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MEMORANDUM

Date: May 1, 2018 Project #: 21001.0

To: Jacob Graichen, City of St Helens
Ken Shonkwiler, Oregon Department of Transportation (ODOT)

From: Matt Bell, Krista Purser, and Chris Brehmer, Kittelson & Associates, Inc.

Project: St Helens Riverfront Connector Plan

Subject: Future Year 2031 Baseline Transportation System Conditions (Subtask 4.8)

FUTURE CONDITIONS OVERVIEW

This memorandum documents planned improvements and future traffic conditions in the southeast part of St. Helens in support of the St. Helens Riverfront Connector Plan. The information provided in this memorandum is intended to convey an understanding of assumed future infrastructure that is expected to be in place, forecast traffic volumes, and an assessment of how the study intersections would operate in this baseline condition. The forecast intersection operations suggest areas where additional improvement efforts should be focused while multi-modal opportunities and constraints to improve safety and mobility within the study area are highlighted.

This document highlights improvement needs for the baseline year 2031 future condition. It does not identify or prescribe solutions. Potential mitigation options were identified, vetted, and prioritized through subsequent project efforts.

EXECUTIVE SUMMARY

Key findings of this memorandum are as follows:

- Traffic analysis incorporates projected growth in the waterfront area.
- Traffic analysis does not assume completion of intersection or roadway improvements which are not funded.
- ODOT plans to install a traffic signal and turn lane improvements at the US 30/Millard Road intersection in 2019. The signal will include protected/permissive left-turns from US 30 and permissive left-turns with separate right-turn lanes on Millard Road.
- Potential pedestrian and bicycle improvements include reconstructing study area road segments to the standard cross-sections (width, number of turn lanes, multi-modal amenities) identified in the City's Transportation System Plan (TSP).

    - Per the TSP, collectors and arterials would include landscape-buffered sidewalks and bicycle lanes for collectors and arterials.
    - Local street cross sections include sidewalks and bicycles sharing travel lanes with vehicles.
- Future year 2031 traffic volumes include growth identified in the 2011 TSP, additional growth based on updated land use forecasts, and rerouted traffic due to US 30/Millard Road signalization.
- The following intersections are projected to exceed jurisdictional operating standards during the year 2031 future weekday p.m. peak hour under baseline (unmitigated) conditions:
    - Old Portland Road/Plymouth Street
    - Old Portland Road/S 15th Street
    - Old Portland Road/S 18th Street/Kaster Road
    - Old Portland Road/Railroad Avenue
    - Old Portland Road/Gable Road
    - McNulty Way/Gable Road
    - US 30/Gable Road
    - US 30/Millard Road
- From a pedestrian perspective, Pedestrian Level of Traffic Stress (PLTS) 1 or 2 is achievable where TSP standard roadway cross sections, adequate illumination, and good pavement conditions are present.
- From a bicycle perspective, Bicycle Level of Traffic Stress (BLTS) 1 can be achieved where standard cross sections are provided and the posted speed limit is less than 40 miles per hour (mph). Roadways with a posted speed above 40 mph will be deemed to operate at BLTS 4 even with the TSP-standard road section.

This memorandum was reviewed and revised based on input from the project management team (PMT), the Committee Overseeing Overt Long-range Passageway Planning (COOLPPL), and the public.

PLANNED IMPROVEMENTS

The City of St. Helens Transportation System Plan (TSP, Reference 1) and Waterfront Redevelopment Plan (Reference 2) identify several improvements to the vehicle, pedestrian, bicycle, and transit facilities within St. Helens. The following summarizes the improvements and identifies which improvements are currently funded, and therefore, included in the 2031 analysis.

VEHICLE IMPROVEMENTS

The TSP and Waterfront Redevelopment Plan identify several vehicle improvements at the study intersections, including additional lanes, signalization, and reconfiguration. The following summarizes the funded and unfunded improvements by intersection.

Funded Improvements

US 30/Millard Road

The TSP identifies signalization of the US 30/Millard Road intersection as a mid-term (2017 to 2021) improvement. Per discussions with ODOT staff, reconstruction of the intersection and signalization is anticipated to begin in 2019. The signal will likely include protected/permissive left-turns from US 30 and permissive left-turns from Millard Road with separate right-turn lanes on the east and westbound approaches. Note that the additional right-turn lane at the westbound approach will require widening and reconstruction of the adjacent Portland & Western Railroad (PNWR) grade crossing. This improvement is assumed to be in place for the year 2031 baseline analysis.

Unfunded Improvements

The improvement described below are not funded projects were not included in the 2031 analysis.

US 30/Millard Road

The TSP also identifies a potential overpass at the US 30/Millard intersection as a long-term vision for St. Helens; one that would not be completed within the 20-year planning horizon of the TSP.

US 30/Gable Road

The TSP identifies the addition of a westbound right-turn lane at the US 30/Gable Road intersection as a long-term (2022 to 2031) improvement. Construction of the additional right-turn lane at the westbound approach will require widening and reconstruction of the adjacent PNWR grade crossing. This potential improvement was also identified in the Waterfront Redevelopment Plan as an important improvement to provide additional capacity at the intersection.

Old Portland Road/Millard Road

The TSP identifies reconfiguration of the Old Portland Road/Millard Road intersection to accommodate heavy truck turning movements as a mid-term (2017 to 2021) improvement. This potential improvement was also identified in the Waterfront Redevelopment Plan as an important improvement to provide access to the waterfront area as well as truck access to the industrial areas to the south. Columbia County also recently identified the potential to realign Millard Road to remove the “skew” from the intersection.

Old Portland Road/Gable Road

The TSP identifies a long-term (2022 to 2031) improvement at the Old Portland Road/Gable Road intersection. The improvement includes realigning the intersection to emphasize through movements on Old Portland Road. The Waterfront Redevelopment Plan identifies two potential alternative improvements at the intersection, including realigning 1) Old Portland Road so that it intersects with Gable Road further to the west, providing greater separation from the railroad crossing near Railroad Avenue; or 2) realigning Old Portland Road to emphasize the through movement on Old Portland Road and realigning Gable Road so that it connects with Old Portland Road further to the west and installing

a traffic signal at the new Old Portland Road/Gable Road intersection. A final design has not been selected.

Old Portland Road/S 18th Street/Kaster Road

The TSP identifies a near-term (2011 to 2016) improvement need at the Old Portland Road/S 18th Street/Kaster Road intersection. The improvement includes reconfiguring the intersection to provide stop control or upgrading the signal to current standards.

Old Portland Road/Plymouth Street

The Waterfront Redevelopment Plan identifies several potential improvements at the Old Portland Road/Plymouth Street intersection. The improvement options include a minor realignment of the intersection to improvement sight distance; a major realignment of the intersection to emphasize movement from Old Portland to Plymouth Street; installing two closely spaced roundabouts; and/or installing a large five-leg roundabout that connects Old Portland Road to Plymouth Street and 12th Avenue. While a final design of the intersection has not been selected, the City has purchased property in the area that could facilitate the future improvements. A final design has not been selected.

McNulty Way/Gable Road

The Waterfront Redevelopment Plan identifies the addition of a westbound left-turn lane at the McNulty Way/Gable Road intersection to encourage use of McNulty Way and Millard Road to access US 30.

PEDESTRIAN IMPROVEMENTS

The TSP identifies “critical needs” and “additional needs” for pedestrian improvements throughout St. Helens. Improvements include sidewalks on one or both sides of streets and improved pedestrian crossings. Exhibit 1 shows the proposed improvements.

Within the Riverfront Connector Plan study area, identified improvements include sidewalks along McNulty Way in the near-term and Old Portland Road from Gable Road to S 4th Street in the mid-term. Citywide, standard roadway cross sections include 5-feet wide sidewalks for local streets and 6-feet wide sidewalks with a 5-foot landscaping buffer for collectors and arterials.

Study intersections with identified pedestrian crossing improvements include US 30/Millard Road, Old Portland Road/S 18th Street/Kaster Road, and St. Helens Street/S 1st Street. Pedestrian crossing improvements include leading pedestrian intervals at signalized crossings and active treatment at unsignalized intersections. Additional improvements at Old Portland Road/S 18th Street/Kaster Road include marked crosswalks and 6 new handicapped accessible (ADA compliant) ramps.

Exhibit 1: TSP Proposed Pedestrian Improvement Projects

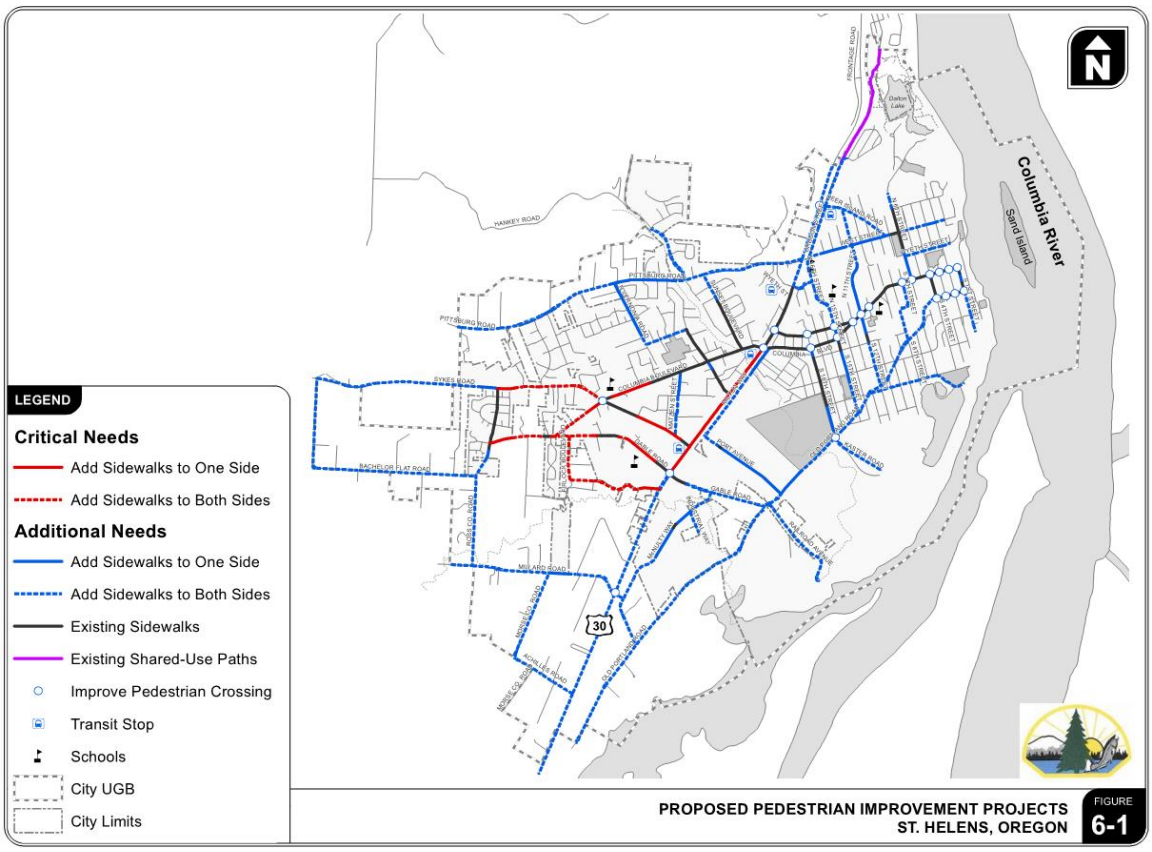


Image Source: St Helens Transportation System Plan, Ordinance 3150

BICYCLE IMPROVEMENTS

The TSP identifies "critical needs" and "additional needs" for bicycle improvements throughout St. Helens. Improvements include bicycle lanes and improved bicycle crossings. Exhibit 2 shows the proposed improvements.

