## Appendix 1 Traffic Operations

 Analysis| Date: | August 2, 2019 | Project \#: 23910.0 |
| :--- | :--- | :--- |
| To: | Lance Calvert and Erich Lais <br>  <br>  <br> City of West Linn |  |
|  | 22500 Salamo Road |  |
|  | West Linn, OR 97068 |  |
| From: | Matt Bell, Bryan Graveline, Marc Butorac, PE, PTOE |  |
| cc: | Gabe Crop, PE, Murraysmith |  |
| Project: | West Linn Arterial Roadways |  |
| Subject: | Intersection Control Evaluation |  |
|  |  |  |

## INTRODUCTION

The City of West Linn (City) is planning to reconfigure the segment of Willamette Falls Drive (WFD) from Chestnut Street to the Lake Oswego Highway (OR 43) to improve traffic operations and safety performance along the corridor as well as facilitate future development of the waterfront area. A conceptual layout of the study area was developed by the City that includes removal of the segment of WFD from Chestnut Street to OR 43 and construction of new street connections from WFD to Sunset Drive, Sunset Drive to West A Street, and Sunset Drive to OR 43. The conceptual layout also includes the reconfiguration of several intersections, including the WFD/Sunset Avenue, Sunset Avenue/West A Street, and Sunset Avenue/OR 43 intersections. Appendix "A" contains the conceptual layout of the roadway.

This memorandum summarizes the results of an intersection control evaluation (ICE) at the study intersections. The purpose of an intersection control evaluation is to consistently consider multiple context-sensitive control strategies when planning a new or modified intersection. This evaluation consists of the following elements at several study intersections:

- An analysis of right-of-way and topographical constraints;
- Operational analysis under weekday existing and year 2040 traffic conditions; and
- An analysis of safety performance.

The results of the analysis indicate that the proposed conceptual layout will be feasible and will improve traffic operations and safety performance along the corridor under future traffic conditions assuming the following lane configurations and traffic control devices at the study intersections:

- Configure the WFD/Sunset Drive intersection as a two-way stop-controlled intersection with separate left- and right-turn lanes at the northbound approach, a shared through/right-turn lane at the eastbound approach, and separate left-turn lane and through lane at the westbound approach.
- Configure the Sunset Avenue/West A Street intersection as a single lane roundabout with a shared left/right-turn lane at the southbound approach, a shared through/right-turn lane at the eastbound approach, and a shared left/through lane at the westbound approach.
- Configure the Sunset Avenue/OR 43 intersection as a two-lane roundabout with separate left- and right turn lanes at the northbound approach, separate through and right-turn lanes at the eastbound approach, and separate left and through lanes at the westbound approach.
- Note that this intersection should not be developed into a roundabout until the intersection of I-205/OR 43 is developed into a roundabout, as the current signalized configuration of I-205/OR 43 could result in queueing that adversely impacts the Sunset Avenue/OR 43 roundabout. As such, the Sunset Avenue/OR 43 intersection should be developed as an interim signalized intersection until the I-205/OR 43 intersection is developed into a roundabout.


## RIGHT-OF-WAY AND TOPOGRAPHICAL CONSTRAINTS

The following section describes constraints stemming from existing rights-of-way and topography at the study intersections that may limit the possible intersection control options at the study intersections.

## WFD/Sunset Drive

The northbound approach of this intersection has a steep uphill grade and the eastbound approach of this intersection is a bridge structure that spans I-205. While there is sufficient right-of-way to explore a roundabout solution here, topographical constraints preclude this configuration. As such, a roundabout configuration was not analyzed at this intersection.

## West A Street/WFD

Sufficient right-of-way exists to explore a roundabout alternative at this location and no topographical constraints preclude this possibility. As such, a roundabout configuration was analyzed at this intersection

## OR 43/WFD

Sufficient right-of-way exists to explore a roundabout alternative at this location and no topographical constraints preclude this possibility. As such, a roundabout configuration was analyzed at this intersection.

## OPERATIONAL ANALYSIS

Additional information on the study methodology and findings of the operational analysis is provided herein.

## Analysis Tools and Methodology

All analyses described in this memorandum were performed in accordance with the procedures stated in the Highway Capacity Manual, $6^{\text {th }}$ Edition (HCM, Reference 1). Synchro 10 was used to analyze traffic operations at the study intersections as signalized and unsignalized intersections. SIDRA was used to analyze traffic operations at the study intersection as roundabouts. Synchro and SIDRA are software tools designed to assist with implementation of HCM methodologies.

## Intersection Performance Measures

The following performance measures were used to evaluate traffic operations at the study intersections under existing and future year 2040 traffic conditions.

Level-of-service (LOS) is the most commonly used performance measure. LOS uses an " A " to " F " ranking system based on the average control delay experienced by motorists. LOS " A " reflects relatively low vehicle delay times ( 10 seconds or less), while LOS " $F$ " reflects relatively high vehicle delay times (over 80 seconds per vehicle at a signalized intersection and over 50 seconds per vehicle at an unsignalized intersection or roundabout). The LOS for signalized intersections and roundabouts is based on a weighted average of control delay for the overall intersection while the LOS for unsignalized intersections is based on the average control delay of the critical movement. According to the City of West Linn Transportation System Plan (TSP, Reference 2), both signalized and unsignalized intersections are expected to operate at LOS D or better, except at major arterials where the minimum is LOS E (OR 43 is a major arterial),

Volume-to-capacity ( $\mathrm{V} / \mathrm{C}$ ) compares the volume of traffic to the theoretical capacity of the facility to accommodate traffic. A V/C ratio of 1.0 indicates an intersection is operating at capacity. A V/C ratio over 1.0 indicates the intersection's capacity is exceeded, meaning that the vehicle may have to wait more than one signal cycle length at a signalized intersection before moving through the intersection. Per the Oregon Highway Plan (OHP - Reference 3 ), the V/C ratio target for the OR 43/WFD and the OR 43/Mill Street intersections is 1.1 in the $1^{\text {st }}$ Hour and 0.99 in the $2^{\text {nd }}$ hour.

## Existing Traffic Conditions

The existing traffic conditions analysis identifies the current physical and operational characteristics of the study intersections. These conditions will be compared with future conditions later in this report. Figure 1 illustrates the existing lane configurations and traffic control devices at the study intersections.


Traffic Volumes
Manual turning movement counts were conducted at the study intersections in June 2019 when school was insession and no inclement weather was present that affected typical traffic patterns. The counts were conducted on a typical mid-week day during the morning (7:00 to 9:00 AM) and evening (4:00 to 6:00 PM) peak time periods. The system-wide morning and evening peak hours were found to occur from 7:30 to 8:30 AM and 4:00 to 5:00 PM, respectively. Figures 2 and 3 summarize the turning movement counts for the weekday morning and evening peak hours. Appendix " $B$ " contains the traffic count worksheets used in this study.

Existing Intersection Operations
Table 1 and Figures 2 and 3 summarize the results of the existing traffic conditions analysis. As shown, all the study intersections currently operate acceptably during the weekday AM and PM peak hours per their respective mobility standards and targets except the West A Street/WFD (\#4) and OR 43/WFD (\#6) intersections. Appendix " $C$ " includes the existing traffic conditions worksheets.

## Table 1: Existing Traffic Conditions

| $\begin{gathered} \text { Map } \\ \text { ID } \end{gathered}$ | AM Peak Hour |  |  |  | PM Peak Hour |  |  |  | Agency | Standard/ Target | Met? |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Delay | Los | v/c | $\begin{aligned} & \text { 95\% Queues } \\ & \text { Exceed Storage? } \end{aligned}$ | Delay | Los | v/c | 95\% Queues Exceed Storage? |  |  |  |
| 1 | 10.9 | в | 0.09 | No | 9.7 | A | 0.04 | No | West Linn | LOS D | Yes |
| 2 | 14.6 | в | 0.05 | No | 12.7 | в | 0.11 | No | West Linn | LOS D | Yes |
| 3 | 20.8 | C | 0.62 | No | 15.6 | c | 0.37 | No | West Linn | LOS D | Yes |
| 4 | 51.2 | F | 0.32 | No | 34.0 | D | 0.47 | No | West Linn | LOS D | No |
| 5 | 13.0 | в | 0.06 | No | 18.7 | c | 0.27 | No | West Linn | LOS D | Yes |
| 6 | 104.7 | F | 0.98 | Yes | 107.6 | F | 1.06 | Yes | ODOT | LOS E/1.1 | No |
| 7 | 36.1 | E | 0.10 | No | 39.0 | E | 0.08 | No | ODOT | LOSE/1.1 | Yes |

## West A Street/WFD

The southbound approach to the West A Street/WFD intersection currently operates at LOS F during the weekday AM peak hour due to delay; however, it operates below capacity and the intersection does not meet signal warrants.

## OR 43/WFD

The eastbound approach to the OR 43/WFD intersection currently operates at LOS F during the weekday AM and PM peak hours due to delay and above capacity during the weekday PM peak hour. The intersection does not meet signal warrants

## Year 2040 No-Build Traffic Conditions

The year 2040 no-build traffic conditions analysis identifies how the study intersections will operate without the conceptual layout. This analysis includes traffic attributed to general growth in the region but does not include any changes in traffic patterns related to the conceptual layout.


Existing Traffic Conditions



Year 2040 Build Traffic Conditions
The year 2040 build traffic conditions analysis identifies how the study intersections will operate with the proposed conceptual layout as well as with signalized and unsignalized intersections and roundabouts. Figure 6 illustrates the year 2040 build lane configurations and traffic control devices at the study intersections with the conceptual layout.

## Forecast Traffic Volumes

Forecast traffic volumes were developed at the study intersection by re-routing the background traffic volumes shown in Figures 4 and 5 to reflect the conceptual layout. Figures 7 and 8 summarize the traffic volumes developed at the study intersections for the year 2040 build traffic conditions analysis.

Year 2040 Build Intersection Operations
Table 3 and Figures 7 and 8 summarize the results of the year 2040 build traffic conditions analysis. As shown, the WFD/Sunset Avenue intersection operates acceptably under two-way stop-control. Because it does not meet signal warrants, this location was not evaluated as a traffic signal, and because of topographical constraints, this intersection was not evaluated as a roundabout. While the Sunset Avenue/West A Street and Sunset Avenue/OR 43 intersections do not operate acceptably under two-way stop-control, both intersections operate acceptably as traffic signals and roundabouts. Appendix "F" includes the year 2040 build traffic conditions worksheets.

## Table 3: Year 2040 Build Traffic Conditions

| $\begin{gathered} \text { Map } \\ \text { ID } \end{gathered}$ | AM Peak Hour |  |  |  | PM Peak Hour |  |  |  | Agency | Standard/ | Met? |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Delay | Los | v/c | 95\% Queues Exceed Storage? | Delay | Los | v/c | 95\% Queues Exceed Storage? |  |  |  |
| Two-way Stop-Control |  |  |  |  |  |  |  |  |  |  |  |
| 2 | 43.1 | E | 0.28 | No | 23.1 | c | 0.13 | No | West Linn | Los D | Yes |
| 3 | 70.8 | F | 0.47 | No | >80 | F | 0.84 | No | West Linn | LOS D | No |
| 6 | >80 | F | >1.1 | Yes | >80 | F | >1.1 | Yes | ODOT | LOS E/1.1 | No |
| Traffic Signals |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Not Analyzed - Does Not Meet Signal Warrants |  |  |  |  |  |  |  |  |  |  |
| 3 | 8.2 | A | 0.50 | No | 7.3 | A | 0.54 | No | West Linn | LOS D | Yes |
| 6 | 7.8 | A | 0.44 | Yes ${ }^{1}$ | 10.9 | B | 0.42 | Yes ${ }^{1}$ | OODT | LOSE/1.1 | Yes |
| Roundabouts |  |  |  |  |  |  |  |  |  |  |  |
| 2 | Not Analyzed - Topographical Constraints |  |  |  |  |  |  |  |  |  |  |
| 3 | 17.4 | B | 0.80 | No | 14.8 | в | 0.76 | No | West Linn | LOS D | Yes |
| 6 | 9.7 | A | 0.75 | No | 17.4 | в | 0.85 | Yes ${ }^{2}$ | ODOT | LOS E/1.1 | Yes |

[^0]${ }^{2} 95^{\text {th }}$ percentile queue lengths from the Sunset Avenue/OR 43 roundabout concept eastbound approach have the potential to extend to the Terminal Drive access.



