Metro Orange Line Bus Rapid Transit Improvements Study

Traffic Analysis

Final Report

July 25, 2019

Submitted to:

Metro

Prepared by **Iteris, Inc.**

Innovating Through Informatics™

TABLE OF CONTENTS

TABLES

FIGURES

1 INTRODUCTION

The Metro Orange Line (MOL) Bus Rapid Transit (BRT) Improvements Study covers the 18-mile bus corridor from North Hollywood Station to Chatsworth Station. On July 26, 2018, the Los Angeles Metro Board of Directors approved improvements to the Metro Orange Line (MOL) Bus Rapid Transit (BRT) that include four-quadrant gates at the crossings, roadway closure, and two grade separations at Sepulveda Boulevard and Van Nuys Boulevard. Measure M, a transportation bond measure passed by Los Angeles County voters in November 2016, set aside $286 million for grade separations and other improvements for the Orange Line.

This report documents the traffic analysis methodology, results for the various improvement alternative scenarios for the MOL, and potential transportation impacts due to implementation of these improvements. The assumptions included in this report are based on extensive coordination with the Los Angeles County Metropolitan Transportation Authority (Metro), the Los Angeles Department of Transportation (LADOT) and Iteris' experience and work performed to-date on the MOL corridor, including:

- 2017 Grade Separation Analysis Operational Improvements Technical Study
- 2016 MOL Speed Evaluation Study

1.1 Project Description

The project description used for analysis and summarized in this report was approved by Metro's Board on July 26, 2018, and the Board authorized filing a California Environmental Quality Act (CEQA) Notice of Exemption (NOE) for the project.

The proposed improvements to the MOL, referred in this document as the "project", are described below and illustrated in **Figure 1**:

- Four-quadrant gates at up to 35 at-grade crossings
- Pedestrian gate and a swing gate combination at four of five pedestrian crossings:
    - Agnes Avenue pedestrian crossing
    - Goodland Avenue pedestrian crossing
    - Hayvenhurst Avenue pedestrian crossing
    - Zelzah Avenue pedestrian crossing
- Grade separation of the MOL busway at:
    - Sepulveda Station pedestrian crossing
    - Sepulveda Boulevard
    - City of Los Angeles, Bureau of Street Maintenance, Van Nuys District Yard (Private)
    - Vesper Avenue
    - Van Nuys Boulevard
- Closure of vehicular traffic at Tyrone Avenue and the MOL busway
- MOL Operational Improvements
    - Bus headway: 6-minute headways are evaluated in this study
    - Bus platooning

Figure 1 – MOL BRT Improvements

1.2 Alternative Scenarios

This report summarizes results for the worst peak hour; therefore, traffic operations were evaluated for each of the following scenarios during the weekday p.m. peak hour:

- Existing (2017) conditions
- Future opening year (2025) without project
- Future opening year (2025) with project 6-minute headway and bus platooning

1.3 Study Area

The study area and intersections were defined in consultation with Metro and LADOT. A total of 42 intersections, shown in **Figure 2**, within the study area that consist of roadways crossing the MOL busway or immediately adjacent to the busway as listed below:

1-1 Chandler Blvd/Tujunga Ave/MOL Busway
2-1 Chandler Blvd/Colfax Ave/MOL Busway
3-1 Chandler Blvd/Laurel Canyon Blvd/MOL Busway
4-1 Chandler Blvd/Corteen Place/MOL Busway
5-1 Chandler Blvd/Whitsett Ave/MOL Busway
6-1 Chandler Blvd/Bellaire Ave/MOL Busway
7-1 Chandler Blvd/Coldwater Canyon Blvd/MOL Busway
8-1 Chandler Blvd/MOL Busway
9-1 Ethel Ave/MOL Busway
9-2 Ethel Ave/Chandler Blvd
10-1 Burbank Blvd/Fulton Ave/MOL Busway
11-1 Oxnard St/Buffalo Ave/MOL Busway
12-1 Woodman Ave/MOL Busway
12-2 Woodman Ave/Oxnard St
13-1 Hazeltine Ave/MOL Busway
14-1 Tyrone Ave/MOL Busway
15-1 Van Nuys Blvd/Aetna St /MOL Busway
16-1 Vesper Ave/MOL Busway
17-1 Kester Ave/MOL Busway
18-1 Sepulveda Blvd/MOL Busway
19-1 Victory Blvd/Densmore Ave
20-1 Woodley Ave/Victory Blvd/MOL Busway
22-1 Victory Blvd/Balboa Blvd
22-2 Balboa Blvd/MOL Busway
23-1 Oxnard St/White Oak Ave/MOL Busway
24-1 Oxnard St/Lindley Ave/MOL Busway
25-1 Reseda Blvd/Bessemer St/Oxnard St/MOL Busway
26-1 Wilbur Ave/Oxnard St/MOL Busway
27-1 Tampa Ave/Topham St/MOL Busway
28-1 Corbin Ave/Topham St/MOL Busway
29-1 Victory Blvd/Topham St/MOL Busway
30-1 Winnetka Ave/MOL Busway
31-1 Victory Blvd/Mason Ave/MOL Busway
32-1 Victory Blvd/De Soto Ave/MOL Busway
33-1 Canoga Ave/Vanowen St/MOL Busway
34-1 Canoga Ave/Sherman Way/MOL Busway/Deering Ave
35-1 Canoga Ave/Valerio St/MOL Busway
36-1 Canoga Ave/Saticoy St/MOL Busway
37-1 Canoga Ave/Roscoe Blvd/MOL Busway
38-1 Canoga Ave/Parthenia St/MOL Busway
39-1 Canoga Ave/Nordhoff St/MOL Busway
40-1 Canoga Ave/Prairie Ave/MOL Busway

2 EXISTING CONDITIONS

This section describes the MOL existing physical configuration, at-grade crossings, station locations, and bus travel times.

2.1 MOL Corridor Configuration

The MOL BRT extends for approximately 18 miles from North Hollywood Station to Chatsworth Station, and it encompasses 17 stations:

1. North Hollywood
2. Laurel Canyon
3. Valley College
4. Woodman
5. Van Nuys
6. Sepulveda
7. Woodley
8. Balboa
9. Reseda
10. Tampa
11. Pierce College
12. De Soto
13. Canoga
14. Sherman Way
15. Roscoe
16. Nordhoff
17. Chatsworth

The MOL runs parallel to Chandler Boulevard, Oxnard Street, Victory Boulevard, and Canoga Avenue. There is also a bikeway running adjacent to the MOL busway that is comprised of two segments: Class II bike lanes from the North Hollywood Station to Coldwater Canyon Avenue, and a Class I dedicated bicycle path adjacent to the MOL busway from Coldwater Canyon on the east/west segment to Prairie on the north/south segment.

2.2 MOL Corridor Crossings

The MOL has 39 at-grade crossings, including three private driveways and five pedestrian crossings. After the 2015 MOL Speed Evaluation Study, Metro increased the intersection crossing speeds from 10 miles per hour (mph) to 15 mph and 25 mph, depending on crossing configurations and station proximity.

2.3 Existing MOL Bus Travel Time

In coordination with Metro and LADOT, travel time runs were conducted using the floating car method as part of the previous MOL corridor Studies: the 2016 MOL Speed Evaluation Study and the 2017 MOL Grade Separation Analysis and Operational Improvements Technical Study. **Table 1** summarizes the travel time data that was utilized for this current Study.