Within the Riverfront Connector Plan study area, improvements include bicycle lanes along McNulty Way in the near-term and Old Portland Road from McNulty Way to S 4th Street in the mid-term. Citywide, standard cross sections include mixed traffic for local streets and 6-feet wide marked bicycle lanes for collectors and arterials. Bicycle parking facilities are recommended along US 30's commercial areas and in the developing Riverfront area.

Bicycle crossing improvements are identified at the US 30/Gable Road intersection. Improvements include enhancing the existing bicycle facilities in the near-term to include pavement markings and signage that directs bicyclists through the intersection. Potential long-term roadway improvements include provision of a separate westbound right-turn lane, at which time the westbound approach could be restriped to accommodate a bicycle lane between the through and right-turn lanes.

TSP-recommendations for multi-use paths and trails include replacement of the existing path along Old Portland Road with separated bicycle lanes, curb, and sidewalk and provision of a new multi-use path

on Old Portland Road south of Gable Road. The County's recently adopted TSP includes a project to study the feasibility of constructing an off-street trail from the St. Helens south city limits to Scappoose along US 30. The project is included in the County's financially constrained and aspirational project list.

Exhibit 2: TSP Proposed Bicycle Improvement Projects

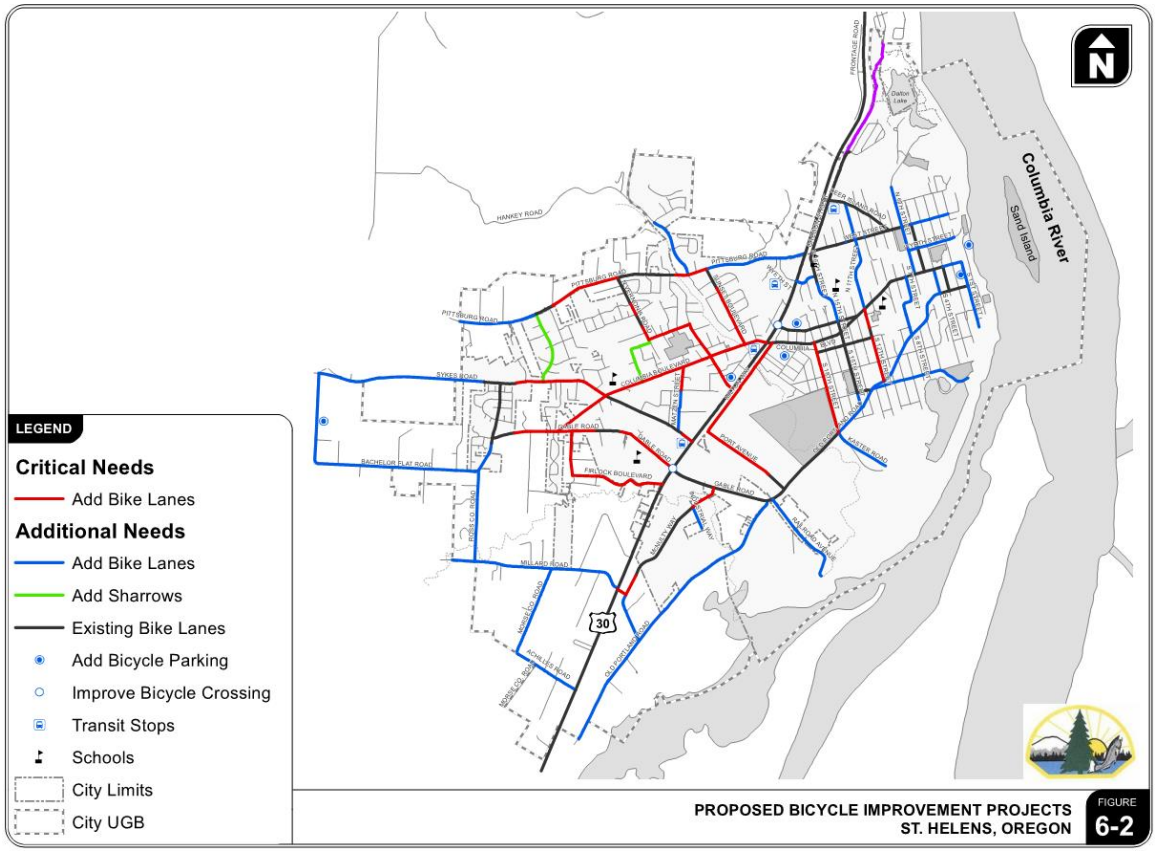


Image Source: St Helens Transportation System Plan, Ordinance 3150

TRANSIT IMPROVEMENTS

No additional planned and funded transit improvements were identified within the study area. The CC Rider Transit Center is located on Deer Island Road near US 30 and several park-and-ride lots are located along US 30. Study roadway segments serve as pedestrian, bicycle, and vehicle routes between these locations and the Riverfront area.

FUTURE BASELINE 2031 CONDITIONS

Future conditions were assessed based on planned improvements and forecasts of the study area. Vehicle volume development, vehicle traffic operations, pedestrian level of traffic stress, and bicycle level of traffic stress are described below.

VEHICLE CONDITIONS

The following sections summarize the future traffic volume development and future vehicle operations for the study area.

Traffic Volume Development

Traffic volumes were developed based on TSP forecasted traffic volume growth, updated land use forecasts, and rerouted volumes due to the US 30/Millard Road intersection signalization.

TSP Forecasted Growth

2031 traffic volume forecasts were developed as part of the TSP. These forecasts included:

- Growth rate projections for highway traffic volumes,
- Household and employment growth and where it is likely to occur,
- Vehicle trip estimates associated with the household and employment growth, and
- Allocating those trips across the city to various growth areas.

The TSP identifies existing (2011) traffic counts at the US 30/Gable Road and US 30/Millard Road intersections. The 2011 turning movements to and from the side streets are similar to traffic counts collected in 2017, indicating the TSP-forecast growth has not yet been realized. Therefore, the entirety of the forecasted traffic volume growth was applied to the 2017 counts. For study intersections not evaluated under the TSP, trips were distributed from the US 30/Gable Road, US 30/Millard Road, and Columbia Boulevard/S 12th Street intersections based on existing traffic patterns, including vehicles entering and exiting the study corridor at intermittent driveways. Figure 1 shows the TSP-forecast traffic volume growth during the weekday p.m. peak hour.

Updated Land Use Forecasts

Land use forecasts were updated based on the results of the Waterfront Redevelopment Project and recent developments within the City, detailed in *Technical Memorandum #4: Land Use and Urban Design*. Changes in trip patterns associated with the updated land use assumptions were allocated to a travel model used in the TSP development that tracked trips by subareas.

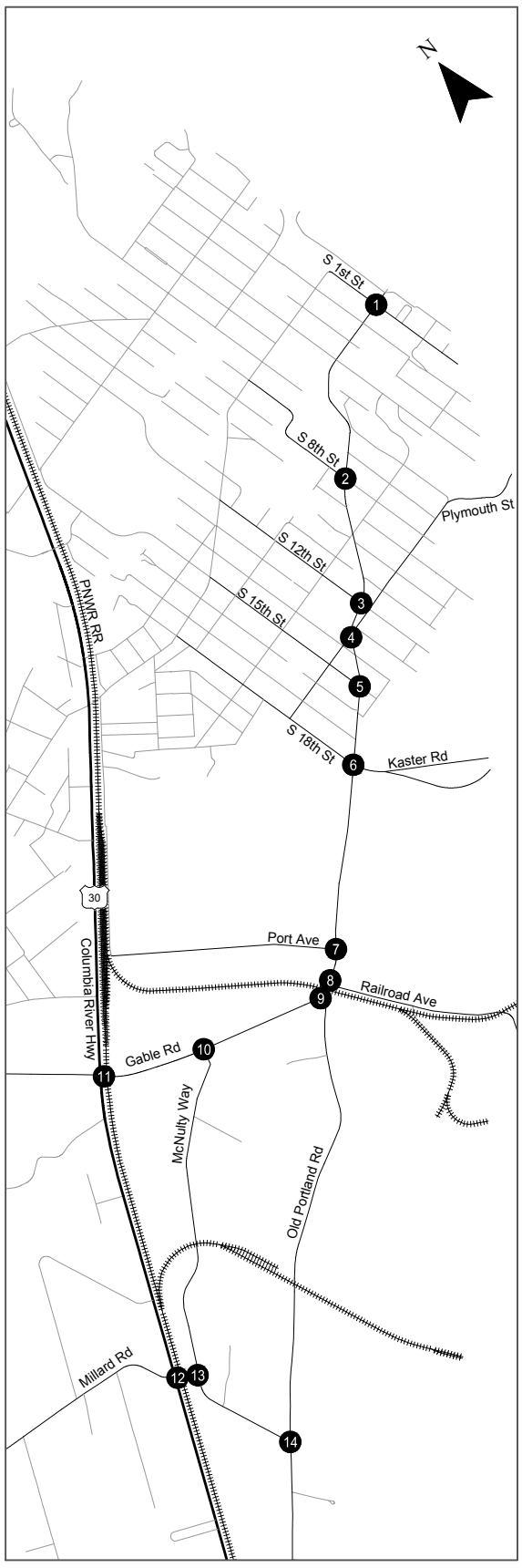
Transportation Analysis Zone (TAZ) 6 encompasses the Riverfront study area. Information provided for TAZ 6 indicates a reduction in the number of single-family homes, an increase in multi-family homes, an increase in retail uses, an increase in commercial uses, and a slight reduction in industrial and institutional land uses. The projected reductions in industrial and institutional land uses have already occurred and are reflected within the 2017 traffic counts.

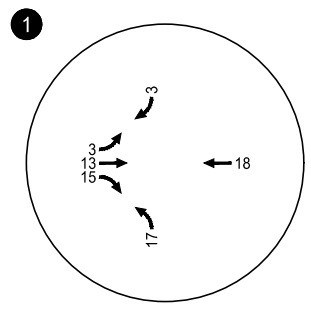
Trip generation estimates were developed for the residential, retail, and commercial land use changes. Trip generation was calculated based on the rates from *Trip Generation Manual*, 10th *Edition*, published by the Institute of Transportation Engineers (ITE – Reference 3). Table 1 shows the trip generation estimate for the updated land use forecasts.