Operational Analysis Findings
Based on the results of this operational analysis, the City should consider installation of a single lane roundabout or traffic signal at the Sunset Avenue/West A Street intersection and a two-lane roundabout or traffic signal at the Sunset Avenue/OR 43 intersections in conjunction with the overall conceptual layout. The following summarizes findings from the analysis:

- All the study intersections currently operate acceptably during the weekday AM and PM peak hours except the West A Street/WFD and OR 43/WFD intersections.
- The West A Street/WFD intersection operates at LOS F during the weekday AM peak hour due to delay; however, the intersection operates below capacity and does not meet signal warrants.
- The OR 43/WFD intersection operates at LOS F during the weekday AM and PM peak hours due to delay and above capacity during the weekday PM peak hour. The intersection does not meet signal warrants.
- All the study intersections are expected to operate acceptably under year 2040 no-build traffic conditions during the weekday AM and PM peak hours except the West A Street/WFD and OR 43/WFD intersections.
- The West A Street/WFD intersection operates at LOS F during the weekday AM and PM peak hours due to delay; however, the intersection is expected to operate below capacity and does not meet signal warrants.
- The OR 43/WFD intersection operates at LOS F and above capacity during the weekday AM and PM peak hours. The intersection is expected to meet signal warrants.
- All the study intersections are expected to operate acceptably under year 2040 build traffic conditions during the weekday AM and PM peak hours assuming buildout of the proposed conceptual layout and the installation of traffic signals or roundabouts as described at the intersections of West A Street/WFD and OR 43/WFD.
- Analysis conducted for the l-205 traffic study was reviewed to determine potential impacts on the study intersections described in this report. However, the l-205 traffic study was placed on hold at the time of this study. Per the I-205 traffic study, a roundabout should not be developed at the intersection of OR 43/WFD until the intersection of I-205/OR 43 is developed into a roundabout, as the current signalized configuration of I-205/OR 43 could result in queueing that adversely impacts a Sunset Avenue/OR 43 roundabout. As such, if a roundabout concept is selected at the Sunset Avenue/OR 43 intersection, it should be developed as an interim signalized intersection until the I-205/OR 43 intersection is developed into a roundabout.


## SAFETY PERFORMANCE

The Highway Safety Manual (HSM, Reference 4) contains data on the potential crash effects of converting a minorroad stop-controlled intersection into a signal or a roundabout. Per the HSM, converting an intersection with minorroad stop control in an urban environment to a modern roundabout with one or two lanes has the potential to reduce all crashes by between $29 \%$ and $39 \%$. Converting an intersection with minor-road stop control in an urban environment to a signalized intersection has the potential to reduce all crashes by $5 \%$.

Additionally, crashes occurring at roundabouts tend to occur at lesser severities than at signalized intersections, given the lower likelihood of angle and head-on crashes and the higher likelihood of sideswipe crashes. Sideswipe crashes tend to have lesser severities than angle or head-on crashes because with both vehicles travelling the same direction, less kinetic energy is transferred upon impact.

Given the greater capacity of roundabouts to reduce crashes compared to signalized intersections and the lesser expected severities of crashes occurring at roundabouts compared to signalized intersections, roundabouts were selected over signalized intersections where possible to account for their expected improved safety performance.

## RECOMMENDATIONS

The following summarizes the recommended lane configurations and traffic control devices at the study intersections to be installed in conjunction with the proposed conceptual layout to ensure feasible construction, acceptable operations, and desirable safety performance under year 2040 traffic conditions. Table 4 summarizes the intersection control evaluation for each intersection.

- Configure the WFD/Sunset Avenue intersection as a two-way stop-controlled intersection with separate left- and right-turn lanes at the northbound approach, a shared through/right-turn lane at the eastbound approach, and separate left-turn lane and through lane at the westbound approach.
- Configure the Sunset Avenue/West A Street intersection as a single lane roundabout with a shared left/right-turn lanes at the southbound approach, a shared through/right-turn lanes at the eastbound approach, and a shared left/through lane at the westbound approach.
- Configure the future Sunset Avenue/OR 43 intersection as a two-lane roundabout with separate leftand right-turn lanes at the northbound approach, separate through and right-turn lanes at the eastbound approach, and separate left and through lanes at the westbound approach.
- Note that this intersection should not be developed into a roundabout until the intersection of I-205/OR 43 is developed into a roundabout, as the current signalized configuration of I-205/OR 43 could result in queueing that adversely impacts the Sunset Avenue/OR 43 roundabout. As such, the Sunset Avenue/OR 43 intersection should be developed as an interim signalized intersection until the I-205/OR 43 intersection is developed into a roundabout.


## Table 4. Intersection Control Evaluation Summary

|  | Keep as Minor-Approach <br> Stop-Control | Install Traffic Signal | Install Roundabout |
| :--- | :--- | :--- | :--- |
| WFD/Sunset Drive | Acceptable operations | Does not meeting signal <br> warrants | Topographical constraints <br> preclude roundabout |
| West A Street/WFD | Unacceptable operations | Acceptable operations but less <br> desirable safety performance | Acceptable operations and <br> desirable safety performance |
| OR 43/WFD | Unacceptable operations | Acceptable operations but less <br> desirabbe safety performance | Acceptable operations and <br> desirable safety performance |

Given the potential for development within the waterfront area, the City should continue to monitor traffic conditions at the study intersections and confirm the recommendations included in this memorandum prior to construction.

## REFERENCES

1. Transportation Research Board. Highway Capacity Manual, $6^{\text {th }}$ Edition. 2018.
2. City of West Linn. City of West Linn Transportation System Plan. 2016
3. Oregon Department of Transportation. Oregon Highway Plan. 2015.
4. American Association of State Highway and Transportation Officials. Highway Safety Manual, $1^{\text {st }}$ Edition 2010.

## APPENDIX

A. Conceptual Layout
B. Traffic Counts
C. Existing Traffic Conditions Worksheets
D. Year 2040 No-build Traffic Conditions Worksheets
E. Signal Warrant Analysis Worksheets
F. Year 2040 Build Traffic Conditions Worksheets

## Appendix A Conceptual Layout



Appendix B Traffic Counts

Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 7:40 AM -- 7:55 AM


| $\begin{aligned} & \text { 5-Min Count } \\ & \text { Period } \\ & \text { Beginning At } \end{aligned}$ | Chestnut St (Northbound) |  |  |  | Chestnut St (Southbound) |  |  |  | Willamette Falls Dr (Eastbound) |  |  |  | Willamette Falls Dr (Westbound) |  |  |  | Total | Hourly Totals |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U |  |  |
| 7:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 3 | 6 | 0 | 0 | 0 | 23 | 0 | 0 | 34 |  |
| 7:05 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 8 | 0 | 0 | 0 | 31 | 0 | 0 | 43 |  |
| 7:10 AM | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 3 | 13 | 0 | 0 | 0 | 25 | 0 | 0 | 47 |  |
| 7:15 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 9 | 0 | 0 | 0 | 33 | 0 | 0 | 45 |  |
| 7:20 AM | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 3 | 14 | 0 | 0 | 0 | 36 | 0 | 0 | 61 |  |
| 7:25 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 18 | 0 | 0 | 0 | 26 | 0 | 0 | 47 |  |
| 7:30 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 11 | 0 | 0 | 0 | 40 | 0 | 0 | 54 |  |
| 7:35 AM | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 22 | 0 | 0 | 0 | 24 | 0 | 0 | 54 |  |
| 7:40 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 17 | 0 | 0 | 0 | 41 | 0 | 0 | 64 |  |
| 7:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 2 | 23 | 0 | 0 | 0 | 34 | 0 | 0 | 64 |  |
| 7:50 AM | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 14 | 0 | 0 | 0 | 33 | 0 | 0 | 55 |  |
| 7:55 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 17 | 0 | 0 | 0 | 30 | 0 | 0 | 53 | 621 |
| 8:00 AM | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 3 | 13 | 0 | 0 | 0 | 25 | 0 | 0 | 47 | 634 |
| 8:05 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 16 | 0 | 0 | 0 | 30 | 0 | 0 | 52 | 643 |
| 8:10 AM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 20 | 0 | 0 | 0 | 35 | 0 | 0 | 58 | 654 |
| 8:15 AM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 37 | 0 | 0 | 0 | 27 | 0 | 0 | 69 | 678 |
| 8:20 AM | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 19 | 0 | 0 | 0 | 26 | 0 | 0 | 48 | 665 |
| 8:25 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 13 | 0 | 0 | 0 | 34 | 0 | 0 | 53 | 671 |
| 8:30 AM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 2 | 14 | 0 | 0 | 0 | 32 | 0 | 0 | 52 | 669 |
| 8:35 AM | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 15 | 0 | 0 | 0 | 36 | 0 | 0 | 56 | 671 |
| 8:40 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 7 | 0 | 0 | 0 | 21 | 1 | 0 | 34 | 641 |
| 8:45 AM | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 1 | 11 | 0 | 0 | 0 | 22 | 0 | 0 | 38 | 615 |
| 8:50 AM | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 12 | 0 | 0 | 0 | 27 | 0 | 0 | 42 | 602 |
| 8:55 AM | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 13 | 0 | 0 | 0 | 22 | 0 | 0 | 41 | 590 |
| Peak 15-Min Flowrates | Northbound |  |  |  | Southbound |  |  |  | Eastbound |  |  |  | Westbound |  |  |  | Total |  |
|  | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U |  |  |  |
| All Vehicles | 0 | 0 | 0 | 0 | 0 | 0 | 68 | 0 | 16 | 216 | 0 | 0 | 0 | 432 | 0 | 0 |  | 32 |
| Heavy Trucks | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 20 | 0 |  |  | 0 |
| Pedestrians |  | 4 |  |  |  | 0 |  |  |  | 0 |  |  |  | 0 |  |  |  |  |
| Bicycles Railroad Stopped Buses | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 0 | 0 |  |  | 0 |

