	0.0	0.0	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay (hr)	0.1	0.4	0.0	2.4	0.3	3.2
Total Del/Veh (s)	4.2	3.2	20.3	33.1	41.6	13.9
Stop/Veh	0.22	0.17	1.00	0.68	0.83	0.35
Travel Time (hr)	0.1	1.0	0.0	2.7	0.3	4.1
Avg Speed (mph)	11	13	2	2	2	5
Density (ft/veh)						133
Occupancy (veh)	0	1	0	3	0	4

9: 18th Avenue & Burnside Performance by movement

Movement	EBT	WBT	WBR	NBL	NBT	NBR	All
Denied Delay (hr)	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Denied Del/Veh (s)	0.0	0.2	0.2	0.2	0.0	0.0	0.1
Total Delay (hr)	0.9	3.7	0.4	0.4	0.3	0.0	5.7
Total Del/Veh (s)	5.2	12.8	10.5	13.5	6.1	3.7	9.8
Stop/Veh	0.17	0.46	0.52	0.28	0.13	0.45	0.34
Travel Time (hr)	2.0	11.4	1.4	0.6	0.5	0.0	15.9
Avg Speed (mph)	13	17	17	4	8	9	15
Density (ft/veh)							160
Occupancy (veh)	2	11	1	1	0	0	16

Total Zone Performance

Denied Delay (hr)	0.4
Denied Del/Veh (s)	0.5
Total Delay (hr)	23.7
Total Del/Veh (s)	1398.3
Stop/Veh	49.48
Travel Time (hr)	49.5
Avg Speed (mph)	12
Density (ft/veh)	226
Occupancy (veh)	49

Appendix D Preferred Concept Design