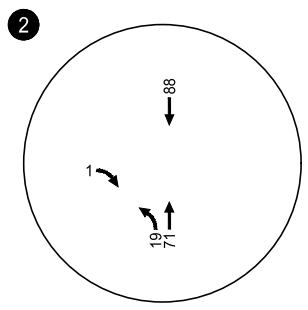
Table 1: Trip Generation for Updated Land Use Forecasts

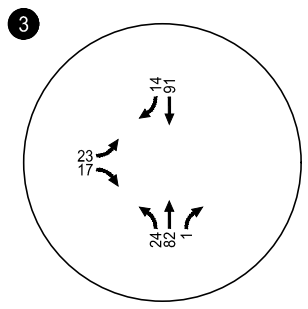
Land Use	ITE Code	Size	Daily Trips	Weekday PM Peak Hour		
				Total	In	Out
Apartment	220	136	987	78	49	29
General Office Building	710	39,537	431	47	8	39
Shopping Center	820	9,368	1,202	94	45	49
Total New Trips			**2,620**	**219**	**102**	**117**
Single-Family Detached Housing	210	*-10*	*-125*	*-11*	*-7*	*-4*
Net New Trips			**2,495**	**208**	**95**	**113**

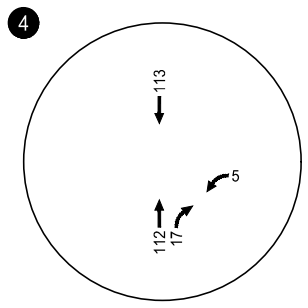
The distribution of trips onto the study area roadway system was estimated based on existing traffic patterns and adjacent land uses. Figure 2 shows the trip distribution and assignment to study intersections during the weekday p.m. peak hour.

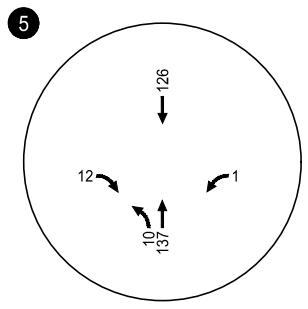


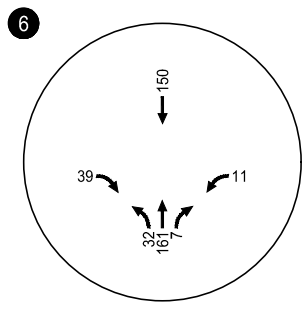


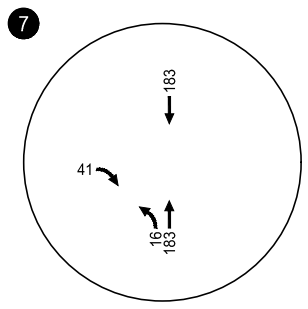


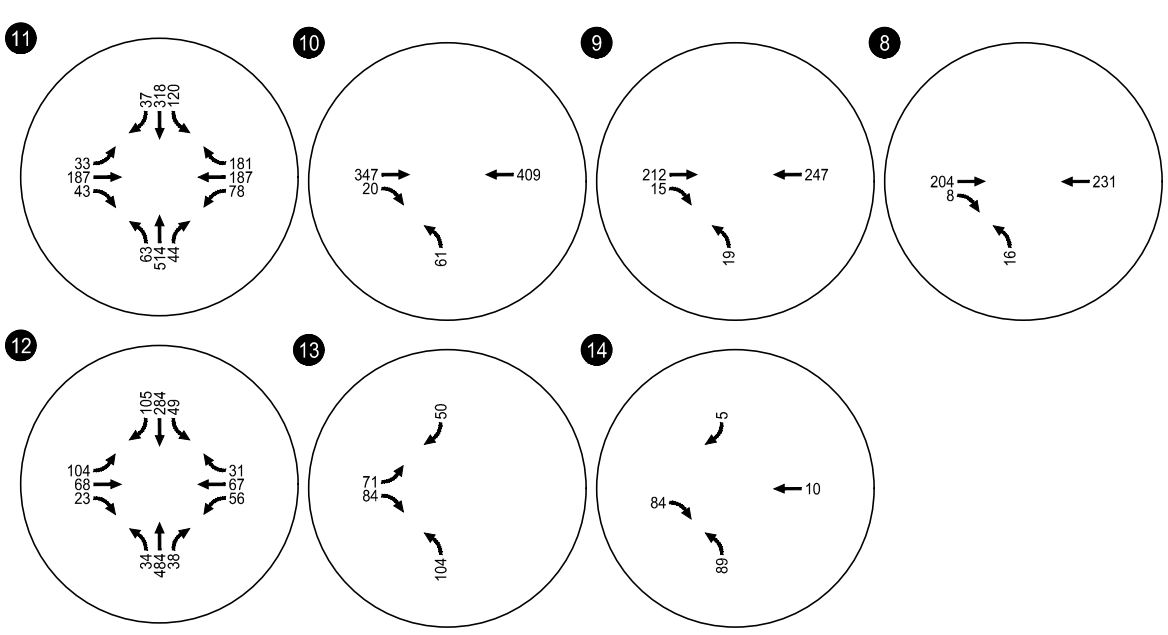






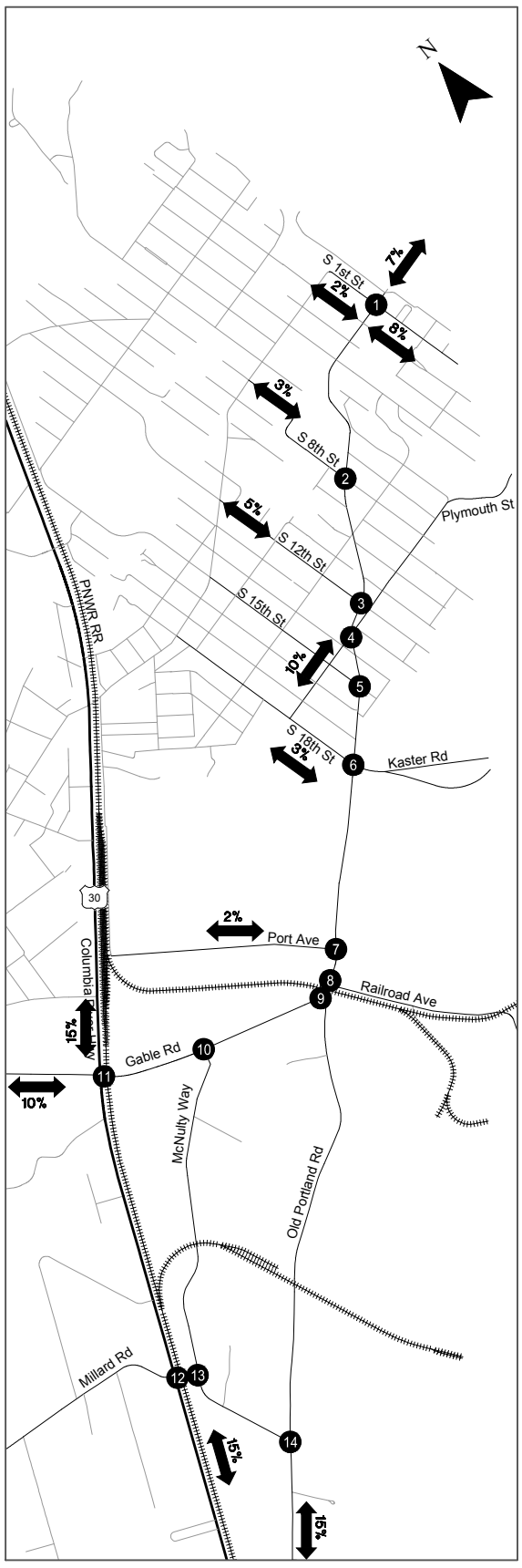


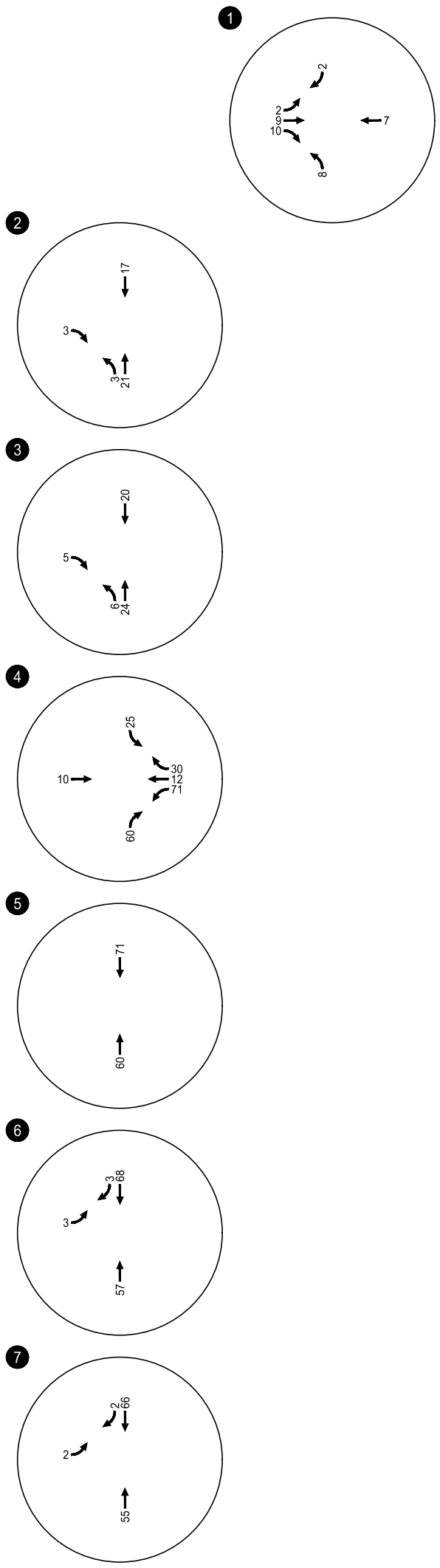


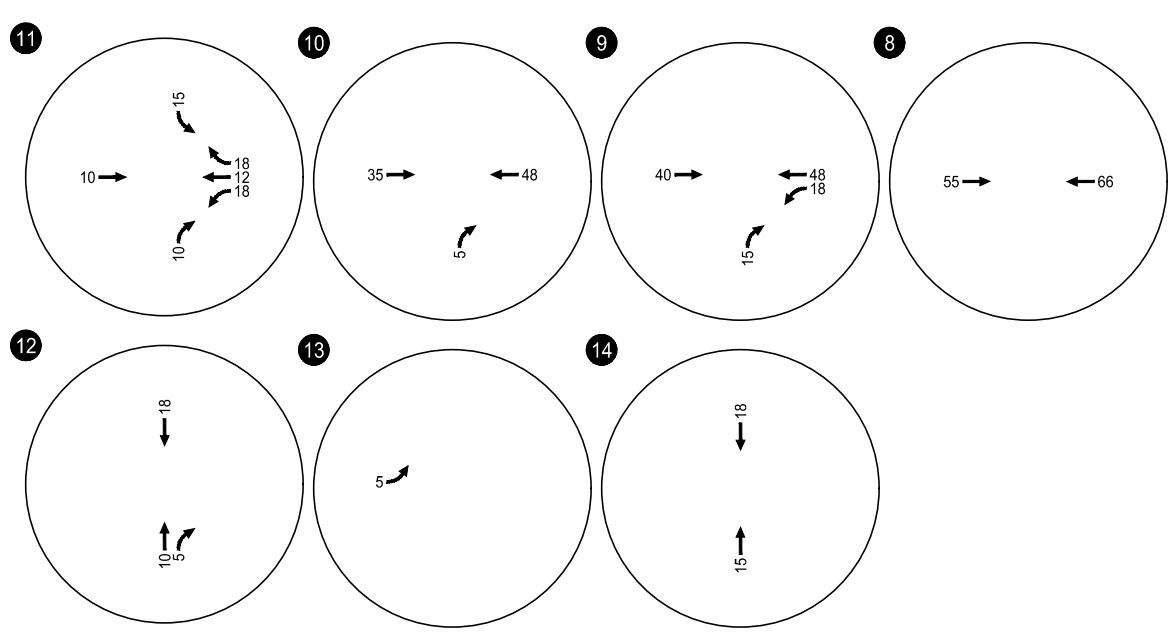


TSP Forecasted Growth
Weekday PM Peak Hour
St. Helens, OR

Figure
1







Updated Land Use Forecast Additional Trips
Weekday PM Peak Hour
St. Helens, OR

Figure **2**

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Millard Signalization Reroute