Comments: This is signed as Will. Falls Dr/Chestnut St


Comments: This is signed as Will. Falls Dr/Chestnut St


Comments: This is signed as Sunset Ave/Chestnut St


Comments: This is signed as Sunset Ave/Chestnut St







Peak-Hour: 7:20 AM -- 8:20 AM
Peak 15-Min: 7:45 AM -- 8:00 AM

Quality Counts
DATA THAT DRIVES COMMUNITIES


| $\begin{aligned} & \text { 5-Min Count } \\ & \text { Period } \\ & \text { Beginning At } \end{aligned}$ | OR-43 <br> (Northbound) |  |  |  | OR-43 <br> (Southbound) |  |  |  | Willamette Falls Dr (Eastbound) |  |  |  | Willamette Falls Dr (Westbound) |  |  |  | Total | Hourly Totals |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U |  |  |
| 7:00 AM | 21 | 58 | 0 | 0 | 0 | 15 | 8 | 0 | 11 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 116 |  |
| 7:05 AM | 24 | 52 | 0 | 0 | 0 | 14 | 20 | 0 | 14 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 127 |  |
| 7:10 AM | 19 | 63 | 0 | 0 | 0 | 17 | 14 | 0 | 19 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 146 |  |
| 7:15 AM | 27 | 59 | 0 | 0 | 0 | 21 | 21 | 0 | 16 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 153 |  |
| 7:20 AM | 33 | 70 | 0 | 0 | 0 | 17 | 20 | 0 | 13 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 162 |  |
| 7:25 AM | 24 | 58 | 0 | 0 | 0 | 15 | 24 | 0 | 15 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 149 |  |
| 7:30 AM | 29 | 67 | 0 | 0 | 0 | 21 | 23 | 0 | 11 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 160 |  |
| 7:35 AM | 24 | 65 | 0 | 0 | 0 | 24 | 22 | 0 | 14 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 173 |  |
| 7:40 AM | 32 | 54 | 0 | 0 | 0 | 21 | 17 | 0 | 21 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 162 |  |
| 7:45 AM | 33 | 49 | 0 | 0 | 0 | 40 | 20 | 0 | 13 | 0 | 22 | 0 | 0 | 0 | 0 | 0 | 177 |  |
| 7:50 AM | 34 | 55 | 0 | 0 | 0 | 25 | 22 | 0 | 14 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 166 |  |
| 7:55 AM | 24 | 56 | 0 | 0 | 0 | 44 | 29 | 0 | 11 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 178 | 1869 |
| 8:00 AM | 29 | 40 | 0 | 0 | 0 | 29 | 21 | 0 | 19 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 152 | 1905 |
| 8:05 AM | 24 | 41 | 0 | 0 | 0 | 30 | 31 | 0 | 19 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 153 | 1931 |
| 8:10 AM | 37 | 45 | 0 | 0 | 0 | 17 | 20 | 0 | 20 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 146 | 1931 |
| 8:15 AM | 17 | 53 | 0 | 0 | 0 | 30 | 29 | 0 | 18 | 0 | 19 | 0 | 0 | 0 | 0 | 0 | 166 | 1944 |
| 8:20 AM | 28 | 47 | 0 | 0 | 0 | 32 | 30 | 0 | 5 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 152 | 1934 |
| 8:25 AM | 17 | 46 | 0 | 0 | 0 | 29 | 30 | 0 | 21 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 154 | 1939 |
| 8:30 AM | 21 | 51 | 0 | 0 | 0 | 23 | 22 | 0 | 20 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 146 | 1925 |
| 8:35 AM | 26 | 38 | 0 | 0 | 0 | 26 | 22 | 0 | 14 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 140 | 1892 |
| 8:40 AM | 17 | 33 | 0 | 0 | 0 | 23 | 18 | 0 | 24 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 123 | 1853 |
| 8:45 AM | 25 | 28 | 0 | 0 | 0 | 28 | 18 | 0 | 19 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 134 | 1810 |
| 8:50 AM | 25 | 49 | 0 | 0 | 0 | 23 | 15 | 0 | 13 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 136 | 1780 |
| 8:55 AM | 22 | 31 | 0 | 0 | 0 | 22 | 14 | 0 | 18 | 0 | 10 | 0 | 0 | 0 | 0 | 0 | 117 | 1719 |
| Peak 15-Min Flowrates | Northbound |  |  |  | Southbound |  |  |  | Eastbound |  |  |  | Westbound |  |  |  | Total |  |
|  | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U | Left | Thru | Right | U |  |  |  |
| All Vehicles | 364 | 640 | 0 | 0 | 0 | 436 | 284 | 0 | 152 | 0 | 208 | 0 | 0 | 0 | 0 | 0 |  | 84 |
| Heavy Trucks | 28 | 0 | 0 |  | 0 | 4 | 4 |  | 20 | 0 | 0 |  | 0 | 0 | 0 |  |  | 5 |
| Pedestrians |  | 0 |  |  |  | 0 |  |  |  | 0 |  |  |  | 0 |  |  |  |  |
| Bicycles Railroad Stopped Buses | 0 | 0 | 0 |  | 0 | 0 | 0 |  | 0 | 0 | 3 |  | 0 | 0 | 0 |  |  | 3 |

Comments:



Comments:



Comments:

## Appendix C Existing Traffic Conditions Worksheets




| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| $l$ |  |  |  |  |  |  |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 4.1 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * 1 |  |  | ${ }_{\text {AT }}$ |  |  | $\uparrow$ |  |  | $\uparrow$ | 「 |
| Traffic Vol, veh/h | 203 | 343 | 0 | 0 | 477 | 133 | 0 | 0 | 0 | 31 | 0 | 110 |
| Future Vol, veh/h | 203 | 343 | 0 | 0 | 477 | 133 | 0 | 0 | 0 | 31 | 0 | 110 |
| Conflicting Peds, \#/hr | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | Stop |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | 75 |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 3 | - | - | 3 | - | - | -3 | - |
| Peak Hour Factor | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 |
| Heavy Vehicles, \% | 4 | 3 | 0 | 100 | 4 | 3 | 0 | 0 | 0 | 3 | 0 | 5 |
| Mvmt Flow | 231 | 390 | 0 | 0 | 542 | 151 | 0 | 0 | 0 | 35 | 0 | 125 |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 0.6 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * $\downarrow$ |  |  | งt |  |  | $\dagger$ |  |  | $\dagger$ |  |
| Traffic Vol, veh/h | 23 | 351 | 0 | 0 | 592 | 30 | 0 | 0 | 0 | 9 | 0 | 18 |
| Future Vol, veh/h | 23 | 351 | 0 | 0 | 592 | 30 | 0 | 0 | 0 | 9 | 0 | 18 |
| Conflicting Peds, \#/hr | 1 | 0 | 1 | 1 | 0 | 1 | 12 | 0 | 0 | 0 | 0 | 12 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | -3 | - | - | 3 | - | - | 0 | - | - | -5 | - |
| Peak Hour Factor | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 |
| Heavy Vehicles, \% | 0 | 3 | 0 | 0 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 25 | 377 | 0 | 0 | 637 | 32 | 0 | 0 | 0 | 10 | 0 | 19 |









| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Int Delay, s/veh | 2.4 |  |  |  |  |  |
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
| Lane Configurations | 164 |  |  | $\uparrow$ | $\uparrow$ | $\mathbf{F}$ |
| Traffic Vol, veh/h | 164 | 17 | 4 | 548 | 221 | 239 |
| Future Vol, veh/h | 164 | 17 | 4 | 548 | 221 | 239 |
| Conflicting Peds, \#/hr | 0 | 0 | 1 | 0 | 0 | 1 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | - | - | - | 0 |
| Veh in Median Storage, \# | 0 | - | - | 0 | 0 | - |
| Grade, \% | -5 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, \% | 3 | 0 | 0 | 3 | 2 | 2 |
| Mvmt Flow | 178 | 18 | 4 | 596 | 240 | 260 |


| Major/Minor M | Minor2 |  | Major1 |  | Major2 |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conflicting Flow All | 845 | 241 | 501 | 0 | - | 0 |
| Stage 1 | 241 | - | - | - | - | - |
| Stage 2 | 604 | - | - | - | - | - |
| Critical Hdwy | 5.43 | 5.7 | 4.1 | - | - | - |
| Critical Hdwy Stg 1 | 4.43 | - |  | - | - | - |
| Critical Hdwy Stg 2 | 4.43 | - | - | - | - | - |
| Follow-up Hdwy | 3.527 | 3.3 | 2.2 | - | - | - |
| Pot Cap-1 Maneuver | 420 | 830 | 1074 | - | - | - |
| Stage 1 | 852 | - | - | - | - | - |
| Stage 2 | 643 | - | - | - | - | - |
| Platoon blocked, \% |  |  |  | - | - | - |
| Mov Cap-1 Maneuver | 417 | 829 | 1073 | - | - | - |
| Mov Cap-2 Maneuver | 515 | - | - | - | - | - |
| Stage 1 | 846 | - | - | - | - | - |
| Stage 2 | 642 | - | - | - | - | - |
|  |  |  |  |  |  |  |
| Approach | EB |  | NB |  | SB |  |
| HCM Control Delay, s | 15.6 |  | 0.1 |  | 0 |  |
| HCM LOS | C |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Minor Lane/Major Mvmt |  | NBL | NBT | EBLn1 | SBT |  |
| Capacity (veh/h) |  | 1073 |  | 534 | - | - |
| HCM Lane V/C Ratio |  | 0.004 | - | 0.368 | - | - |
| HCM Control Delay (s) |  | 8.4 | 0 | 15.6 | - | - |
| HCM Lane LOS |  | A | A | C | - | - |
| HCM 95th \%tile Q(veh) |  | 0 | - | 1.7 | - | - |


| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 3.9 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * $\hat{\square}$ |  |  | * ${ }^{\text {¢ }}$ |  |  | * |  |  | $\uparrow$ | 「 |
| Traffic Vol, veh/h | 68 | 644 | 0 | 0 | 359 | 33 | 0 | 0 | 0 | 92 | 0 | 101 |
| Future Vol, veh/h | 68 | 644 | 0 | 0 | 359 | 33 | 0 | 0 | 0 | 92 | 0 | 101 |
| Conflicting Peds, \#/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | Stop |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | 75 |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 3 | - | - | 3 | - | - | -3 | - |
| Peak Hour Factor | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| Heavy Vehicles, \% | 0 | 3 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| Mvmt Flow | 78 | 740 | 0 | 0 | 413 | 38 | 0 | 0 | 0 | 106 | 0 | 116 |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 1.4 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * 1 |  |  | * $\uparrow$ |  |  | \$ |  |  | \$ |  |
| Traffic Vol, veh/h | 2 | 734 | 0 | 0 | 382 | 11 | 0 | 0 | 0 | 82 | 0 | 10 |
| Future Vol, veh/h | 2 | 734 | 0 | 0 | 382 | 11 | 0 | 0 | 0 | 82 | 0 | 10 |
| Conflicting Peds, \#/hr | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 16 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | -3 | - | - | 3 | - | - | 0 | - | - | -5 | - |
| Peak Hour Factor | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 |
| Heavy Vehicles, \% | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Mvmt Flow | 2 | 773 | 0 | 0 | 402 | 12 | 0 | 0 | 0 | 86 | 0 | 11 |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |




| Major/Minor | Minor2 | Major1 |  | Major2 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conflicting Flow All | 1652 | 1026 | 1032 | 0 | - | 0 |  |
| Stage 1 | 1026 | - | - | - | - | - |  |
| Stage 2 | 626 | - | - | - | - | - |  |
| Critical Hdwy | 6.4 | 6.2 | 4.1 | - | - | - |  |
| Critical Hdwy Stg 1 | 5.4 | - | - | - | - | - |  |
| Critical Hdwy Stg 2 | 5.4 | - | - | - | - | - |  |
| Follow-up Hdwy | 3.5 | 3.3 | 2.2 | - | - | - |  |
| Pot Cap-1 Maneuver | 110 | 288 | 681 | - | - | - |  |
| Stage 1 | 349 | - | - | - | - | - |  |
| Stage 2 | 537 | - | - | - | - | - |  |
| Platoon blocked, \% |  |  |  | - | - | - |  |
| Mov Cap-1 Maneuver | 107 | 284 | 672 | - | - | - |  |
| Mov Cap-2 Maneuver | 107 | - | - | - | - | - |  |
| Stage 1 | 343 | - | - | - | - | - |  |
| Stage 2 | 530 | - | - | - | - | - |  |
|  |  |  |  |  |  |  |  |
| Approach | EB |  | NB |  | SB |  |  |
| HCM Control Delay, s | 39 |  | 0 |  | 0 |  |  |
| HCM LOS | E |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Minor Lane/Major Mvm |  | NBL | NBT | BLn1 | SBT | SBR |  |
| Capacity (veh/h) |  | 672 | - | 115 | - | - |  |
| HCM Lane V/C Ratio |  | 0.003 | - | 0.08 | - | - |  |
| HCM Control Delay (s) |  | 10.4 | 0 | 39 | - | - |  |
| HCM Lane LOS |  | B | A | E | - | - |  |
| HCM 95th \%tile Q(veh) |  | 0 | - | 0.3 | - | - |  |