Table 1 – Travel Time Data

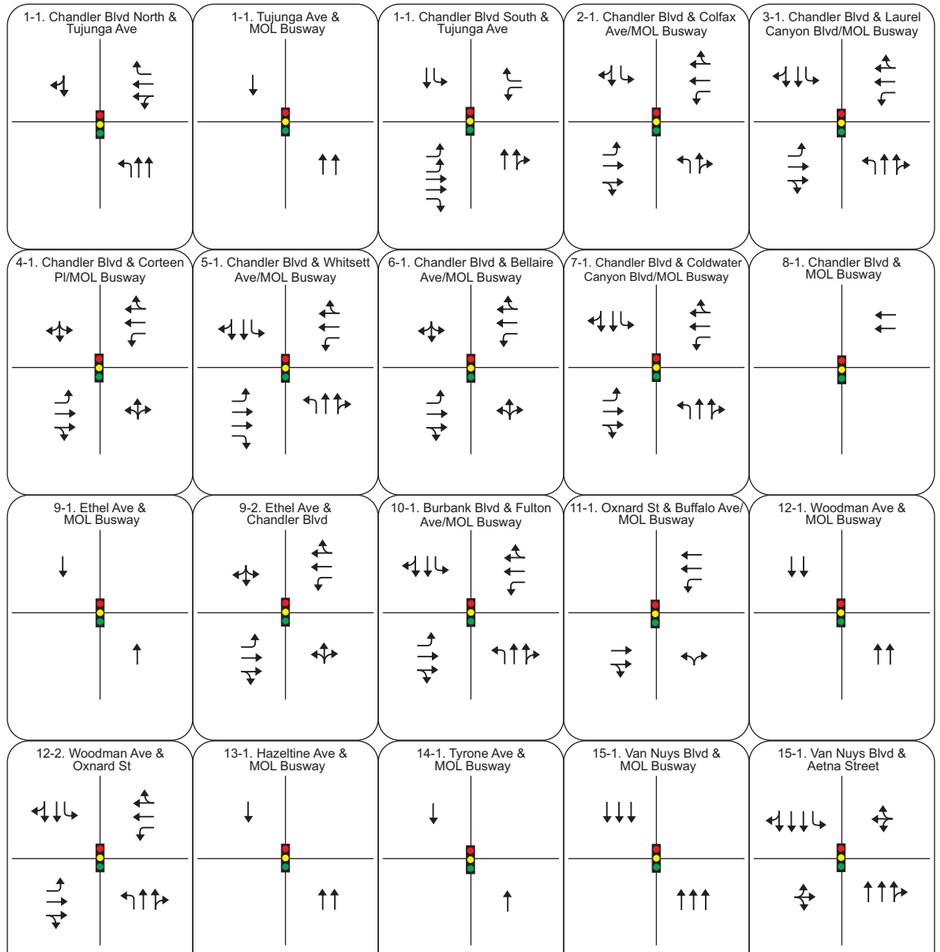
Travel Time Corridor	Segment	Date Collected	AM		PM	
			Average Travel Time (mm:ss)	Average Speed (mph)	Average Travel Time (mm:ss)	Average Speed (mph)
WB MOL Busway	North Hollywood Station to Canoga Station	January 2017	39:48	20.0 mph	41:18	19.3 mph
	Canoga Station to Chatsworth Station	August 2015	13:06	19.7 mph	14:12	18.1 mph
EB MOL Busway	Chatsworth Station to Canoga Station	August 2015	14:00	18.2 mph	13:48	18.5 mph
	Canoga Station to North Hollywood Station	January 2017	39:18	20.4 mph	38:4	20.9 mph
NB Canoga Ave	Vanowen St to Nordhoff St	November 2015	08:24	20.7 mph	08:24	20.8 mph
SB Canoga Ave	Nordhoff St to Vanowen St	November 2015	09:12	19.0 mph	08:24	20.7 mph
EB Chandler Blvd	Coldwater Canyon Blvd to Tujunga Ave	November 2015	04:12	28.8 mph	08:18	26.3 mph
WB Chandler Blvd	Tujunga Avenue to Coldwater Canyon Blvd	November 2015	05:06	23.7 mph	07:30	25.6 mph

2.4 Traffic Data

Intersection turning movement counts were collected in December 2017 at locations closest to the MOL busway corridor for the AM and PM peak periods. The new peak hour volumes for vehicles, pedestrians, and bicycles were entered into the model at these count locations as part of the model update.

2.5 Existing Roadway Configuration

Intersection geometry was collected for all 42 study intersections. **Figure 3** presents the intersection geometry, as agreed upon with LADOT.