ODOT is planning to install a traffic signal at the US 30/Millard Road intersection in 2019. Detailed design information on the traffic signal was limited at the time this report was prepared; however, given the proximity of the US 30/Millard Road intersection to other signalized intersections along the US 30 corridor, the new signal is expected to operate actuated-uncoordinated with protected-permissive northbound and southbound left-turn movements and permissive westbound and eastbound left-turn movements. The new signal is expected to result in a shift in existing traffic volumes and projected growth from the US 30/Gable Road intersection to the US 30/Millard Road intersection, particularly the eastbound and westbound through and left-turn movements. Based on a review of the street network and the expected capacity of the new signal, 10 percent of the eastbound and westbound through movements and 20 percent of the eastbound and westbound left-turn movements were rerouted from the US 30/Gable Road intersection to the US 30/Millard Road intersection during the weekday p.m. peak hour. The rerouted trips during the weekday p.m. peak hour are shown in Figure 3.

2017 to 2031 Total Growth

TSP forecasted growth (Figure 1), updated land use forecasted growth (Figure 2), and Millard signalization rerouted trips (Figure 3) were added to arrive at the 2017 to 2031 total growth. Total growth is shown in Figure 4.

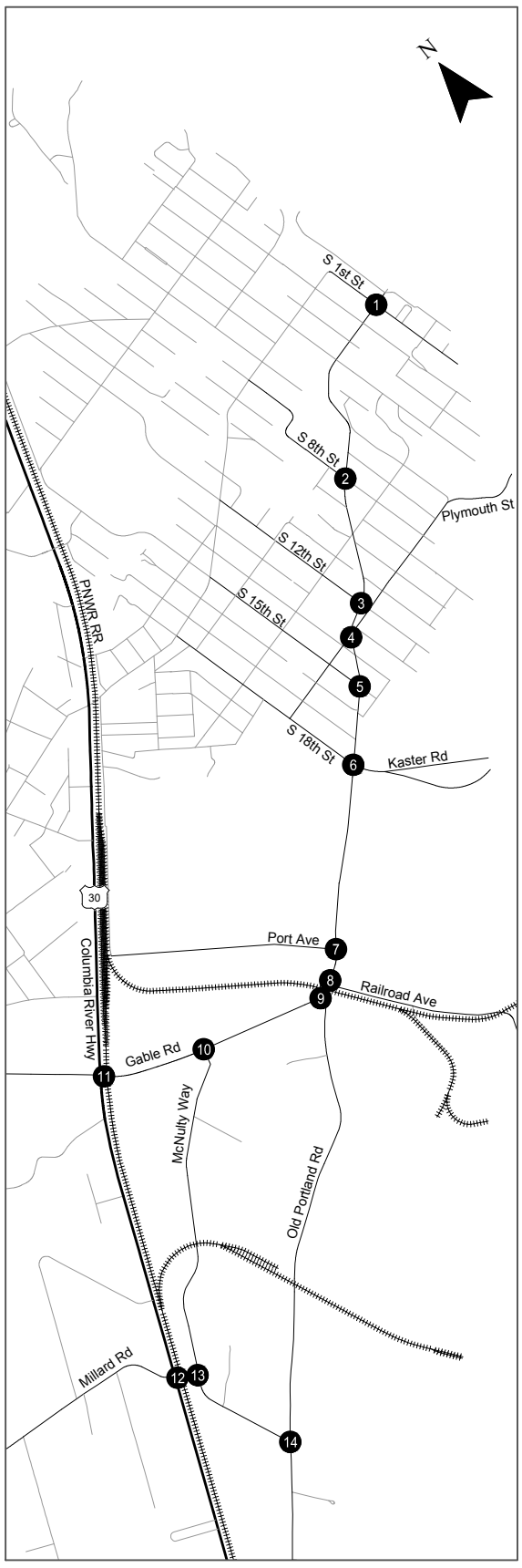
Vehicle Operations

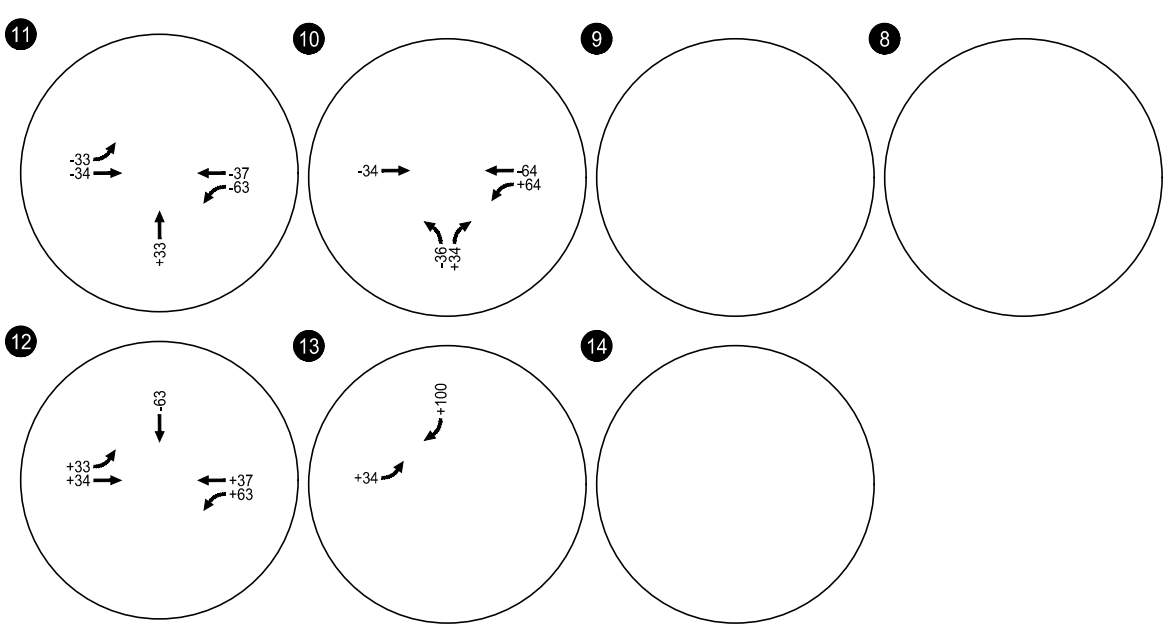
Future traffic conditions were assessed using the operations analysis methodology and compared to jurisdictional operating standards and thresholds established in Technical *Memorandum #2: Existing Conditions*.

Future Levels of Service

The total growth volumes in Figure 4 were added to 2017 existing volumes, resulting in the 2031 traffic volumes. Figure 5 summarizes the results of the future traffic conditions analysis. The following intersections are projected to exceed jurisdictional operating standards during the weekday p.m. peak hour:

- Old Portland Road/Plymouth Street
- Old Portland Road/S 15th Street
- Old Portland Road/S 18th Street/Kaster Road
- Old Portland Road/Railroad Avenue
- Old Portland Road/Gable Road
- McNulty Way/Gable Road
- US 30/Gable Road
- US 30/Millard Road





Millard Signalization Rerouted Trips
Weekday PM Peak Hour
St. Helens, OR

Figure **3**

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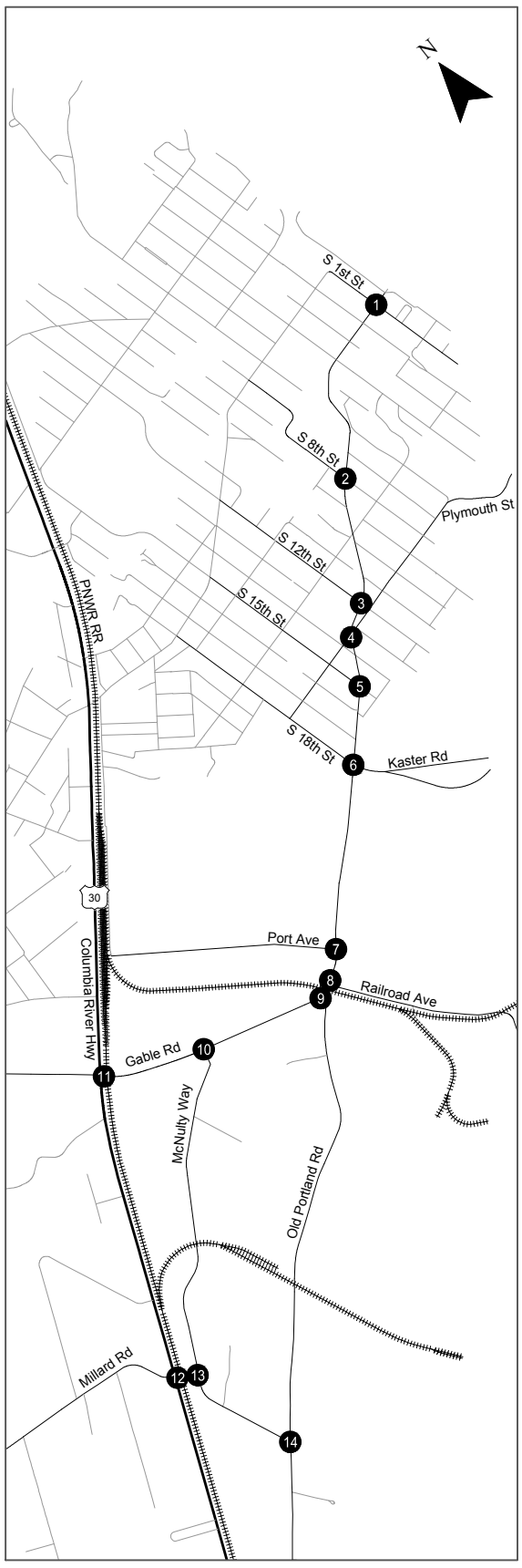