## Appendix D Year 2040 No-build Traffic Conditions Worksheets

| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh 1 |  |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * |  |  | ¢ |  |  | * |  |  | * |  |
| Traffic Vol, veh/h | 32 | 285 | 0 | 0 | 364 | 0 | 0 | 0 | 0 | 0 | 0 | 41 |
| Future Vol, veh/h | 32 | 285 | 0 | 0 | 364 | 0 | 0 | 0 | 0 | 0 | 0 | 41 |
| Conflicting Peds, \#/hr | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 0 | - | - | 5 | - | - | -5 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, \% | 11 | 3 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Mvmt Flow | 35 | 310 | 0 | 0 | 396 | 0 | 0 | 0 | 0 | 0 | 0 | 45 |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |


| Major/Minor | Minor2 | Major1 |  |  | Major2 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conflicting Flow All | 732 | 412 | 690 | 0 | - | 0 |  |
| Stage 1 | 412 | - | - | - | - | - |  |
| Stage 2 | 320 | - | - | - | - | - |  |
| Critical Hdwy | 5.44 | 5.7 | 4.1 | - | - | - |  |
| Critical Hdwy Stg 1 | 4.44 | - | - | - | - | - |  |
| Critical Hdwy Stg 2 | 4.44 | - | - | - | - | - |  |
| Follow-up Hdwy | 3.536 | 3.3 | 2.2 | - | - | - |  |
| Pot Cap-1 Maneuver | 472 | 682 | 914 | - | - | - |  |
| Stage 1 | 745 | - | - | - | - | - |  |
| Stage 2 | 800 | - | - | - | - | - |  |
| Platoon blocked, \% |  |  |  | - | - | - |  |
| Mov Cap-1 Maneuver | 469 | 680 | 911 | - | - | - |  |
| Mov Cap-2 Maneuver | 565 | - | - | - | - | - |  |
| Stage 1 | 743 | - | - | - | - | - |  |
| Stage 2 | 798 | - | - | - | - | - |  |
|  |  |  |  |  |  |  |  |
| Approach | EB |  | NB |  | SB |  |  |
| HCM Control Delay, s | 25.4 |  | 0 |  | 0 |  |  |
| HCM LOS | D |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Minor Lane/Major Mvmt |  | NBL | NBT | BLn1 | SBT | SBR |  |
| Capacity (veh/h) |  | 911 | - | 565 | - | - |  |
| HCM Lane V/C Ratio |  | - | - | 0.71 | - | - |  |
| HCM Control Delay (s) |  | 0 | - | 25.4 | - | - |  |
| HCM Lane LOS |  | A | - | D | - | - |  |
| HCM 95th \%tile Q(veh) |  | 0 | - | 5.7 | - | - |  |


| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 6 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | ${ }_{\text {AT }}$ |  |  | ${ }_{\text {AT }}$ |  |  | $\uparrow$ |  |  | $\uparrow$ | 「 |
| Traffic Vol, veh/h | 246 | 396 | 0 | 0 | 461 | 134 | 0 | 0 | 0 | 41 | 0 | 150 |
| Future Vol, veh/h | 246 | 396 | 0 | 0 | 461 | 134 | 0 | 0 | 0 | 41 | 0 | 150 |
| Conflicting Peds, \#/hr | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | Stop |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | 75 |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 3 | - | - | 3 | - | - | -3 | - |
| Peak Hour Factor | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 | 88 |
| Heavy Vehicles, \% | 4 | 3 | 0 | 100 | 4 | 3 | 0 | 0 | 0 | 3 | 0 | 5 |
| Mvmt Flow | 280 | 450 | 0 | 0 | 524 | 152 | 0 | 0 | 0 | 47 | 0 | 170 |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 0.5 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * ${ }^{\text {a }}$ |  |  | * ${ }^{\text {¢ }}$ |  |  | * |  |  | * |  |
| Traffic Vol, veh/h | 23 | 428 | 0 | 0 | 565 | 30 | 0 | 0 | 0 | 9 | 0 | 18 |
| Future Vol, veh/h | 23 | 428 | 0 | 0 | 565 | 30 | 0 | 0 | 0 | 9 | 0 | 18 |
| Conflicting Peds, \#/hr | 1 | 0 | 1 | 1 | 0 | 1 | 12 | 0 | 0 | 0 | 0 | 12 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | -3 | - | - | 3 | - | - | 0 | - | - | -5 | - |
| Peak Hour Factor | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 | 93 |
| Heavy Vehicles, \% | 0 | 3 | 0 | 0 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mvmt Flow | 25 | 460 | 0 | 0 | 608 | 32 | 0 | 0 | 0 | 10 | 0 | 19 |



| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |




| Major/Minor | Minor2 | Major1 |  | Major2 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conflicting Flow All | 2114 | 894 | 903 | 0 | - | 0 |  |
| Stage 1 | 894 | - | - | - | - | - |  |
| Stage 2 | 1220 | - | - | - | - | - |  |
| Critical Hdwy | 6.52 | 6.2 | 4.1 | - | - | - |  |
| Critical Hdwy Stg 1 | 5.52 | - | - | - | - | - |  |
| Critical Hdwy Stg 2 | 5.52 | - | - | - | - | - |  |
| Follow-up Hdwy | 3.608 | 3.3 | 2.2 | - | - | - |  |
| Pot Cap-1 Maneuver | 52 | 343 | 761 | - | - | - |  |
| Stage 1 | 384 | - | - | - | - | - |  |
| Stage 2 | 266 | - | - | - | - | - |  |
| Platoon blocked, \% |  |  |  | - | - | - |  |
| Mov Cap-1 Maneuver | 50 | 339 | 752 | - | - | - |  |
| Mov Cap-2 Maneuver | 50 | - | - | - | - | - |  |
| Stage 1 | 373 | - | - | - | - | - |  |
| Stage 2 | 263 | - | - | - | - | - |  |
|  |  |  |  |  |  |  |  |
| Approach | EB |  | NB |  | SB |  |  |
| HCM Control Delay, s | 73 |  | 0 |  | 0 |  |  |
| HCM LOS | F |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Minor Lane/Major Mvm |  | NBL | NBT | BLn1 | SBT | SBR |  |
| Capacity (veh/h) |  | 752 | - | 65 | - | - |  |
| HCM Lane V/C Ratio |  | 0.006 | - | 0.19 | - | - |  |
| HCM Control Delay (s) |  | 9.8 | 0 | 73 | - | - |  |
| HCM Lane LOS |  | A | A | F | - | - |  |
| HCM 95th \%tile Q(veh) |  | 0 | - | 0.6 | - | - |  |


| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 0.7 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | $\uparrow$ |  |  | * |  |  | * |  |  | * |  |
| Traffic Vol, veh/h | 23 | 491 | 0 | 0 | 210 | 8 | 0 | 0 | 0 | 0 | 0 | 35 |
| Future Vol, veh/h | 23 | 491 | 0 | 0 | 210 | 8 | 0 | 0 | 0 | 0 | 0 | 35 |
| Conflicting Peds, \#/hr | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 0 | - | - | 5 | - | - | -5 | - |
| Peak Hour Factor | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 | 94 |
| Heavy Vehicles, \% | 9 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| Mvmt Flow | 24 | 522 | 0 | 0 | 223 | 9 | 0 | 0 | 0 | 0 | 0 | 37 |





| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Int Delay, s/veh | 2 |  |  |  |  |  |
| Movement | EBL | EBR | NBL | NBT | SBT | SBR |
| Lane Configurations | 1 |  |  | $\uparrow$ | $\uparrow$ | $\mathbf{F}$ |
| Traffic Vol, veh/h | 161 | 11 | 4 | 487 | 207 | 395 |
| Future Vol, veh/h | 161 | 11 | 4 | 487 | 207 | 395 |
| Conflicting Peds, \#/hr | 0 | 0 | 1 | 0 | 0 | 1 |
| Sign Control | Stop | Stop | Free | Free | Free | Free |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | 0 | - | - | - | - | 0 |
| Veh in Median Storage, \# | 0 | - | - | 0 | 0 | - |
| Grade, \% | -5 | - | - | 0 | 0 | - |
| Peak Hour Factor | 92 | 92 | 92 | 92 | 92 | 92 |
| Heavy Vehicles, \% | 3 | 0 | 0 | 3 | 2 | 2 |
| Mvmt Flow | 175 | 12 | 4 | 529 | 225 | 429 |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh | 7.7 |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * 1 |  |  | ${ }^{\text {AT }}$ |  |  | $\uparrow$ |  |  | $\uparrow$ | 「 |
| Traffic Vol, veh/h | 86 | 562 | 0 | 0 | 455 | 59 | 0 | 0 | 0 | 120 | 0 | 147 |
| Future Vol, veh/h | 86 | 562 | 0 | 0 | 455 | 59 | 0 | 0 | 0 | 120 | 0 | 147 |
| Conflicting Peds, \#/hr | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | Stop |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | 75 |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | 0 | - | - | 3 | - | - | 3 | - | - | -3 | - |
| Peak Hour Factor | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 | 87 |
| Heavy Vehicles, \% | 0 | 3 | 2 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 6 |
| Mvmt Flow | 99 | 646 | 0 | 0 | 523 | 68 | 0 | 0 | 0 | 138 | 0 | 169 |



| Intersection |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Int Delay, s/veh 1.5 |  |  |  |  |  |  |  |  |  |  |  |  |
| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
| Lane Configurations |  | * ${ }^{\text {a }}$ |  |  | ${ }^{\text {AT }}$ |  |  | \$ |  |  | * |  |
| Traffic Vol, veh/h | 2 | 607 | 0 | 0 | 491 | 11 | 0 | 0 | 0 | 82 | 0 | 10 |
| Future Vol, veh/h | 2 | 607 | 0 | 0 | 491 | 11 | 0 | 0 | 0 | 82 | 0 | 10 |
| Conflicting Peds, \#/hr | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 16 |
| Sign Control | Free | Free | Free | Free | Free | Free | Stop | Stop | Stop | Stop | Stop | Stop |
| RT Channelized | - | - | None | - | - | None | - | - | None | - | - | None |
| Storage Length | - | - | - | - | - | - | - | - | - | - | - | - |
| Veh in Median Storage, \# | \# | 0 | - | - | 0 | - | - | 0 | - | - | 0 | - |
| Grade, \% | - | -3 | - | - | 3 | - | - | 0 | - | - | -5 | - |
| Peak Hour Factor | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 | 95 |
| Heavy Vehicles, \% | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Mvmt Flow | 2 | 639 | 0 | 0 | 517 | 12 | 0 | 0 | 0 | 86 | 0 | 11 |






| Major/Minor | Minor2 | Major1 |  | Major2 |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Conflicting Flow All | 2011 | 1111 | 1117 | 0 | - | 0 |  |
| Stage 1 | 1111 | - | - | - | - | - |  |
| Stage 2 | 900 | - | - | - | - | - |  |
| Critical Hdwy | 6.4 | 6.2 | 4.1 | - | - | - |  |
| Critical Hdwy Stg 1 | 5.4 | - | - | - | - | - |  |
| Critical Hdwy Stg 2 | 5.4 | - | - | - | - | - |  |
| Follow-up Hdwy | 3.5 | 3.3 | 2.2 | - | - | - |  |
| Pot Cap-1 Maneuver | 66 | 257 | 633 | - | - | - |  |
| Stage 1 | 318 | - | - | - | - | - |  |
| Stage 2 | 400 | - | - | - | - | - |  |
| Platoon blocked, \% |  |  |  | - | - | - |  |
| Mov Cap-1 Maneuver | 64 | 254 | 625 | - | - | - |  |
| Mov Cap-2 Maneuver | 64 | - | - | - | - | - |  |
| Stage 1 | 312 | - | - | - | - | - |  |
| Stage 2 | 395 | - | - | - | - | - |  |
|  |  |  |  |  |  |  |  |
| Approach | EB |  | NB |  | SB |  |  |
| HCM Control Delay, s | 64 |  | 0 |  | 0 |  |  |
| HCM LOS | F |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| Minor Lane/Major Mvm |  | NBL | NBT | BLn1 | SBT | SBR |  |
| Capacity (veh/h) |  | 625 | - | 70 | - | - |  |
| HCM Lane V/C Ratio |  | 0.003 | - | 0.131 | - | - |  |
| HCM Control Delay (s) |  | 10.8 | 0 | 64 | - | - |  |
| HCM Lane LOS |  | B | A | F | - | - |  |
| HCM 95th \%tile Q(veh) |  | 0 | - | 0.4 | - | - |  |