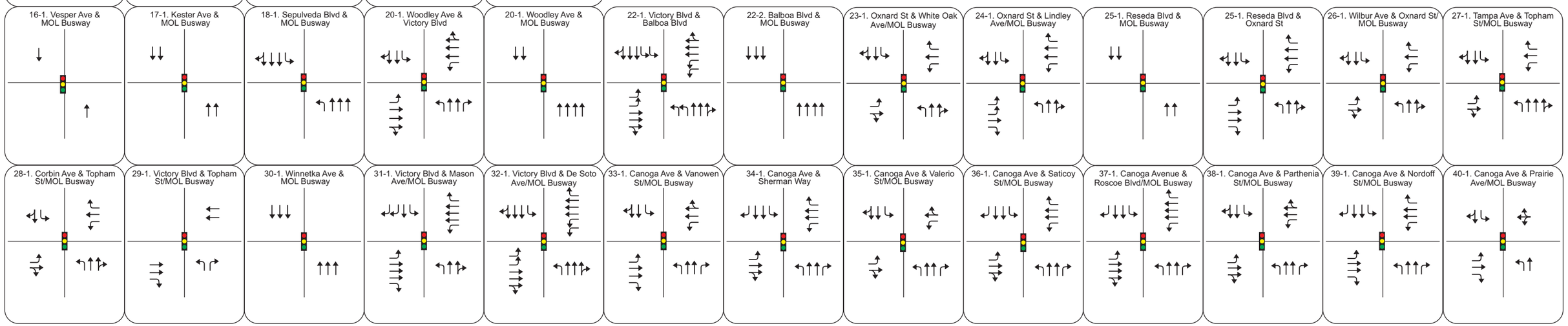


Figure 3
Existing Intersection Lane Configuration

3 MICROSIMULATION ANALYSIS SETUP

Utilizing the data and findings collected as part of the project and previous MOL studies, Iteris prepared a computer-based traffic simulation, using the VISSIM 9 software, to serve as the traffic operations analysis tool for comparing potential improvement scenarios for the MOL. The steps taken to update the existing VISSIM model, to recalibrate and validate under existing conditions, as well as to develop the future model scenarios are described in this section.

3.1 Existing Model

On May 25, 2018, Iteris submitted the *MOL – Calibration of Traffic Simulation Model for Existing Conditions* memo to Metro and can be referred to in **Appendix A**. The following summary highlights the document.

3.1.1 Model Update

The VISSIM model was first developed for the MOL Speed Evaluation Study (completed in 2015) and was calibrated for existing year 2015 PM conditions. The VISSIM model included the existing roadway geometrics, traffic signal parameters, and driver behavior characteristics. New turning movement counts collected in December 2017 at intersections closest to the MOL Busway corridor were input into the model. Travel times collected from previous projects were utilized to calibrate the model travel times. Additional bus travel times were collected in April 2018 to capture existing operations. This model update was performed using VISSIM build 9.00-06. The following is included in the existing model update:

- **Network Coding** - The network included the MOL busway between the North Hollywood Station and the western terminus of the busway at the Chatsworth Metrolink Station as well as neighboring street corridors, perpendicular to the MOL. The Existing lane geometries in the VISSIM model are shown above in **Figure 3**.
- **Signal Timing Data** - The network contains approximately 50 signalized intersections, including the busway signals and signalized intersections on parallel roadways. Signal timing data was provided by LADOT for the initial model development. The signal timing inputs in the model were validated to the signal timing sheets as part of the update.
- **Traffic Count Data** - Intersection turning movement counts were collected in December 2017 at locations closest to the MOL busway corridor for the AM and PM peak periods. The new peak hour volumes for vehicles, pedestrians, and bicycles were entered into the model at these count locations as part of the model update.
- **Travel Time Data** - For the 2016 MOL Speed Evaluation Study and the 2017 MOL Grade Separation Analysis and Operational Improvements Technical Study, travel time runs were conducted using the floating car method, shown above in **Table 1** of Section 2.3.
- **MOL Bus Assumptions** – MOL corridor bus length was assumed to be 60 feet in length and operating speeds were assumed at 35 mph with intersection crossing speeds reduced to 15 and 25 mph depending on the crossing.
- **Platooning Assumptions –** No platooning bus service was assumed for existing operations.
- **Dwell Time Assumptions** – Existing dwell times at individual stations were provided by Metro and incorporated into the existing model.
- **Headway assumptions**
    - EB/WB Segment - Headway of 4 minutes with buses going to Chatsworth or Warner Center

- NB/SB Segment - Headway of 8 minutes for buses coming from North Hollywood to Chatsworth. Shuttle between Chatsworth and Warner Center have a 20 minute headways.