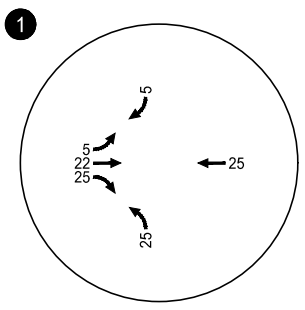

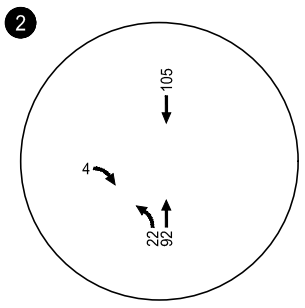

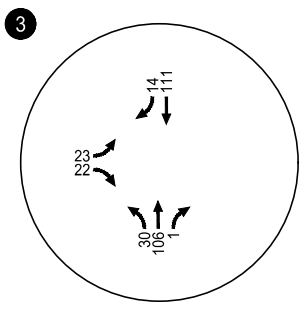

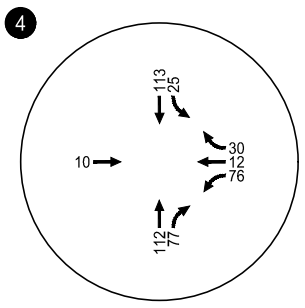

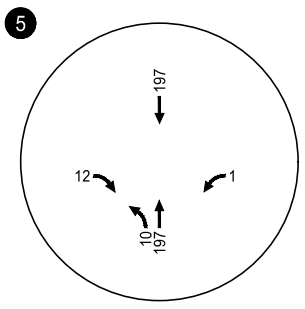

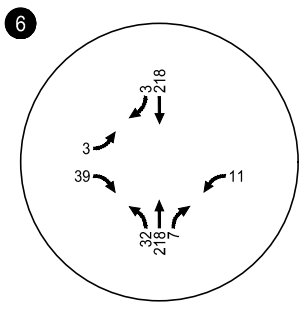

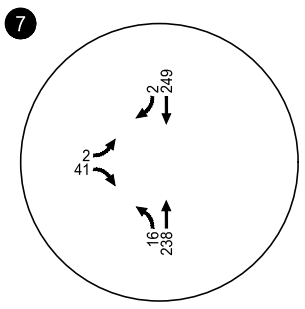

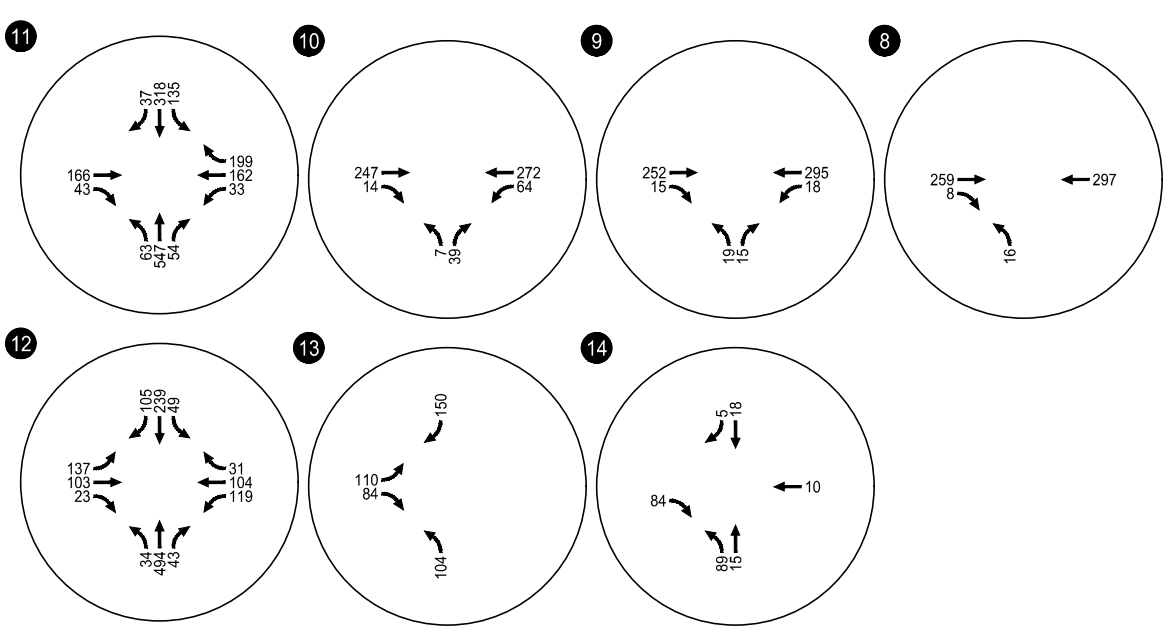

2017 to 2031 Total Growth
Weekday PM Peak Hour
St. Helens, OR

Figure
4

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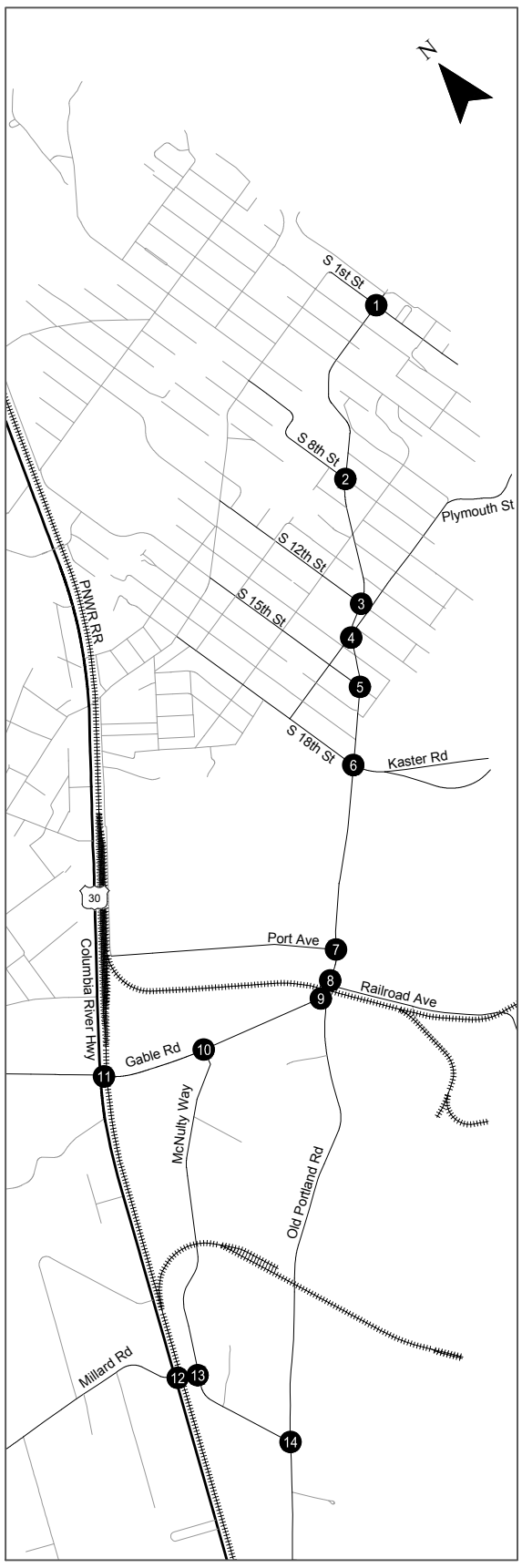

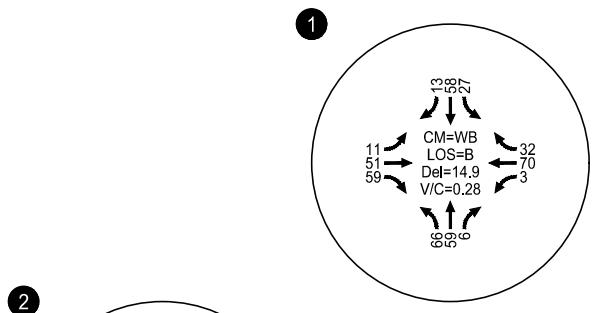

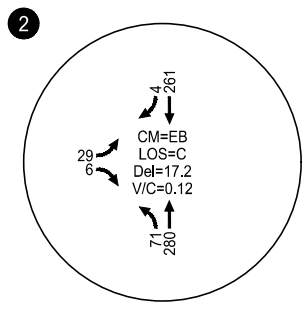

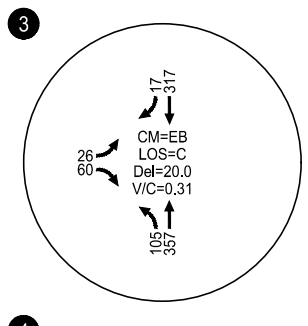

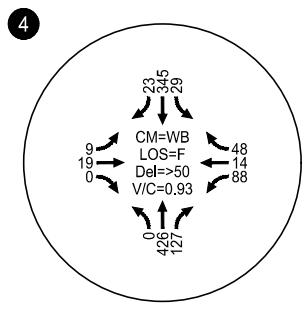

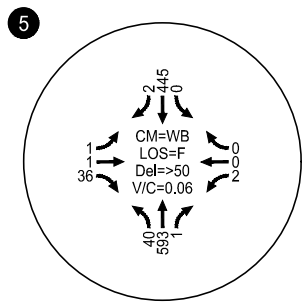

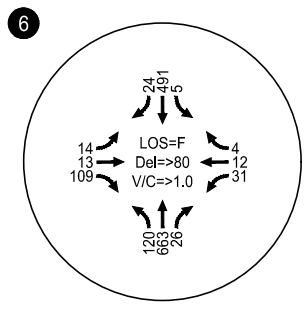

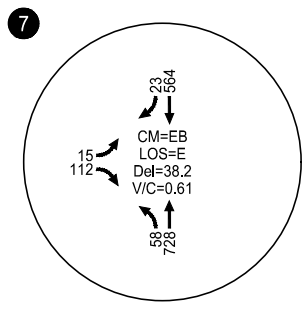

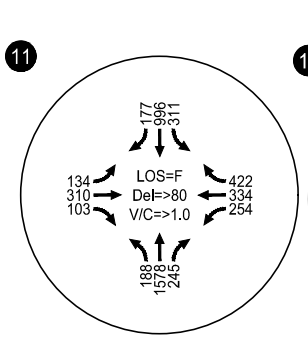

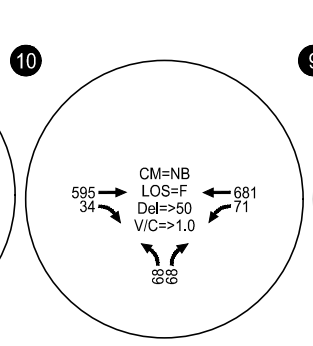

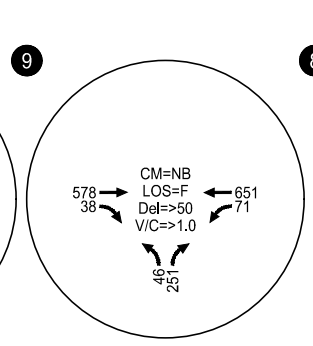

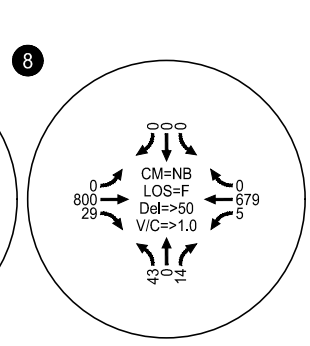

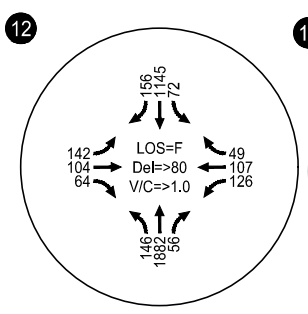

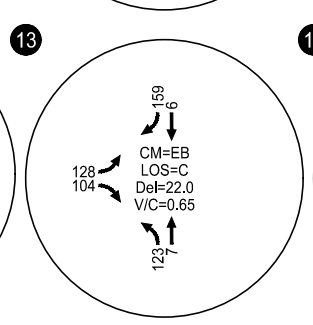

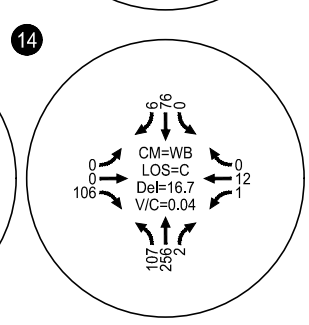

Future Traffic Conditions
Weekday PM Peak Hour
St. Helens, OR

Figure **5**

The 2011 TSP also forecasted US 30/Gable Road and US 30/Millard Road to exceed jurisdictional operating standards under future conditions. All remaining study intersections are projected to operate acceptably during the weekday p.m. peak hours. Appendix "A" includes the worksheets used to evaluate future traffic conditions at the study intersections. Summaries of the individual intersection needs follow. Mitigation options were assessed separately in subsequent phases of the project.