## Appendix E Signal Warrant Analysis Worksheets

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

| Project \#: | 23910 |  |
| :--- | :--- | :--- |
| Project Name: | West Linn Arterial Roadways |  |
| Analyst: | RBG |  |
| Date: | 7/2/2019 |  |
| Intersection: | Sunset Ave / Willamette Falls Dr (102) |  |
| Scenario: | 2040 Build AM |  |
|  |  |  |
| Volume Adjustment Factor $=$ | 1.0 |  |
| North-South Approach = | Minor |  |
| East-West Approach = | Major |  |
| Major Street Thru Lanes = | 1 |  |
| Minor Street Thru Lanes = | 1 |  |
| Speed > 40 mph? | No |  |
| Population < 10,000? | No |  |
| Warrant Factor | $100 \%$ |  |
| Peak Hour or Daily Count? | Peak Hour |  |
|  |  |  |


| Warrant Summary |  |  |  |
| :---: | :---: | :---: | :---: |
| Warrant | Name | Analyzed? | Met? |
| \#1 | Eight-Highest | Yes | No |
| \#2 | Four-Hour | Yes | No |
| \#3 | Peak Hour | Yes | No |

Select Type Of Major Street Approach From Dropdown Menu Select Type Of Minor Street Approach From Dropdown Menu

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

| Traffic Volumes |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Hour | Major Street |  | Minor Street |  | Major St. <br> Adj. Factor | Minor St. Adj. Factor |
| Begin End | EB | WB | NB | SB |  |  |
| 7:30 AM 8:30 AM | 398 | 611 | 32 | 0 | 1.00 | 1.00 |
| 2nd Highest Hour | 377 | 578 | 30 | 0 | 0.95 | 0.95 |
| 3rd Highest Hour | 371 | 570 | 30 | 0 | 0.93 | 0.93 |
| 4th Highest Hour | 356 | 546 | 29 | 0 | 0.89 | 0.89 |
| 5th Highest Hour | 350 | 538 | 28 | 0 | 0.88 | 0.88 |
| 6th Highest Hour | 350 | 538 | 28 | 0 | 0.88 | 0.88 |
| 7th Highest Hour | 334 | 513 | 27 | 0 | 0.84 | 0.84 |
| 8th Highest Hour | 329 | 505 | 26 | 0 | 0.83 | 0.83 |
| 9th Highest Hour | 318 | 489 | 26 | 0 | 0.80 | 0.80 |
| 10th Highest Hour | 297 | 456 | 24 | 0 | 0.75 | 0.75 |
| 11th Highest Hour | 287 | 440 | 23 | 0 | 0.72 | 0.72 |
| 12th Highest Hour | 281 | 432 | 23 | 0 | 0.71 | 0.71 |
| 13th Highest Hour | 271 | 415 | 22 | 0 | 0.68 | 0.68 |
| 14th Highest Hour | 233 | 358 | 19 | 0 | 0.59 | 0.59 |
| 15th Highest Hour | 186 | 285 | 15 | 0 | 0.47 | 0.47 |
| 16th Highest Hour | 175 | 269 | 14 | 0 | 0.44 | 0.44 |
| 17th Highest Hour | 122 | 187 | 10 | 0 | 0.31 | 0.31 |
| 18th Highest Hour | 101 | 155 | 8 | 0 | 0.25 | 0.25 |
| 19th Highest Hour | 53 | 81 | 4 | 0 | 0.13 | 0.13 |
| 20th Highest Hour | 37 | 57 | 3 | 0 | 0.09 | 0.09 |
| 21st Highest Hour | 32 | 49 | 3 | 0 | 0.08 | 0.08 |
| 22nd Highest Hour | 21 | 33 | 2 | 0 | 0.05 | 0.05 |
| 23rd Highest Hour | 11 | 16 | 1 | 0 | 0.03 | 0.03 |
| 24th Highest Hour | 11 | 16 | 1 | 0 | 0.03 | 0.03 |

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

| Project \#: | 23910 |  |
| :--- | :--- | :--- |
| Project Name: | West Linn Arterial Roadways |  |
| Analyst: | RBG |  |
| Date: | 7/2/2019 |  |
| Intersection: | Sunset Ave / West A St (103) |  |
| Scenario: | 2040 Build PM |  |
|  |  |  |
| Volume Adjustment Factor $=$ | 1.0 |  |
| North-South Approach = | Minor |  |
| East-West Approach = | Major |  |
| Major Street Thru Lanes = | 1 |  |
| Minor Street Thru Lanes = | 1 |  |
| Speed > 40 mph? | No |  |
| Population < 10,000? | No |  |
| Warrant Factor | $100 \%$ |  |
| Peak Hour or Daily Count? | Peak Hour |  |
|  |  |  |
|  |  |  |


| Warrant Summary |  |  |  |
| :---: | :---: | :---: | :---: |
| Warrant | Name | Analyzed? | Met? |
| \#1 | Eight-Highest | Yes | Yes |
| \#2 | Four-Hour | Yes | Yes |
| \#3 | Peak Hour | Yes | No |

Select Type Of Major Street Approach From Dropdown Menu Select Type Of Minor Street Approach From Dropdown Menu

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

| Traffic Volumes |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Hour | Major Street |  | Minor Street |  | Major St. Adj. Factor | Minor St. Adj. Factor |
| Begin End | EB | WB | NB | SB |  |  |
| 7:30 AM 8:30 AM | 648 | 514 | 0 | 127 | 1.00 | 1.00 |
| 2nd Highest Hour | 613 | 487 | 0 | 120 | 0.95 | 0.95 |
| 3 drd Highest Hour | 605 | 480 | 0 | 119 | 0.93 | 0.93 |
| 4th Highest Hour | 579 | 459 | 0 | 113 | 0.89 | 0.89 |
| 5th Highest Hour | 570 | 452 | 0 | 112 | 0.88 | 0.88 |
| 6th Highest Hour | 570 | 452 | 0 | 112 | 0.88 | 0.88 |
| 7th Highest Hour | 544 | 432 | 0 | 107 | 0.84 | 0.84 |
| 8th Highest Hour | 536 | 425 | 0 | 105 | 0.83 | 0.83 |
| 9th Highest Hour | 518 | 411 | 0 | 102 | 0.80 | 0.80 |
| 10th Highest Hour | 484 | 384 | 0 | 95 | 0.75 | 0.75 |
| 11th Highest Hour | 467 | 370 | 0 | 91 | 0.72 | 0.72 |
| 12th Highest Hour | 458 | 363 | 0 | 90 | 0.71 | 0.71 |
| 13th Highest Hour | 441 | 350 | 0 | 86 | 0.68 | 0.68 |
| 14th Highest Hour | 380 | 302 | 0 | 75 | 0.59 | 0.59 |
| 15th Highest Hour | 302 | 240 | 0 | 59 | 0.47 | 0.47 |
| 16th Highest Hour | 285 | 226 | 0 | 56 | 0.44 | 0.44 |
| 17th Highest Hour | 199 | 158 | 0 | 39 | 0.31 | 0.31 |
| 18th Highest Hour | 164 | 130 | 0 | 32 | 0.25 | 0.25 |
| 19th Highest Hour | 86 | 69 | 0 | 17 | 0.13 | 0.13 |
| 20th Highest Hour | 60 | 48 | 0 | 12 | 0.09 | 0.09 |
| 21st Highest Hour | 52 | 41 | 0 | 10 | 0.08 | 0.08 |
| 22nd Highest Hour | 35 | 27 | 0 | 7 | 0.05 | 0.05 |
| 23rd Highest Hour | 17 | 14 | 0 | 3 | 0.03 | 0.03 |
| 24th Highest Hour | 17 | 14 | 0 |  | 0.03 | 0.03 |

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

| Project \#: | 23910 |
| :--- | :--- |
| Project Name: | West Linn Arterial Roadways |
| Analyst: | RBG |
| Date: | $7 / 2 / 2019$ |
| Intersection: | Willamette Falls Dr / West A St (104) |
| Scenario: | 2040 No-Build PM |

Volume Adjustment Factor = North-South Approach =
East-West Approach =
Major Street Thru Lanes =
Minor Street Thru Lanes =
Speed > 40 mph ?
Population < 10,000?
Warrant Factor
Peak Hour or Daily Count?
1.0
Minor
Major
2
1
No
No
$100 \%$
Peak Hour

|  | Warrant Summary |  |  |
| :---: | :---: | :---: | :---: |
| Warrant | Name | Analyzed? | Met? |
| \#1 | Eight-Highest | Yes | Yes |
| \#2 | Four-Hour | Yes | No |
| \#3 | Peak Hour | Yes | No |

Select Type Of Major Street Approach From Dropdown Menu Select Type Of Minor Street Approach From Dropdown Menu

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

| Hour | Major Street |  | Minor Street |  | Major St. <br> Adj. Factor | Minor St. <br> Adj. Factor |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Begin End | EB | WB | NB | SB |  |  |
| 7:30 AM 8:30 AM | 648 | 514 | 0 | 120 | 1.00 | 1.00 |
| 2nd Highest Hour | 613 | 487 | 0 | 114 | 0.95 | 0.95 |
| 3rd Highest Hour | 605 | 480 | 0 | 112 | 0.93 | 0.93 |
| 4th Highest Hour | 579 | 459 | 0 | 107 | 0.89 | 0.89 |
| 5th Highest Hour | 570 | 452 | 0 | 106 | 0.88 | 0.88 |
| 6th Highest Hour | 570 | 452 | 0 | 106 | 0.88 | 0.88 |
| 7th Highest Hour | 544 | 432 | 0 | 101 | 0.84 | 0.84 |
| 8th Highest Hour | 536 | 425 | 0 | 99 | 0.83 | 0.83 |
| 9 9th Highest Hour | 518 | 411 | 0 | 96 | 0.80 | 0.80 |
| 10th Highest Hour | 484 | 384 | 0 | 90 | 0.75 | 0.75 |
| 11th Highest Hour | 467 | 370 | 0 | 86 | 0.72 | 0.72 |
| 12th Highest Hour | 458 | 363 | 0 | 85 | 0.71 | 0.71 |
| 13th Highest Hour | 441 | 350 | 0 | 82 | 0.68 | 0.68 |
| 14th Highest Hour | 380 | 302 | 0 | 70 | 0.59 | 0.59 |
| 15th Highest Hour | 302 | 240 | 0 | 56 | 0.47 | 0.47 |
| 16th Highest Hour | 285 | 226 | 0 | 53 | 0.44 | 0.44 |
| 17th Highest Hour | 199 | 158 | 0 | 37 | 0.31 | 0.31 |
| 18th Highest Hour | 164 | 130 | 0 | 30 | 0.25 | 0.25 |
| 19th Highest Hour | 86 | 69 | 0 | 16 | 0.13 | 0.13 |
| 20th Highest Hour | 60 | 48 | 0 | 11 | 0.09 | 0.09 |
| 21st Highest Hour | 52 | 41 | 0 | 10 | 0.08 | 0.08 |
| 22nd Highest Hour | 35 | 27 | 0 | 6 | 0.05 | 0.05 |
| 23rd Highest Hour | 17 | 14 | 0 | 3 | 0.03 | 0.03 |
| 24th Highest Hour | 17 | 14 | 0 | 3 | 0.03 | 0.03 |