3.1.2 Calibration Methodology and Results

The following calibration targets set for microsimulation models by the Federal Highway Administration (FHWA) were applied:

- Hourly Flows, Model Versus Observed
  - Individual Link Flows
    - Within 100 vehicles/hour (v/h), for Flows < 700 v/h
    - Within 15%, for 700 v/h < Flow < 2,700 v/h
    - Within 400 v/h, for Flow > 2,700 v/h
  - Sum of All Link Flows
    - Within 5% of the sum of all link counts
  - GEH Statistic < 5 for Individual Link Flows > 85% of cases
  - GEH Statistic for Sum of All Link Flows GEH < 4 for sum of all link counts
- Travel Times, Model Versus Observed
  - Travel Times, Network within 15% (or 1 minute, if higher) of > 85% of cases
- Visual Audits – Bottlenecks
  - Visually acceptable queuing – to analyst's satisfaction

The model is set to run for 5,400 simulation seconds (a simulation period of 1 hour and 30 minutes). This allows for a 30-minute "warm-up" period (0 to 1,800 seconds) where congestion can develop, and then a 60-minute period (1,800 to 5,400 seconds) when the analysis statistics are collected. The simulation resolution is set at 10 time steps per simulation second. In order to increase the confidence level of the data obtained from the simulation runs, a total of 10 simulation runs, each with a different random seed, and the average of these runs were used in the calibration. All calibration targets based on volumes and travel times were achieved. **Appendix A** shows the calibration model results.

3.2 Future Model

Following Metro and LADOT's approval of the existing model, Iteris continued with the development of the future model scenarios, including future year traffic volumes as well as the future roadway and bus operating assumptions.

3.2.1 Future Traffic Forecasts

On June 4, 2018, Iteris submitted the *2025 Opening Year Traffic Volume Forecasting Methodology* memo to Metro and can be referred to in **Appendix B**. The memo outlines the methodology for developing the a.m. and p.m. Future Opening Year 2025 traffic volumes to be used in the future model scenarios. Future traffic forecasts were developed for the following scenarios:

- Future Opening Year (2025) Without Project
- Future Opening Year (2025) Year With Project

The 2016 Southern California Association of Governments (SCAG) Regional Transportation model was utilized to develop the Future Opening Year 2025 traffic volumes. Link volumes at each MOL crossing for the model's base

year (2017) and horizon year (2040) were extracted for the a.m. and p.m. peak period. The difference in volumes represents 23 years of model volume growth at each crossing. The 23 years of traffic volume growth were factored down linearly to develop an annual average growth rate for each MOL crossing in the SCAG model. Cumulative 8-year growth rates (representing 2017 to 2025) were developed for the MOL crossing links.

In analyzing these observed traffic growth rates along the entire MOL study area, similar trends were recognized for 5 distinct subareas. An average growth rate for all the links within each of the subareas was calculated. The cumulative 8-year growth rates were applied to the 2017 traffic counts to obtain future opening year 2025 turning movement volumes.