Old Portland Road/Plymouth Street

The westbound left-turn movement at the Old Portland Road/Plymouth Street intersection is expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. This is primarily due to the increase in volume associated with the Waterfront Redevelopment Plan. As indicated above, several alternatives have been considered for improving the intersection, including:

- reconfiguring the intersection to emphasize movement from Old Portland Road to Plymouth Road
- reconfiguring the intersection as dual single-lane roundabout
- reconfiguring the intersection as a five-leg roundabout

Further evaluation of these alternatives is included in subsequent analyses.

Old Portland Road/S 15th Street

The westbound left-turn movement at the Old Portland Road/S 15th Street intersection is expected to operate at level of service "F", but below capacity during the weekday p.m. peak hour. No alternatives have been considered as part of previous efforts to improve the intersection; however, preliminary signal warrants indicate that a signal is not warranted. Potential mitigation options include multiway stop-control and roundabout intersections. Further evaluation of these alternatives is included in subsequent analyses.

Old Portland Road/S 18th Street/Kaster Road

The northbound approach to the Old Portland Road/S 18th Street/Kaster Road intersection is expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. As indicated above, two alternatives have been identified to address future traffic conditions at the intersection, including:

- Reconfiguring the intersection with stop control
- Upgrading the signal to current standards

Further evaluation of these alternatives is included in subsequent analyses.

Old Portland Road/Railroad Avenue

The northbound approach to the Old Portland Road/Railroad Avenue intersection is expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. No alternatives

have been considered as part of previous efforts to improve the intersection; however, preliminary signal warrants indicate that a signal is not warranted. Potential mitigation options include multiway stop-control and roundabout intersections. Further evaluation of these alternatives is included in subsequent analyses.

Old Portland Road/Gable Road

The northbound approach to the Old Portland Road/Gable Road intersection is expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. As indicated above, several alternatives previously have been considered for improving the intersection, including:

- reconfiguring the intersection to emphasize the through movement on Old Portland Road
- realigning Old Portland Road so that it connects with Gable Road further to the west, providing greater separation from Railroad Avenue
- reconfiguring the intersection to emphasize the through movement on Old Portland Road, realigning Gable Road to intersection with Old Portland Road further to the west, and installing a traffic signal

Further evaluation of these alternatives is included in subsequent analyses.

McNulty Way/Gable Road

The northbound approach to the McNulty Way/Gable Road intersection is expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. Installation of a westbound left-turn lane has previously been identified as a potential mitigation. The westbound left-turn lane could be designed as a center-two way left-turn lane that in concept would allow motorists from McNulty way to complete a two-stage left-turn movement.

US 30/Gable Road

Multiple approaches to the US 30/Gable Road intersection are expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. Note: this analysis reflects installation of a traffic signal at the US 30/Millard Road intersection and a shift in traffic volumes from US 30/Gable Road to US 30/Millard Road. The TSP identified installation of a westbound right-turn as one potential mitigation alternative, however, this improvement alone may not be sufficient. A grade-separated intersection may be explored as a long-term vision for US 30/Gable Road.

The TSP also identifies a potential overpass at the US 30/Millard intersection as a long-term vision for St. Helens; one that would not be completed within the 20-year planning horizon of the TSP.

US 30/Millard Road

Multiple approaches to the US 30/Millard Road intersection are expected to operate at level of service "F" and above capacity during the weekday p.m. peak hour. Note this analysis assumes installation of a

traffic signal at the US 30/Millard Road intersection and a shift in traffic volumes from US 30/Gable Road to US 30/Millard Road.

PEDESTRIAN GAPS AND DEFICIENCIES

Pedestrian gaps and deficiencies were identified in *Technical Memorandum #2: Existing Conditions* using ODOT Analysis Procedures Manual (APM – Reference 4) methodology. Key findings were as follows:

- Several arterial and collector streets do not currently provide sidewalks along one or two sides of the roadway, including segments of Old Portland Road, Gable Road, Millard Road, Plymouth Street, and McNulty Way.
- Many sidewalks throughout the City do not provide sufficient width to accommodate pedestrian activity or are in a state of disrepair.
- Many sidewalks and pedestrian ramps throughout the City are not constructed to current handicapped accessible standards (ADA compliant).
- There are several major (and minor) intersections that do not provide marked pedestrian crossings.

TSP-standard roadway cross sections include 5-foot wide sidewalks for local streets and 6-feet wide sidewalks with a 5-foot landscaping buffer for collectors and arterials. Assuming adequate illumination and good pavement conditions, these cross sections result in the following:

- **PLTS 2** on US 30, Gable Road, and Old Portland Road (S 18th Street to Millard Road) due to physical buffer type and total buffering width.
- **PLTS 1** on Millard Road, Old Portland Road (S 18th Street to S 1st Street), Plymouth Street, and McNulty Way.

The PLTS results above do not consider the general land use criteria, which affects the desired walkability of a segment. Industrial and lower-density areas would result in higher PLTS rating whereas residential and/or higher density areas would maintain lower PLTS ratings.

BICYCLE GAPS AND DEFICIENCIES

Bicycle gaps and deficiencies were also identified in *Technical Memorandum #2: Existing Conditions* using ODOT Analysis Procedures Manual (APM – Reference 4) methodology. Key findings were as follows:

- There are several study roadways that currently do not provide on-street bike lanes. These roadways include segments of Old Portland Road, Millard Road, Plymouth Street, and McNulty Way. Bike lanes would need to be installed at 5.5 feet width for 30 mph and slower roadways or at 7 feet for 35 mph roadways to achieve a BLTS 2 rating.
- There are several study roadways whose bike lanes are too narrow or adjacent speeds are too high to provide a comfortable riding experience. These streets include US 30, Gable Road, and segments of Old Portland Road. Bike lanes would either need to be widened to 7

feet and/or the posted speed limit would need to be reduced to as low as 35 mph to achieve a BLTS 2 rating.

- There are several study area roadways with mixed traffic where posted speed limits are too high. These roadways include Millard Road and segments of Old Portland Road. Bike lanes or a separated bike path would need to be provided and/or the posted speed limit would need to be reduced to as low as 25 mph or the centerline stripe would need to be removed to achieve a BLTS 2 rating.

Citywide, TSP-standard cross sections include mixed traffic for local streets and 6-foot wide marked bicycle lanes for collectors and arterials. If constructed, these cross sections result in the following results:

- **BLTS 4** on US 30, Gable Road, and Old Portland Road (S 18th Street to Millard Road) due to a lack of buffer and speeds at or above 40 mph.
- **BLTS 1** on Millard Road, Old Portland Road (S 18th Street to S 1st Street), Plymouth Street, and McNulty Way.

Bike lane buffers and/or lower speeds would be needed to decrease BLTS on US 30, Gable Road, and Old Portland Road.

NEXT STEPS

The information presented in this document was used to assist in the identification of near-term transportation improvement needs as well as for comparison to future conditions.

REFERENCES

1. City of St. Helens. *City of St. Helens Transportation System Plan*. 2011.
2. City of St. Helens. *Waterfront Redevelopment Project*. 2013.
3. Institute of Transportation Engineers. *Trip Generation, 10th Edition*. 2017.
4. Oregon Department of Transportation. *Analysis Procedures Manual*. December 2017 update.

Appendix A Future Traffic Conditions

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	11	51	59	3	70	32	66	59	6	27	58	13
Future Volume (Veh/h)	11	51	59	3	70	32	66	59	6	27	58	13
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Hourly flow rate (vph)	15	68	79	4	93	43	88	79	8	36	77	17
Pedestrians		2			9			8				
Lane Width (ft)		12.0			12.0			12.0				
Walking Speed (ft/s)		3.5			3.5			3.5				
Percent Blockage		0			1			1				
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	508	432	96	546	436	92	96			96		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	508	432	96	546	436	92	96			96		
tC, single (s)	7.3	6.9	6.4	8.1	6.7	6.4	4.3			4.3		
tC, 2 stage (s)												
tF (s)	3.7	4.4	3.4	4.4	4.2	3.5	2.4			2.4		
p0 queue free %	96	84	91	98	79	95	94			97		
cM capacity (veh/h)	334	418	918	239	435	905	1406			1369		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	162	140	175	130
Volume Left	15	4	88	36
Volume Right	79	43	8	17
cSH	551	504	1406	1369
Volume to Capacity	0.29	0.28	0.06	0.03
Queue Length 95th (ft)	30	28	5	2
Control Delay (s)	14.2	14.9	4.1	2.3
Lane LOS	B	B	A	A
Approach Delay (s)	14.2	14.9	4.1	2.3
Approach LOS	B	B		

Intersection Summary				
Average Delay	8.9			
Intersection Capacity Utilization	32.0%	ICU Level of Service	A	
Analysis Period (min)	15			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	29	6	71	280	261	4
Future Volume (Veh/h)	29	6	71	280	261	4
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87
Hourly flow rate (vph)	33	7	82	322	300	5
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	788	302	305			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	788	302	305			
tC, single (s)	6.7	6.2	4.2			
tC, 2 stage (s)						
tF (s)	3.8	3.3	2.3			
p0 queue free %	89	99	93			
cM capacity (veh/h)	300	742	1191			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	40	404	305
Volume Left	33	82	0
Volume Right	7	0	5
cSH	335	1191	1700
Volume to Capacity	0.12	0.07	0.18
Queue Length 95th (ft)	10	6	0
Control Delay (s)	17.2	2.2	0.0
Lane LOS	C	A	
Approach Delay (s)	17.2	2.2	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	2.1		
Intersection Capacity Utilization	46.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	26	60	105	357	317	17
Future Volume (Veh/h)	26	60	105	357	317	17
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	33	76	133	452	401	22
Pedestrians				2		
Lane Width (ft)				12.0		
Walking Speed (ft/s)				3.5		
Percent Blockage				0		
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1130	414	423			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1130	414	423			
tC, single (s)	6.7	6.3	4.2			
tC, 2 stage (s)						
tF (s)	3.8	3.4	2.3			
p0 queue free %	81	88	88			
cM capacity (veh/h)	172	624	1070			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	109	585	423
Volume Left	33	133	0
Volume Right	76	0	22
cSH	347	1070	1700
Volume to Capacity	0.31	0.12	0.25
Queue Length 95th (ft)	33	11	0
Control Delay (s)	20.0	3.2	0.0
Lane LOS	C	A	
Approach Delay (s)	20.0	3.2	0.0
Approach LOS	C		