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

| Project \#: | 23910 |
| :--- | :--- |
| Project Name: | West Linn Arterial Roadways |
| Analyst: | RBG |
| Date: | $7 / 2 / 2019$ |
| Intersection: | OR 43/Willamette Falls Dr (106) |
| Scenario: | 2040 No-Build PM |


| Volume Adjustment Factor $=$ | 1.0 |
| :--- | :---: |
| North-South Approach $=$ | Major |
| East-West Approach $=$ | Minor |
| Major Street Thru Lanes $=$ | 1 |
| Minor Street Thru Lanes $=$ | 1 |
| Speed $>40$ mph? | No |
| Population $<10,000$ ? | No |
| Warrant Factor | $100 \%$ |
| Peak Hour or Daily Count? | Peak Hour |



Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

| Hour | Major Street |  | Minor Street |  | Major St. Adj. Factor | Minor St. <br> Adj. Factor |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Begin End | NB | SB | EB | WB |  |  |
| 7:30 AM 8:30 AM | 886 | 843 | 280 | 0 | 1.00 | 1.00 |
| 2nd Highest Hour | 839 | 798 | 265 | 0 | 0.95 | 0.95 |
| 3rd Highest Hour | 827 | 787 | 261 | 0 | 0.93 | 0.93 |
| 4th Highest Hour | 791 | 753 | 250 | 0 | 0.89 | 0.89 |
| 5th Highest Hour | 780 | 742 | 246 | 0 | 0.88 | 0.88 |
| 6th Highest Hour | 780 | 742 | 246 | 0 | 0.88 | 0.88 |
| 7th Highest Hour | 744 | 708 | 235 | 0 | 0.84 | 0.84 |
| 8th Highest Hour | 732 | 697 | 231 | 0 | 0.83 | 0.83 |
| 9th Highest Hour | 709 | 674 | 224 | 0 | 0.80 | 0.80 |
| 10th Highest Hour | 662 | 629 | 209 | 0 | 0.75 | 0.75 |
| 11th Highest Hour | 638 | 607 | 202 | 0 | 0.72 | 0.72 |
| 12th Highest Hour | 626 | 596 | 198 | 0 | 0.71 | 0.71 |
| 13th Highest Hour | 602 | 573 | 190 | 0 | 0.68 | 0.68 |
| 14th Highest Hour | 520 | 495 | 164 | 0 | 0.59 | 0.59 |
| 15th Highest Hour | 413 | 393 | 131 | 0 | 0.47 | 0.47 |
| 16th Highest Hour | 390 | 371 | 123 | 0 | 0.44 | 0.44 |
| 17th Highest Hour | 272 | 259 | 86 | 0 | 0.31 | 0.31 |
| 18th Highest Hour | 224 | 214 | 71 | 0 | 0.25 | 0.25 |
| 19th Highest Hour | 118 | 112 | 37 | 0 | 0.13 | 0.13 |
| 20th Highest Hour | 83 | 79 | 26 | 0 | 0.09 | 0.09 |
| 21st Highest Hour | 71 | 67 | 22 | 0 | 0.08 | 0.08 |
| 22nd Highest Hour | 47 | 45 | 15 | 0 | 0.05 | 0.05 |
| 23rd Highest Hour | 24 | 22 | 7 | 0 | 0.03 | 0.03 |
| 24th Highest Hour | 24 | 22 | 7 | 0 | 0.03 | 0.03 |

## Signal Warrant Assessment

Based on 2009 Edition of the MUTCD

| Project \#: | 23910 |
| :--- | :--- |
| Project Name: | West Linn Arterial Roadways |
| Analyst: | RBG |
| Date: | $7 / 2 / 2019$ |
| Intersection: | OR $43 /$ Mill St (107) |
| Scenario: | 2040 No-Build PM |


| Volume Adjustment Factor $=$ | 1.0 |
| :--- | :---: |
| North-South Approach $=$ | Major |
| East-West Approach $=$ | Minor |
| Major Street Thru Lanes $=$ | 1 |
| Minor Street Thru Lanes $=$ | 1 |
| Speed $>40$ mph? | No |
| Population $<10,000$ ? | No |
| Warrant Factor | $100 \%$ |
| Peak Hour or Daily Count? | Peak Hour |


| Warrant Summary |  |  |  |
| :---: | :---: | :---: | :---: |
| Warrant | Name | Analyzed? | Met? |
| \#1 | Eight-Highest | Yes | No |
| \#2 | Four-Hour | Yes | No |
| \#3 | Peak Hour | Yes | No |

Select Type Of Major Street Approach From Dropdown Menu Select Type Of Minor Street Approach From Dropdown Menu
Urban Principal Arterial Urban Minor Arterial

Note: traffic volume profile for weekday (if weekend is desired, tab "vol profile" needs to be adjusted)

|  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Hour |  |  |  |  | Major St. | Minor St. |
| Begin End | NB | SB | EB | wB | Adj. Factor | Adj. Factor |
| 7:30 AM 8:30 AM | 880 | 1081 | 8 | 0 | 1.00 | 1.00 |
| 2nd Highest Hour | 823 | 1011 | 8 | 0 | 0.94 | 0.95 |
| 3rd Highest Hour | 811 | 997 | 7 | 0 | 0.92 | 0.93 |
| 4th Highest Hour | 789 | 969 | 7 | 0 | 0.90 | 0.89 |
| 5th Highest Hour | 720 | 884 | 7 | 0 | 0.82 | 0.88 |
| 6th Highest Hour | 709 | 870 | 7 | 0 | 0.81 | 0.88 |
| 7th Highest Hour | 663 | 814 | 7 | 0 | 0.75 | 0.84 |
| 8th Highest Hour | 617 | 758 | 7 | 0 | 0.70 | 0.83 |
| 9th Highest Hour | 617 | 758 | 6 | 0 | 0.70 | 0.80 |
| 10th Highest Hour | 606 | 744 | 6 | 0 | 0.69 | 0.75 |
| 11th Highest Hour | 571 | 702 | 6 | 0 | 0.65 | 0.72 |
| 12th Highest Hour | 537 | 660 | 6 | 0 | 0.61 | 0.71 |
| 13th Highest Hour | 526 | 646 | 5 | 0 | 0.60 | 0.68 |
| 14th Highest Hour | 503 | 618 | 5 | 0 | 0.57 | 0.59 |
| 15th Highest Hour | 400 | 491 | 4 | 0 | 0.45 | 0.47 |
| 16th Highest Hour | 377 | 463 | 4 | 0 | 0.43 | 0.44 |
| 17th Highest Hour | 343 | 421 | 2 | 0 | 0.39 | 0.31 |
| 18th Highest Hour | 297 | 365 | 2 | 0 | 0.34 | 0.25 |
| 19th Highest Hour | 240 | 295 | 1 | 0 | 0.27 | 0.13 |
| 20th Highest Hour | 114 | 140 | 1 | 0 | 0.13 | 0.09 |
| 21st Highest Hour | 103 | 126 | 1 | 0 | 0.12 | 0.08 |
| 22nd Highest Hour | 69 | 84 | 0 | 0 | 0.08 | 0.05 |
| 23rd Highest Hour | 57 | 70 | 0 | 0 | 0.06 | 0.03 |
| $\underline{\text { 24th Highest Hour }}$ | 57 | 70 | 0 | 0 | 0.06 | 0.03 |

## Appendix F Year 2040 Build Traffic Conditions Worksheets

| Intersection |  |  |  |  |  |  |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Int Delay, s/veh | 8.4 |  |  |  |  |  |
| Movement | EBT | EBR | WBL | WBT | NBL | NBR |
| Lane Configurations | f |  | T | 个 | 〒 | $\mathbf{7}$ |
| Traffic Vol, veh/h | 161 | 46 | 199 | 403 | 27 | 487 |
| Future Vol, veh/h | 161 | 46 | 199 | 403 | 27 | 487 |
| Conflicting Peds, \#/hr | 0 | 3 | 3 | 0 | 0 | 0 |
| Sign Control | Free | Free | Free | Free | Stop | Stop |
| RT Channelized | - | None | - | None | - | None |
| Storage Length | - | - | 100 | - | 125 | 0 |
| Veh in Median Storage, \# | 0 | - | - | 0 | 0 | - |
| Grade, \% | -3 | - | - | 3 | 3 | - |
| Peak Hour Factor | 88 | 88 | 88 | 88 | 88 | 88 |
| Heavy Vehicles, \% | 4 | 4 | 0 | 5 | 11 | 0 |
| Mvmt Flow | 183 | 52 | 226 | 458 | 31 | 553 |



## MOVEMENT SUMMARY

## Site: 103 [2040 Build PM]

Sunset Ave / Willamette Falls Dr
Site Category: (None)
Roundabout

| Movement Performance - Vehicles |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Mov } \\ & \text { ID } \end{aligned}$ | Turn | Deman Total veh/h | $\begin{aligned} & \text { lows } \\ & \text { HV } \\ & \% \end{aligned}$ | Deg. Satn v/c | Average Delay sec | Level of Service | 95\% Back Vehicles veh | of Queue Distance ft | Prop. Queued | Effective Stop Rate | Aver. No. Cycles | Average Speed mph |
| East: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | T1 | 511 | 2.0 | 0.576 | 11.2 | LOS B | 3.9 | 98.2 | 0.41 | 0.25 | 0.41 | 32.1 |
| 16 | R2 | 66 | 2.0 | 0.576 | 11.2 | LOS B | 3.9 | 98.2 | 0.41 | 0.25 | 0.41 | 31.3 |
| Appr |  | 578 | 2.0 | 0.576 | 11.2 | LOS B | 3.9 | 98.2 | 0.41 | 0.25 | 0.41 | 32.0 |
| North: Willamette Falls Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | L2 | 143 | 2.0 | 0.486 | 13.0 | LOS B | 2.9 | 71.7 | 0.65 | 0.76 | 0.96 | 30.2 |
| 14 | R2 | 177 | 2.0 | 0.486 | 13.0 | LOS B | 2.9 | 71.7 | 0.65 | 0.76 | 0.96 | 29.0 |
| Approach |  | 320 | 2.0 | 0.486 | 13.0 | LOS B | 2.9 | 71.7 | 0.65 | 0.76 | 0.96 | 29.5 |
| West: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | L2 | 97 | 3.0 | 0.761 | 18.5 | LOS B | 14.4 | 366.8 | 0.69 | 0.69 | 1.04 | 28.9 |
| 2 | T1 | 631 | 2.0 | 0.761 | 18.5 | LOS B | 14.4 | 366.8 | 0.69 | 0.69 | 1.04 | 28.9 |
| Appr |  | 728 | 2.1 | 0.761 | 18.5 | LOS B | 14.4 | 366.8 | 0.69 | 0.69 | 1.04 | 28.9 |
| All V | cles | 1625 | 2.1 | 0.761 | 14.8 | LOS B | 14.4 | 366.8 | 0.58 | 0.55 | 0.80 | 30.1 |

Site Level of Service (LOS) Method: Delay \& v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab). Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement. LOS F will result if $\mathrm{v} / \mathrm{c}>1$ irrespective of movement delay value (does not apply for approaches and intersection). Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6). Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies. Gap-Acceptance Capacity: Traditional M1.
HV (\%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

## MOVEMENT SUMMARY

## Site: 106 [2040 Build PM]

Willamette Dr/Sunset Ave
Site Category: (None)
Roundabout

| Movement Performance - Vehicles |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Mov } \\ & \text { ID } \end{aligned}$ |  | Deman Total veh/h | $\begin{aligned} & \text { lows } \\ & \text { HV } \\ & \% \\ & \hline \end{aligned}$ | Deg. Satn v/c | Average Delay sec | Level of Service | 95\% Back <br> Vehicles <br> veh | of Queue Distance ft | Prop. Queued | Effective Stop Rate | Aver. No. Cycles | Average Speed mph |
| South: Willamette Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 3u | U | 1 | 3.0 | 0.431 | 10.4 | LOS B | 2.3 | 56.8 | 0.57 | 0.58 | 0.66 | 31.0 |
| 3 | L2 | 328 | 2.0 | 0.431 | 10.4 | LOS B | 2.3 | 56.8 | 0.57 | 0.58 | 0.66 | 30.3 |
| 18 | R2 | 627 | 1.0 | 0.378 | 0.0 | LOS A | 0.0 | 0.0 | 0.00 | 0.00 | 0.00 | 36.8 |
| Appr |  | 956 | 1.3 | 0.431 | 3.6 | LOS A | 2.3 | 56.8 | 0.20 | 0.20 | 0.23 | 34.2 |
| East: Willamette Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 1u | U | 1 | 3.0 | 0.845 | 28.1 | LOS C | 18.6 | 465.1 | 0.95 | 1.46 | 2.26 | 25.1 |
| 1 | L2 | 675 | 1.0 | 0.845 | 28.0 | LOS C | 18.6 | 465.1 | 0.95 | 1.46 | 2.26 | 24.7 |
| 6 | T1 | 223 | 3.0 | 0.284 | 7.8 | LOS A | 1.1 | 28.7 | 0.48 | 0.42 | 0.48 | 33.7 |
| Approach |  | 899 | 1.5 | 0.845 | 23.0 | LOS C | 18.6 | 465.1 | 0.83 | 1.20 | 1.82 | 26.4 |
| West: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| $5 u$ <br> 2 <br> 12 | U | 1 | 3.0 | 0.651 | 21.1 | LOS C | 4.8 | 123.5 | 0.77 | 1.00 | 1.49 | 28.9 |
|  | T1 | 357 | 4.0 | 0.651 | 21.2 | LOS C | 4.8 | 123.5 | 0.77 | 1.00 | 1.49 | 28.2 |
|  | R2 | 470 | 3.0 | 0.846 | 36.6 | LOS D | 10.6 | 270.4 | 0.90 | 1.39 | 2.47 | 22.9 |
| Approach |  | 828 | 3.4 | 0.846 | 29.9 | LOS C | 10.6 | 270.4 | 0.84 | 1.22 | 2.05 | 25.0 |
| All Vehicles |  | 2683 | 2.0 | 0.846 | 18.2 | LOS B | 18.6 | 465.1 | 0.61 | 0.85 | 1.32 | 28.2 |

Site Level of Service (LOS) Method: Delay \& v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab). Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement.
LOS F will result if $\mathrm{v} / \mathrm{c}>1$ irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010).
Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (\%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.



## MOVEMENT SUMMARY

## Site: 103 [2040 Build AM]

Sunset Ave / Willamette Falls Dr
Site Category: (None)
Roundabout

| Movement Performance - Vehicles |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Mov } \\ & \text { ID } \end{aligned}$ | Turn | Deman <br> Total veh/h | $\begin{aligned} & \text { lows } \\ & \text { HV } \\ & \% \end{aligned}$ | Deg. Satn v/c | Average Delay sec | Level of Service | 95\% Back Vehicles veh | of Queue Distance ft | Prop. Queued | Effective Stop Rate | Aver. No. Cycles | Average Speed mph |
| East: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | T1 | 518 | 2.0 | 0.804 | 23.5 | LOS C | 16.4 | 417.7 | 0.87 | 1.23 | 1.87 | 27.3 |
| 16 | R2 | 151 | 2.0 | 0.804 | 23.5 | LOS C | 16.4 | 417.7 | 0.87 | 1.23 | 1.87 | 26.7 |
| Appr | ch | 669 | 2.0 | 0.804 | 23.5 | LOS C | 16.4 | 417.7 | 0.87 | 1.23 | 1.87 | 27.2 |
| North: Willamette Falls Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 7 | L2 | 46 | 2.0 | 0.327 | 9.8 | LOS A | 1.3 | 32.6 | 0.58 | 0.59 | 0.59 | 32.2 |
| 14 | R2 | 171 | 0.0 | 0.327 | 9.6 | LOS A | 1.3 | 32.6 | 0.58 | 0.59 | 0.59 | 31.2 |
| Approach |  | 217 | 0.4 | 0.327 | 9.7 | LOS A | 1.3 | 32.6 | 0.58 | 0.59 | 0.59 | 31.4 |
| West: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | L2 | 276 | 4.0 | 0.688 | 14.1 | LOS B | 6.2 | 158.9 | 0.36 | 0.16 | 0.36 | 30.1 |
| 2 | T1 | 445 | 2.0 | 0.688 | 14.0 | LOS B | 6.2 | 158.9 | 0.36 | 0.16 | 0.36 | 30.1 |
| Appr |  | 721 | 2.8 | 0.688 | 14.1 | LOS B | 6.2 | 158.9 | 0.36 | 0.16 | 0.36 | 30.1 |
| All V | cles | 1607 | 2.1 | 0.804 | 17.4 | LOS B | 16.4 | 417.7 | 0.60 | 0.67 | 1.02 | 29.0 |

Site Level of Service (LOS) Method: Delay \& v/c (HCM 6). Site LOS Method is specified in the Parameter Settings dialog (Site tab). Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement. LOS F will result if $\mathrm{v} / \mathrm{c}>1$ irrespective of movement delay value (does not apply for approaches and intersection). Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 6). Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies. Gap-Acceptance Capacity: Traditional M1.
HV (\%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

## MOVEMENT SUMMARY

## Site: 106 [2040 Build AM]

Willamette Dr/Sunset Ave
Site Category: (None)
Roundabout

| Movement Performance - Vehicles |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\begin{aligned} & \text { Mov } \\ & \text { ID } \end{aligned}$ |  | Deman <br> Total veh/h | $\begin{aligned} & \text { lows } \\ & \text { HV } \\ & \% \end{aligned}$ | Deg. Satn v/c | Average Delay sec | Level of Service | 95\% Back <br> Vehicles veh | of Queue Distance ft | Prop. Queued | Effective Stop Rate | Aver. No. Cycles | Average Speed mph |
| South: Willamette Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 3u | U | 1 | 3.0 | 0.456 | 9.5 | LOS A | 2.3 | 59.7 | 0.45 | 0.34 | 0.45 | 31.6 |
| 3 | L2 | 377 | 3.0 | 0.456 | 9.5 | LOS A | 2.3 | 59.7 | 0.45 | 0.34 | 0.45 | 30.9 |
| 18 | R2 | 791 | 1.0 | 0.456 | 0.4 | LOS A | 2.3 | 59.7 | 0.02 | 0.02 | 0.02 | 36.4 |
| Appro |  | 1170 | 1.6 | 0.456 | 3.4 | LOS A | 2.3 | 59.7 | 0.16 | 0.12 | 0.16 | 34.4 |
| East: Willamette Dr |  |  |  |  |  |  |  |  |  |  |  |  |
| 1u | U | 1 | 3.0 | 0.745 | 21.1 | LOS C | 10.3 | 260.3 | 0.82 | 1.15 | 1.69 | 27.2 |
| 1 | L2 | 562 | 1.0 | 0.745 | 21.0 | LOS C | 10.3 | 260.3 | 0.82 | 1.15 | 1.69 | 26.7 |
| 6 | T1 | 275 | 6.0 | 0.382 | 10.0 | LOS A | 1.6 | 41.8 | 0.54 | 0.53 | 0.56 | 32.7 |
| Approach |  | 839 | 2.6 | 0.745 | 17.4 | LOS B | 10.3 | 260.3 | 0.73 | 0.95 | 1.32 | 28.4 |
| West: Sunset Ave |  |  |  |  |  |  |  |  |  |  |  |  |
| $\begin{array}{\|l\|} \hline 5 u \\ 2 \\ 12 \\ \hline \end{array}$ | U | 1 | 3.0 | 0.299 | 9.8 | LOS A | 1.1 | 28.3 | 0.58 | 0.58 | 0.58 | 33.7 |
|  | T1 | 181 | 5.0 | 0.299 | 9.9 | LOS A | 1.1 | 28.3 | 0.58 | 0.58 | 0.58 | 32.7 |
|  | R2 | 296 | 1.0 | 0.468 | 12.9 | LOS B | 2.6 | 65.3 | 0.66 | 0.76 | 0.95 | 30.2 |
| Approach |  | 477 | 2.5 | 0.468 | 11.8 | LOS B | 2.6 | 65.3 | 0.63 | 0.69 | 0.81 | 31.1 |
| All Vehicles |  | 2486 | 2.2 | 0.745 | 9.7 | LOS A | 10.3 | 260.3 | 0.44 | 0.51 | 0.68 | 31.5 |

Site Level of Service (LOS) Method: Delay \& v/c (HCM 2010). Site LOS Method is specified in the Parameter Settings dialog (Site tab). Roundabout LOS Method: Same as Signalised Intersections.
Vehicle movement LOS values are based on average delay and v/c ratio (degree of saturation) per movement. LOS F will result if $\mathrm{v} / \mathrm{c}>1$ irrespective of movement delay value (does not apply for approaches and intersection).
Intersection and Approach LOS values are based on average delay for all movements (v/c not used as specified in HCM 2010). Roundabout Capacity Model: US HCM 2010.
HCM Delay Formula option is used. Control Delay does not include Geometric Delay since Exclude Geometric Delay option applies.
Gap-Acceptance Capacity: Traditional M1.
HV (\%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

## Appendix 2 Segment Alternatives Memorandum

| Date: | March 2, 2020 | Project \#: 23910 |
| :---: | :---: | :---: |
| To: | Lance Calvert |  |
|  | City of West Linn |  |
|  | 22500 Salamo Road |  |
|  | West Linn, OR 97068 |  |
| From: | Nick Gross, Nicholas Polenske, PE, Marc Butorac, PE, PTOE |  |
| Project: | West Linn Arterial Roadways |  |
| Subject: | Project Roll Map Narrative |  |

## NTRODUCTION

The City of West Linn (City) is planning to improve Willamette Falls Drive (WFD) from the Tualatin River to the Lake Oswego Highway (OR43) to improve traffic operations and provide multimodal connectivity along the corridor as well as facilitate future development of the waterfront area. As part of the roadway reconfiguration, separated multimodal facilities including the preferred sidewalk and "cycletrack" configurations as defined by the City's standard details are proposed. A conceptual project roll map of the study area was developed to illustrate the best fit centerline alignment based on existing Geographic Information System (GIS) data. Appendix "A" contains the conceptual project roll map of the project study area.

## TRAFFIC CONDITIONS

A traffic operations analysis was conducted at several study intersections along the corridor under existing and year 2040 traffic conditions. The purpose of the traffic operations analysis was to ensure adequate capacity and determine the appropriate traffic control devices and lane configurations at each study intersection. A conceptual layout of the study area was developed by the City that includes removal of the segment of WFD from Chestnut Street to OR43 and construction of new street connections from WFD to Sunset Drive, Sunset Drive to West A Street, and Sunset Drive to OR43. The results of the analysis indicate that the proposed conceptual layout will improve traffic operations, safety, and multimodal connectivity along the corridor under year 2040 traffic conditions assuming minor modifications to the traffic control and lane configurations. Appendix " $B$ " contains the draft Traffic Operations Analysis.

## CONNECTIVITY

WFD is an east-west connection and identified as a Minor Arterial in the City of West Linn Transportation System Plan (TSP - Reference 1). As defined in the TSP, "Minor arterials serve to interconnect and support the major arterial system. These streets link major commercial, residential, industrial and institutional areas. Minor arterial streets are typically spaced about one mile apart to assure accessibility and reduce traffic using collectors or local streets in lieu of a well-placed minor arterial street. Many of these routes connect to cities surrounding West Linn. Access control is a key feature of an arterial route. Minor arterials are typically multiple miles in length. Neighborhood Traffic Management strategies are not appropriate on minor arterials."