Intersection Summary			
Average Delay	3.6		
Intersection Capacity Utilization	58.1%	ICU Level of Service	B
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	9	19	0	88	14	48	0	426	127	29	345	23
Future Volume (Veh/h)	9	19	0	88	14	48	0	426	127	29	345	23
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Hourly flow rate (vph)	11	23	0	109	17	59	0	526	157	36	426	28
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	1184	1195	440	1128	1130	604	454			683		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1184	1195	440	1128	1130	604	454			683		
tC, single (s)	7.2	6.8	6.2	7.2	6.5	6.4	4.1			4.3		
tC, 2 stage (s)												
tF (s)	3.6	4.2	3.3	3.6	4.0	3.5	2.2			2.4		
p0 queue free %	91	86	100	28	91	87	100			96		
cM capacity (veh/h)	126	161	621	151	196	470	1117			811		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	34	185	683	490
Volume Left	11	109	0	36
Volume Right	0	59	157	28
cSH	148	198	1117	811
Volume to Capacity	0.23	0.93	0.00	0.04
Queue Length 95th (ft)	21	188	0	3
Control Delay (s)	36.5	96.5	0.0	1.2
Lane LOS	E	F		A
Approach Delay (s)	36.5	96.5	0.0	1.2
Approach LOS	E	F		

Intersection Summary				
Average Delay	14.2			
Intersection Capacity Utilization	65.5%	ICU Level of Service	C	
Analysis Period (min)	15			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	1	1	36	2	0	0	40	593	1	0	445	2
Future Volume (Veh/h)	1	1	36	2	0	0	40	593	1	0	445	2
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Hourly flow rate (vph)	1	1	46	3	0	0	51	751	1	0	563	3
Pedestrians					3							
Lane Width (ft)					12.0							
Walking Speed (ft/s)					3.5							
Percent Blockage					0							
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)								962				
pX, platoon unblocked	0.56	0.56		0.56	0.56	0.56				0.56		
vC, conflicting volume	1418	1422	564	1468	1422	754	566			755		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	1352	1359	564	1441	1360	157	566			158		
tC, single (s)	8.1	6.5	6.3	7.1	6.5	6.2	4.4			4.1		
tC, 2 stage (s)												
tF (s)	4.4	4.0	3.4	3.5	4.0	3.3	2.4			2.2		
p0 queue free %	98	99	91	94	100	100	94			100		
cM capacity (veh/h)	42	78	506	53	78	495	893			794		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	48	3	803	566
Volume Left	1	3	51	0
Volume Right	46	0	1	3
cSH	377	53	893	794
Volume to Capacity	0.13	0.06	0.06	0.00
Queue Length 95th (ft)	11	4	5	0
Control Delay (s)	15.9	77.0	1.5	0.0
Lane LOS	C	F	A	
Approach Delay (s)	15.9	77.0	1.5	0.0
Approach LOS	C	F		

Intersection Summary				
Average Delay	1.5			
Intersection Capacity Utilization	70.4%	ICU Level of Service	C	
Analysis Period (min)	15			

Lane Group	EBT	WBL	WBT	NBT	SBT
Lane Group Flow (vph)	162	37	19	963	620
v/c Ratio	0.47	0.21	0.08	1.27	0.65
Control Delay	11.3	21.6	16.6	150.3	11.5
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	11.3	21.6	16.6	150.3	11.5
Queue Length 50th (ft)	8	10	4	~403	110
Queue Length 95th (ft)	44	29	17	#545	176
Internal Link Dist (ft)	578		441	1146	882
Turn Bay Length (ft)					
Base Capacity (vph)	348	177	233	757	947
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.47	0.21	0.08	1.27	0.65

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	14	13	109	31	12	4	120	663	26	5	491	24
Future Volume (vph)	14	13	109	31	12	4	120	663	26	5	491	24
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0		6.0	6.0			6.0			6.0	
Lane Util. Factor		1.00		1.00	1.00			1.00			1.00	
Frpb, ped/bikes		1.00		1.00	1.00			1.00			1.00	
Flpb, ped/bikes		1.00		1.00	1.00			1.00			1.00	
Frt		0.89		1.00	0.96			1.00			0.99	
Flt Protected		0.99		0.95	1.00			0.99			1.00	
Satd. Flow (prot)		1329		1203	1217			1538			1629	
Flt Permitted		0.96		0.74	1.00			0.83			0.99	
Satd. Flow (perm)		1287		941	1217			1291			1615	
Peak-hour factor, PHF	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Adj. Flow (vph)	17	15	130	37	14	5	143	789	31	6	585	29
RTOR Reduction (vph)	0	105	0	0	4	0	0	2	0	0	3	0
Lane Group Flow (vph)	0	57	0	37	15	0	0	961	0	0	617	0
Confl. Peds. (#/hr)							2		1	1		2
Confl. Bikes (#/hr)									3			
Heavy Vehicles (%)	9%	54%	26%	50%	50%	50%	24%	20%	63%	20%	16%	10%
Turn Type	Perm	NA		Perm	NA		Perm	NA		Perm	NA	
Protected Phases		6			2			4			8	
Permitted Phases	6			2			4			8		
Actuated Green, G (s)		10.0		10.0	10.0			31.0			31.0	
Effective Green, g (s)		10.0		10.0	10.0			31.0			31.0	
Actuated g/C Ratio		0.19		0.19	0.19			0.58			0.58	
Clearance Time (s)		6.0		6.0	6.0			6.0			6.0	
Lane Grp Cap (vph)		242		177	229			755			944	
v/s Ratio Prot					0.01							
v/s Ratio Perm		c0.04		0.04				c0.74			0.38	
v/c Ratio		0.23		0.21	0.07			1.27			0.65	
Uniform Delay, d1		18.2		18.2	17.7			11.0			7.4	
Progression Factor		1.00		1.00	1.00			1.00			1.00	
Incremental Delay, d2		2.3		2.7	0.5			133.0			3.5	
Delay (s)		20.5		20.8	18.2			144.0			10.9	
Level of Service		C		C	B			F			B	
Approach Delay (s)		20.5			19.9			144.0			10.9	
Approach LOS		C			B			F			B	

Intersection Summary			
HCM 2000 Control Delay	83.2	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.02		
Actuated Cycle Length (s)	53.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	100.5%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	15	112	58	728	564	23
Future Volume (Veh/h)	15	112	58	728	564	23
Sign Control	Stop			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.81	0.81	0.81	0.81	0.81	0.81
Hourly flow rate (vph)	19	138	72	899	696	28
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	1753	710	724			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	1753	710	724			
tC, single (s)	6.6	6.5	4.4			
tC, 2 stage (s)						
tF (s)	3.7	3.6	2.5			
p0 queue free %	75	65	91			
cM capacity (veh/h)	75	390	767			

Direction, Lane #	EB 1	NB 1	SB 1
Volume Total	157	971	724
Volume Left	19	72	0
Volume Right	138	0	28
cSH	259	767	1700
Volume to Capacity	0.61	0.09	0.43
Queue Length 95th (ft)	90	8	0
Control Delay (s)	38.2	2.6	0.0
Lane LOS	E	A	
Approach Delay (s)	38.2	2.6	0.0
Approach LOS	E		

Intersection Summary			
Average Delay	4.6		
Intersection Capacity Utilization	90.3%	ICU Level of Service	E
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	800	29	5	679	0	43	0	14	0	0	0
Future Volume (Veh/h)	0	800	29	5	679	0	43	0	14	0	0	0
Sign Control		Free			Free			Stop			Stop	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81
Hourly flow rate (vph)	0	988	36	6	838	0	53	0	17	0	0	0
Pedestrians								8			3	
Lane Width (ft)								12.0			12.0	
Walking Speed (ft/s)								3.5			3.5	
Percent Blockage								1			0	
Right turn flare (veh)												
Median type		None			None							
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	841			1032			1864	1867	1014	1876	1885	841
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	841			1032			1864	1867	1014	1876	1885	841
tC, single (s)	4.1			4.1			7.5	6.5	6.8	7.1	6.5	6.2
tC, 2 stage (s)												
tF (s)	2.2			2.2			3.8	4.0	3.8	3.5	4.0	3.3
p0 queue free %	100			99			0	100	93	100	100	100
cM capacity (veh/h)	801			676			44	72	227	50	70	367

Direction, Lane #	EB 1	WB 1	WB 2	NB 1	SB 1
Volume Total	1024	6	838	70	0
Volume Left	0	6	0	53	0
Volume Right	36	0	0	17	0
cSH	801	676	1700	55	1700
Volume to Capacity	0.00	0.01	0.49	1.27	0.00
Queue Length 95th (ft)	0	1	0	154	0
Control Delay (s)	0.0	10.4	0.0	335.9	0.0
Lane LOS		B		F	A
Approach Delay (s)	0.0	0.1		335.9	0.0
Approach LOS				F	A

Intersection Summary			
Average Delay	12.2		
Intersection Capacity Utilization	53.9%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	578	38	71	651	46	251
Future Volume (Veh/h)	578	38	71	651	46	251
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.83	0.83	0.83	0.83	0.83	0.83
Hourly flow rate (vph)	696	46	86	784	55	302
Pedestrians					7	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					1	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			749		1682	726
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			749		1682	726
tC, single (s)			4.3		6.7	6.4
tC, 2 stage (s)						
tF (s)			2.4		3.8	3.5
p0 queue free %			89		29	23
cM capacity (veh/h)			767		77	390

Direction, Lane #	EB 1	WB 1	WB 2	NB 1
Volume Total	742	86	784	357
Volume Left	0	86	0	55
Volume Right	46	0	0	302
cSH	1700	767	1700	240
Volume to Capacity	0.44	0.11	0.46	1.49
Queue Length 95th (ft)	0	9	0	525
Control Delay (s)	0.0	10.3	0.0	278.5
Lane LOS		B		F
Approach Delay (s)	0.0	1.0		278.5
Approach LOS				F

Intersection Summary			
Average Delay	50.9		
Intersection Capacity Utilization	64.7%	ICU Level of Service	C
Analysis Period (min)	15		

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Traffic Volume (veh/h)	595	34	71	681	68	68
Future Volume (Veh/h)	595	34	71	681	68	68
Sign Control	Free			Free	Stop	
Grade	0%			0%	0%	
Peak Hour Factor	0.81	0.81	0.81	0.81	0.81	0.81
Hourly flow rate (vph)	735	42	88	841	84	84
Pedestrians					2	
Lane Width (ft)					12.0	
Walking Speed (ft/s)					3.5	
Percent Blockage					0	
Right turn flare (veh)						
Median type	None			None		
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume			779		1775	758
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol			779		1775	758
tC, single (s)			4.5		6.7	6.4
tC, 2 stage (s)						
tF (s)			2.6		3.8	3.5
p0 queue free %			87		0	78
cM capacity (veh/h)			681		66	377

Direction, Lane #	EB 1	WB 1	NB 1
Volume Total	777	929	168
Volume Left	0	88	84
Volume Right	42	0	84
cSH	1700	681	112
Volume to Capacity	0.46	0.13	1.50
Queue Length 95th (ft)	0	11	305
Control Delay (s)	0.0	3.6	336.1
Lane LOS		A	F
Approach Delay (s)	0.0	3.6	336.1
Approach LOS			F

Intersection Summary			
Average Delay	31.9		
Intersection Capacity Utilization	91.1%	ICU Level of Service	F
Analysis Period (min)	15		

Lane Group	EBL	EBT	WBL	WBT	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	141	434	267	796	198	1661	258	327	1048	186
v/c Ratio	0.75	1.14	0.89	0.88	0.28	1.48	0.46	0.51	0.98	0.39
Control Delay	72.6	130.6	80.1	51.2	21.1	252.4	7.6	27.3	65.3	13.1
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	72.6	130.6	80.1	51.2	21.1	252.4	7.6	27.3	65.3	13.1
Queue Length 50th (ft)	106	~395	203	560	91	~932	7	170	422	28
Queue Length 95th (ft)	171	#602	#349	#872	145	#1071	74	254	#629	96
Internal Link Dist (ft)		1174		1250		3769			940	
Turn Bay Length (ft)	135		175		135		450	125		140
Base Capacity (vph)	250	380	313	903	765	1123	559	644	1066	482
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	0.56	1.14	0.85	0.88	0.26	1.48	0.46	0.51	0.98	0.39

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	134	310	103	254	334	422	188	1578	245	311	996	177
Future Volume (vph)	134	310	103	254	334	422	188	1578	245	311	996	177
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Total Lost time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor	1.00	1.00		1.00	1.00		1.00	0.95	1.00	1.00	0.95	1.00
Frpb, ped/bikes	1.00	0.99		1.00	0.99		1.00	1.00	0.97	1.00	1.00	1.00
Flpb, ped/bikes	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.96		1.00	0.92		1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00		0.95	1.00		0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1397	1417		1833	2997		1655	3596	1252	1493	3426	1250
Flt Permitted	0.95	1.00		0.95	1.00		0.11	1.00	1.00	0.11	1.00	1.00
Satd. Flow (perm)	1397	1417		1833	2997		1655	3596	1252	1493	3426	1250
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	141	326	108	267	352	444	198	1661	258	327	1048	186
RTOR Reduction (vph)	0	10	0	0	36	0	0	0	168	0	0	94
Lane Group Flow (vph)	141	424	0	267	761	0	198	1661	90	327	1048	92
Confl. Peds. (#/hr)	3		17	17		3			4	4		
Heavy Vehicles (%)	19%	18%	18%	23%	23%	23%	12%	23%	15%	26%	26%	19%
Turn Type	Prot	NA		Prot	NA		pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases	7	4		3	8		5	2		1	6	
Permitted Phases							2		2	6		6
Actuated Green, G (s)	16.2	31.4		19.6	34.8		51.1	37.5	37.5	50.9	37.4	37.4
Effective Green, g (s)	16.2	31.4		19.6	34.8		51.1	37.5	37.5	50.9	37.4	37.4
Actuated g/C Ratio	0.13	0.26		0.16	0.29		0.43	0.31	0.31	0.42	0.31	0.31
Clearance Time (s)	4.5	4.5		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)	2.3	2.3		2.3	2.3		2.3	4.1	4.1	2.3	4.1	4.1
Lane Grp Cap (vph)	188	370		299	869		704	1123	391	633	1067	389
v/s Ratio Prot	0.10	c0.30		c0.15	c0.25		0.03	c0.46		c0.06	0.31	
v/s Ratio Perm							0.09		0.07	0.16		0.07
v/c Ratio	0.75	1.15		0.89	0.88		0.28	1.48	0.23	0.52	0.98	0.24
Uniform Delay, d1	50.0	44.3		49.2	40.5		26.8	41.2	30.5	35.7	41.0	30.7
Progression Factor	1.00	1.00		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	14.4	93.1		26.4	9.6		0.1	220.4	1.4	0.4	23.6	1.4
Delay (s)	64.3	137.4		75.6	50.2		27.0	261.7	31.9	36.2	64.6	32.1
Level of Service	E	F		E	D		C	F	C	D	E	C
Approach Delay (s)		119.5			56.6			211.7			54.8	
Approach LOS		F			E			F			D	

Intersection Summary			
HCM 2000 Control Delay	124.6	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.13		
Actuated Cycle Length (s)	120.0	Sum of lost time (s)	18.0
Intersection Capacity Utilization	136.5%	ICU Level of Service	H
Analysis Period (min)	15		

c Critical Lane Group

Lane Group	EBT	EBR	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Group Flow (vph)	262	68	248	52	155	2002	60	77	1218	166
v/c Ratio	1.02	0.17	1.35	0.14	0.89	1.27	0.09	1.03	0.83	0.22
Control Delay	111.4	7.4	228.4	3.8	64.4	158.2	5.8	162.9	34.7	3.7
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	111.4	7.4	228.4	3.8	64.4	158.2	5.8	162.9	34.7	3.7
Queue Length 50th (ft)	~265	0	~316	0	70	~1298	7	~45	506	5
Queue Length 95th (ft)	#454	32	#498	16	#174	#1432	28	#160	615	41
Internal Link Dist (ft)	619		227			891			3769	
Turn Bay Length (ft)		250		135	120		195	150		260
Base Capacity (vph)	258	395	184	385	175	1571	640	75	1468	744
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0
Reduced v/c Ratio	1.02	0.17	1.35	0.14	0.89	1.27	0.09	1.03	0.83	0.22

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	142	104	64	126	107	49	146	1882	56	72	1145	156
Future Volume (vph)	142	104	64	126	107	49	146	1882	56	72	1145	156
Ideal Flow (vphpl)	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
Total Lost time (s)		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Lane Util. Factor		1.00	1.00		1.00	1.00	1.00	0.95	1.00	1.00	0.95	1.00
Frt		1.00	0.85		1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected		0.97	1.00		0.97	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)		1701	1153		1248	1118	1330	2725	1078	1163	2703	1240
Flt Permitted		0.50	1.00		0.48	1.00	0.12	1.00	1.00	0.05	1.00	1.00
Satd. Flow (perm)		871	1153		622	1118	162	2725	1078	64	2703	1240
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	151	111	68	134	114	52	155	2002	60	77	1218	166
RTOR Reduction (vph)	0	0	48	0	0	37	0	0	19	0	0	71
Lane Group Flow (vph)	0	262	20	0	248	15	155	2002	41	77	1218	95
Heavy Vehicles (%)	0%	0%	29%	25%	50%	33%	25%	22%	38%	43%	23%	20%
Turn Type	Perm	NA	Perm	Perm	NA	Perm	pm+pt	NA	Perm	pm+pt	NA	Perm
Protected Phases		4			8		5	2		1	6	
Permitted Phases	4		4	8		8	2		2	6		6
Actuated Green, G (s)		44.5	44.5		44.5	44.5	86.5	86.5	86.5	81.5	81.5	81.5
Effective Green, g (s)		44.5	44.5		44.5	44.5	86.5	86.5	86.5	81.5	81.5	81.5
Actuated g/C Ratio		0.30	0.30		0.30	0.30	0.58	0.58	0.58	0.54	0.54	0.54
Clearance Time (s)		4.5	4.5		4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Vehicle Extension (s)		3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)		258	342		184	331	175	1571	621	75	1468	673
v/s Ratio Prot							0.06	c0.73		0.04	c0.45	
v/s Ratio Perm		0.30	0.02		c0.40	0.01	0.45		0.04	0.52		0.08
v/c Ratio		1.02	0.06		1.35	0.05	0.89	1.27	0.07	1.03	0.83	0.14
Uniform Delay, d1		52.8	37.8		52.8	37.6	24.4	31.8	14.0	68.2	28.5	16.9
Progression Factor		1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2		60.1	0.1		188.1	0.1	37.3	128.6	0.0	111.5	4.0	0.1
Delay (s)		112.8	37.8		240.8	37.7	61.7	160.3	14.0	179.7	32.5	17.0
Level of Service		F	D		F	D	E	F	B	F	C	B
Approach Delay (s)		97.4			205.6			149.5			38.5	
Approach LOS		F			F			F			D	

Intersection Summary			
HCM 2000 Control Delay	111.8	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.29		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	93.2%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Traffic Volume (veh/h)	128	104	123	7	6	159
Future Volume (Veh/h)	128	104	123	7	6	159
Sign Control	Yield			Free	Free	
Grade	0%			0%	0%	
Peak Hour Factor	0.62	0.62	0.62	0.62	0.62	0.62
Hourly flow rate (vph)	206	168	198	11	10	256
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type				None	None	
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	417	10	266			
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	417	10	266			
tC, single (s)	6.8	6.7	4.5			
tC, 2 stage (s)						
tF (s)	3.8	3.7	2.5			
p0 queue free %	53	82	82			
cM capacity (veh/h)	436	959	1120			

Direction, Lane #	EB 1	NB 1	SB 1	SB 2
Volume Total	374	209	10	256
Volume Left	206	198	0	0
Volume Right	168	0	0	256
cSH	577	1120	1700	1700
Volume to Capacity	0.65	0.18	0.01	0.15
Queue Length 95th (ft)	117	16	0	0
Control Delay (s)	22.0	8.5	0.0	0.0
Lane LOS	C	A		
Approach Delay (s)	22.0	8.5	0.0	
Approach LOS	C			

Intersection Summary			
Average Delay	11.8		
Intersection Capacity Utilization	34.0%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	106	1	12	0	107	256	2	0	76	6
Future Volume (Veh/h)	0	0	106	1	12	0	107	256	2	0	76	6
Sign Control		Stop			Stop			Free			Free	
Grade		0%			0%			0%			0%	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Hourly flow rate (vph)	0	0	115	1	13	0	116	278	2	0	83	7
Pedestrians												
Lane Width (ft)												
Walking Speed (ft/s)												
Percent Blockage												
Right turn flare (veh)												
Median type								None			None	
Median storage veh)												
Upstream signal (ft)												
pX, platoon unblocked												
vC, conflicting volume	604	598	86	712	601	279	90			280		
vC1, stage 1 conf vol												
vC2, stage 2 conf vol												
vCu, unblocked vol	604	598	86	712	601	279	90			280		
tC, single (s)	7.1	6.5	6.6	7.1	7.0	6.2	4.4			4.1		
tC, 2 stage (s)												
tF (s)	3.5	4.0	3.7	3.5	4.5	3.3	2.5			2.2		
p0 queue free %	100	100	87	100	96	100	91			100		
cM capacity (veh/h)	374	382	875	283	325	765	1331			1294		

Direction, Lane #	EB 1	WB 1	NB 1	SB 1
Volume Total	115	14	396	90
Volume Left	0	1	116	0
Volume Right	115	0	2	7
cSH	875	322	1331	1294
Volume to Capacity	0.13	0.04	0.09	0.00
Queue Length 95th (ft)	11	3	7	0
Control Delay (s)	9.7	16.7	2.9	0.0
Lane LOS	A	C	A	
Approach Delay (s)	9.7	16.7	2.9	0.0
Approach LOS	A	C		

Intersection Summary				
Average Delay	4.1			
Intersection Capacity Utilization	39.4%	ICU Level of Service	A	
Analysis Period (min)	15			