The Bicycle Plan Improvements within the TSP identify the installation of cycle tracks along Willamette Falls Drive from Willamette Drive to Sunset Avenue (Map ID B12) and Sunset Avenue to $10^{\text {th }}$ Street (Map ID B13). Both projects are identified as High Priority projects.

Exhibit 1 illustrates Strava Data (Reference 2) along WFD. Strava "Heat Maps" are generated by users raw input activity streams and used to illustrate locations of frequent use by showing heat opacity.

## Exhibit 1: Strava Heat Map



As shown in Exhibit 1, WFD is the most heavily utilized east-west corridor for people biking in West Linn; however, WFD is not suitable for the majority of users as illustrated in the Bicycle Level of Traffic Stress Analysis (Appendix C) conducted as part of the TSP. In order to achieve a comfortable environment for people biking along WFD, a separated bicycle facility or "cycle track" as identified as part of the TSP must be installed to provide adequate separation between the travel land and dedicated space for people biking.

## DESCRIPTION OF 5 SEGMENTS

As illustrated on the Project Roll Map, WFD was separated into five segments based on changes in right-of-way, topography constraints, and general changes to the corridor context. The following analysis provides a brief description of the proposed alternatives within each of the five segments and provides a qualitative evaluation of each alternative utilizing an evaluation matrix scoring metric. A legend of the evaluation matrix is provided below. Appendix " $C$ " contains the alternatives for each segment as prepared for the initial analysis.


Segment A-A runs along WFD from just east of the Tualatin River "WF" $16+00$ to the western leg of the WFD and $16^{\text {th }}$ Street intersection, approximately "WF" $67+00$. Three cross-section alternatives were developed within this segment and have been analyzed based on the evaluation criteria presented in Table 1.

## Table 1: Segment A-A Evaluation Matrix

| Segment | Connectivity | Right-of-Way | Cost | Safety \& Security |
| :---: | :---: | :---: | :---: | :---: |
| $A-A(1)$ |  |  |  |  |
| $A-A(2)$ |  |  |  |  |
| $A-A(3)$ |  |  |  |  |

As illustrated in Table 1, the preferred cross-section alternative was determined to be Segment A-A (2). This crosssection alternative provides two 12 -foot travel lanes with a four and a half-foot landscape strip, six and a half-foot one-way cycle track, and six-foot sidewalk on both sides of the roadway. As compared to Segment A-A (1), the preferred cross-section requires less right-of-way and will cost less to construct. Right-of-way acquisition will be necessary for the preferred alternative as the existing right-of-way boundaries are in the proposed sidewalk.

Segment A-A (2) - Tualatin River to $\mathbf{1 6}^{\text {th }}$ Street, Looking East


The section of WFD between $16^{\text {th }}$ Street and $10^{\text {th }}$ Street is currently being designed as part of a separate project. Segment A-A will match in to these improvements at $16^{\text {th }}$ Street and Segment B-B will match in to these improvements at $10^{\text {th }}$ Street.

Segment B-B runs along WFD from $10^{\text {th }}$ Street intersection, approximately "WF" 93+00 to the WFD and $6^{\text {th }}$ Street intersection at approximately "WF" 109+00. Two cross-section alternatives were developed within this segment and have been analyzed based on the evaluation criteria presented in Table 2.

## Table 2: Segment B-B Evaluation Matrix

| Segment | Connectivity | Right-of-Way | Cost | Safety \& Security |
| :---: | :---: | :---: | :---: | :---: |
| B-B $(1)$ |  | 0 |  |  |
| B-B (2) |  |  |  |  |

As illustrated in Table 2, the preferred cross-section alternative was determined to be Segment B-B (2). This crosssection alternative includes two 13 -foot travel lanes with an offset eight-foot multi-use trail. No sidewalk is being proposed along WFD through this segment. While both cross-section alternatives accommodate people biking on the parallel frontage road located immediately south of WDF, the preferred alternative can fit within a smaller right-of-way resulting in a significant smaller construction cost. This is primarily due to Segment B-B (1) providing a two-way, left-turn lane (TWLTL). People biking on the frontage road will be accommodated using shared lane pavement marking or "sharrows" striped along the full length of the roadway with appropriate signage directing cyclists to this parallel facility. The frontage road has a posted speed of 20 miles per hour ( mph ) and is a comfortable facility for the majority of people biking (LTS 1). Additional safety features that will be investigated through this segment include a possible additional stop sign at the WFD and $6{ }^{\text {th }}$ Street intersection as well as closing an existing frontage road entrance east of the $10^{\text {th }}$ Street intersection due to the proximity of a new traffic signal at WFD and $10^{\text {th }}$ Street.

Section B-B (2) - 10 ${ }^{\text {th }}$ Street to $\mathbf{6}^{\text {th }}$ Street, Looking East


Segment C-C runs along WFD from $6^{\text {th }}$ Street, "WF" 109+00, to "WF" $162+00$. This segment of WFD is extremely constrained due to the topography on both sides of the roadway. Five cross-section alternatives were developed within this segment and have been analyzed based on the evaluation criteria presented in Table 3.

## Table 3: Segment C-C Evaluation Matrix

| Segment | Connectivity | Right-of-Way | Cost | Safety \& Security |
| :---: | :---: | :---: | :---: | :---: |
| C-C (1) |  |  |  |  |
| C-C (2) |  |  |  |  |
| C-C (3) |  |  |  |  |
| C-C (4) |  |  |  |  |
| $C-C(5)$ |  |  |  |  |

As illustrated in Table 3, the preferred cross-section alternative was determined to be Segment C-C (1). This crosssection alternative includes two 12 -foot travel lanes with a five-foot planter and a 10 -foot shared-use path on the south side of the road. While Segment C-C (2), scores closely to the preferred cross-section, it was determined that two retaining walls would be required based on the lower level shared-use path, resulting in an increase to construction cost. All cross-section alternatives require a significant "fill" retaining wall on the south side of WFD to accommodate the proposed shared-use path. Both the preferred alternative, C-C (1), and C-C (2), would require right-of-way acquisition (approximately 1.5 feet) on the south side of WFD to accommodate the proposed retaining wall.

Segment C-C (1) - $\mathbf{6}^{\text {th }}$ Street to Closed Dan Davis Recycling Center, Looking East


Segment D-D runs along WFD from "WF" $162+00$ to "WF" 186+00 at the intersection of Chestnut Street and Sunset Avenue. Similar to Segment C-C, this segment of WFD is extremely constrained to topography on both sides of the roadway. Five cross-section alternatives were developed within this segment and have been analyzed based on the evaluation criteria presented in Table 4.

## Table 4: Segment D-D Evaluation Matrix

| Segment | Connectivity | Right-of-Way | Cost | Safety \& Security |
| :---: | :---: | :---: | :---: | :---: |
| D-D (1) |  |  |  |  |
| D-D (2) |  |  |  |  |
| D-D (3) |  |  |  |  |
| D-D (4) |  |  |  |  |
| D-D (5) |  |  |  |  |

As illustrated in Table 4, the preferred cross-section alternative was determined to be Segment D-D (1). This crosssection alternative is identical to Segment C-C. Segment D-D (2) would require two retaining walls resulting in an increase cost of construction. Maintaining the shared-use path facility on the south side of the roadway is consistent with the preferred alternatives selected for the additional segments along WFD. With the preferred alternative, people walking and biking will be accommodated along a 10 -foot separated shared-use path. In order to construct this facility, a significant "fill" wall on the south side of WFD is required. Similarly to Segment C-C, all preferred alternatives would require right-of-way acquisition on the south side of WFD.


Segment E-E runs along Sunset Avenue to the proposed Sunset Avenue/OR43/I-205 entrance ramp roundabout Once on Sunset Avenue, the alignment turns to the east and follows Sunset Avenue back to WFD where it is proposed to cross WFD to link into the West Linn Mill Property Development. Four cross-section alternatives were developed for this segment and have been analyzed based on the evaluation criteria presented in Table 5.

## Table 5: Segment E-E Evaluation Matrix

| Segment | Connectivity | Right-of-Way | Cost | Safety \& Security |
| :---: | :---: | :---: | :---: | :---: |
| E-E (1) |  |  |  |  |
| E-E (2) |  |  |  |  |
| E-E (3) |  |  |  |  |
| E-E (4) |  |  |  |  |

As illustrated in Table 5, Segment E-E (1), Segment E-E (2), and Segment E-E (4) resulted in similar scoring metrics based on the evaluation criteria. Segment E-E (1) was determined to be the preferred alternative due to the need to accommodate a TWLTL. The preferred cross-section provides two 12 -foot travel lanes and a 12 -foot TWLTL to facilitate left-turns at the Chestnut intersection. On the northside of the roadway, a six-foot sidewalk is provided. On the southside, a five-foot landscape strip, 10 -foot two-way cycle track, and six-foot sidewalk are provided. The preferred segment does not require walls on either side of WFD, however, walls could be used to limit the overall footprint. Due to the new alignments of WFD, Chestnut Street, and Sunset Avenue in this segment of the proposed improvements, right-of-way acquisition is anticipated and the road footprint will be optimized to minimize these impacts.

## Segment E-E (1) - Sunset Avenue to Sunset Avenue/OR43/I-205 Roundabout, Looking East



## Segment E-E (4)

The West Linn Mill Property Development is proposed on the south side of WFD east of Sunset Avenue to W A Street. Within this segment of WFD, a separate alternative would have people walking and biking to be accommodated by a separated shared-use path within the West Linn Mill Property Development. The shared-use path alignment is illustrated in the Project Roll Map and coordination will be required with the development team to refine the path alignment and feasibility.

This alternative is preferred through Segment E-E if the development layout permits this concept. Separating the cycle track from the main road would improve safety for users and would provide a leaner roadway section along WFD, Chestnut Street, and Sunset Avenue allowing the development to maximize the developable space. This alternative would also require less overall $\mathrm{R} / \mathrm{W}$ acquisition for the City as the cycle track through the development would be a part of the West Linn Mill Property Development.

## CONSTRUCTION STAGING

There are three on-going design projects directly adjacent to the Willamette Falls Drive project described in this memorandum:

- I-205 Corridor Widening Project (Oregon Department of Transportation)
- Old Mill Site Development Project (Private Developer)

Historic Willamette Falls Drive Project (City of West Linn)
Each project is responsible for key components of the overall WFD corridor connectivity, but this project can be staged to construct most of the improvements regardless of when each of the three projects listed above are constructed. The ultimate layout of Segment E-E is dependent on both the I-205 Corridor Widening Project and the Old Mill Site Development Project and depending on when either of these two projects are constructed, there will be necessary interim connections of both OR43 and Broadway Street to maintain connectivity throughout the corridor.

## REFERENCES

1. West Linn Transportation System Plan
2. Strava Heat Maps Data

## Appendix A Project Roll Map

## Appendix B Traffic Operations

 Analysis See Appendix 1, main appendices
## Appendix C Segment Alternatives from Analysis




Minor Arterial without
Median/Center Lane
(Cyclists are separated on existing frontage road)
(Preferred Section)


Constrained
Shared-use Path on Right (Split Level)
 on Right


Constrained
Standard Cycle Tracks


Minor Arterial

## Constrained

Shared-use Path on Right (Preferred Section)


Minor Arterial
Constrained
Shared-use Path on Right
(Split level)


Minor Arterial Constrained
Two-way Cycle Track on Right


Minor Arterial Constrained
Two-way Cycle Track on Left


Minor Arterial Constrained
Standard Cycle Tracks


Median/Center Lane
Two-way Cycle Track on Right
(Preferred Section)
E2


Minor Arterial without
Median/Center Lane
Two-way Cycle Track on Right
E3


Minor Arterial with
Median/Center Lane


Minor Arterial without
Median/Center Lane
Separated Cycle Track through Development


[^0]:    95 " percentile queue lengths from the Sunseth.