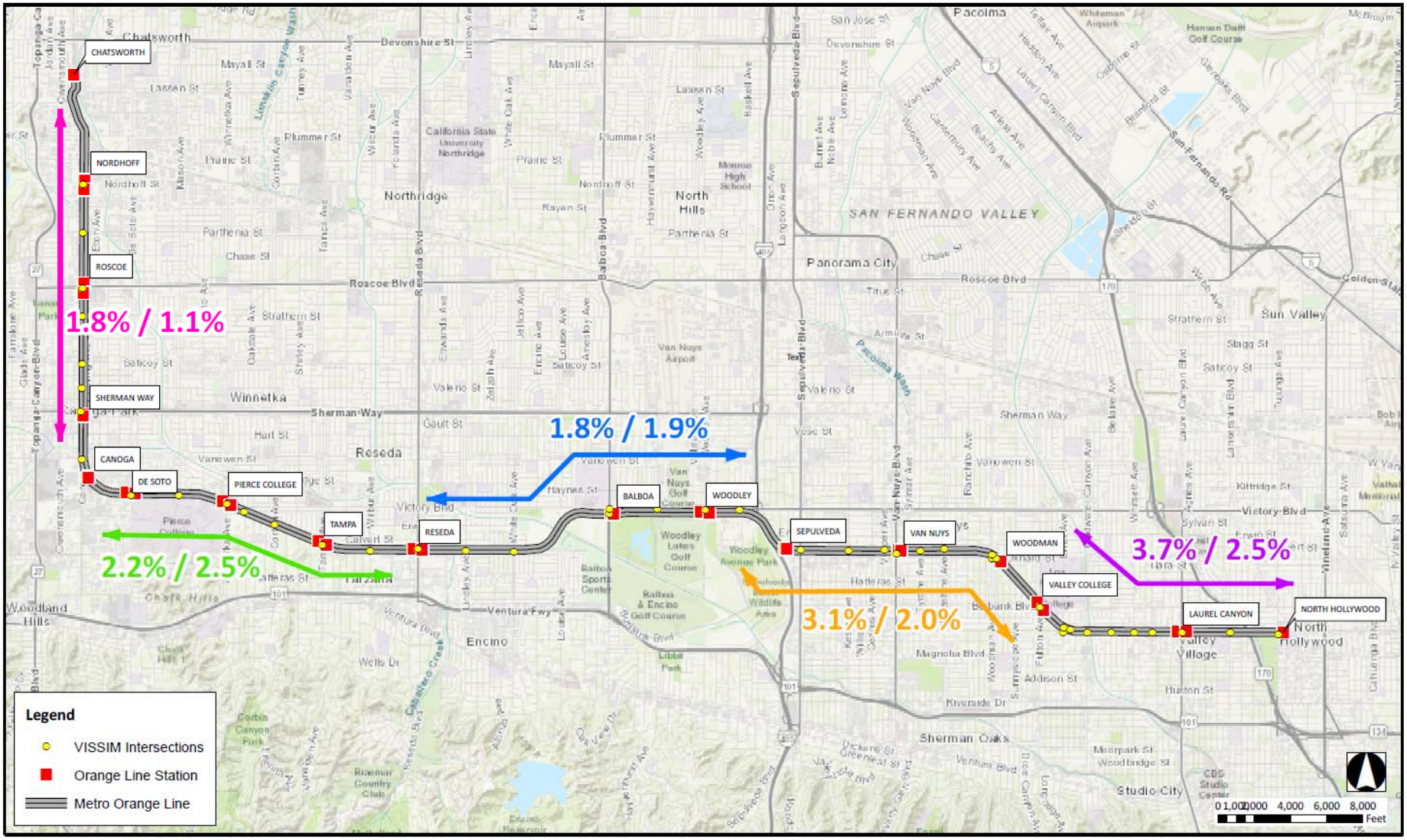
The forecasting methodology was approved by Metro and LADOT and applied to the future VISSIM models. **Table 2** presents findings from the *2025 Opening Year Traffic Volume Forecasting Methodology (see **Appendix B**)*.

Table 2 – Traffic Growth Rates by MOL Subarea

MOL Subarea	Average Annual Growth Rates (2017-2040 SCAG Model)		2017 - 2025 Total Growth Rates	
	AM	PM	AM	PM
Prairie Street to Vanowen Street	0.22%	0.14%	1.8%	1.1%
De Soto Avenue to Wilbur Avenue	0.27%	0.31%	2.2%	2.5%
Reseda Boulevard to Densmore Avenue	0.23%	0.24%	1.8%	1.9%
Sepulveda Boulevard to Woodman Avenue	0.39%	0.25%	3.1%	2.0%
Burbank Boulevard/Fulton Avenue to Tujunga Avenue	0.46%	0.31%	3.7%	2.5%

The growth rates are displayed graphically in **Figure 4**.

Figure 4 – MOL Future Volume Development 2017 -2025 Traffic Growth Rates AM/PM Peak



3.2.2 Future Opening Year (2025) Without Project Model Inputs

In addition to the model inputs listed in Section 3.1.1, the following modifications to the existing model were completed to create the Future Opening Year (2025) Without Project model:

- **Network Coding** - roadway configurations remain same as existing model, except for Winnetka Avenue where a travel lane in each direction was removed to accommodate programmed bike lanes. The Future Opening Year 2025 Without Project lane geometries in the VISSIM model are shown in **Figure 5**.
- **Signal Timing/Operations** – same as existing model
- **Traffic Volumes** – updated to reflect the Future Opening Year (2025) Without Project traffic forecasts described in Section 3.2.1.
- **MOL Bus Assumptions** – MOL corridor bus length was assumed to be 60 foot electric bus and operating speeds were assumed at 35 mph with intersection crossing speeds reduced to 15 and 25 mph depending on the location.
- **Platooning Assumptions** – No platooning bus service was assumed.
- **Dwell Time Assumptions** – The dwell times used in the existing model were incorporated into the 2025 without project model.
- **Headway Assumptions**
    - EB/WB Segment - Headway of 5 minutes with every other bus going to Chatsworth.
    - NB/SB Segment - Headway of 10 minutes for buses on the Canoga segment.

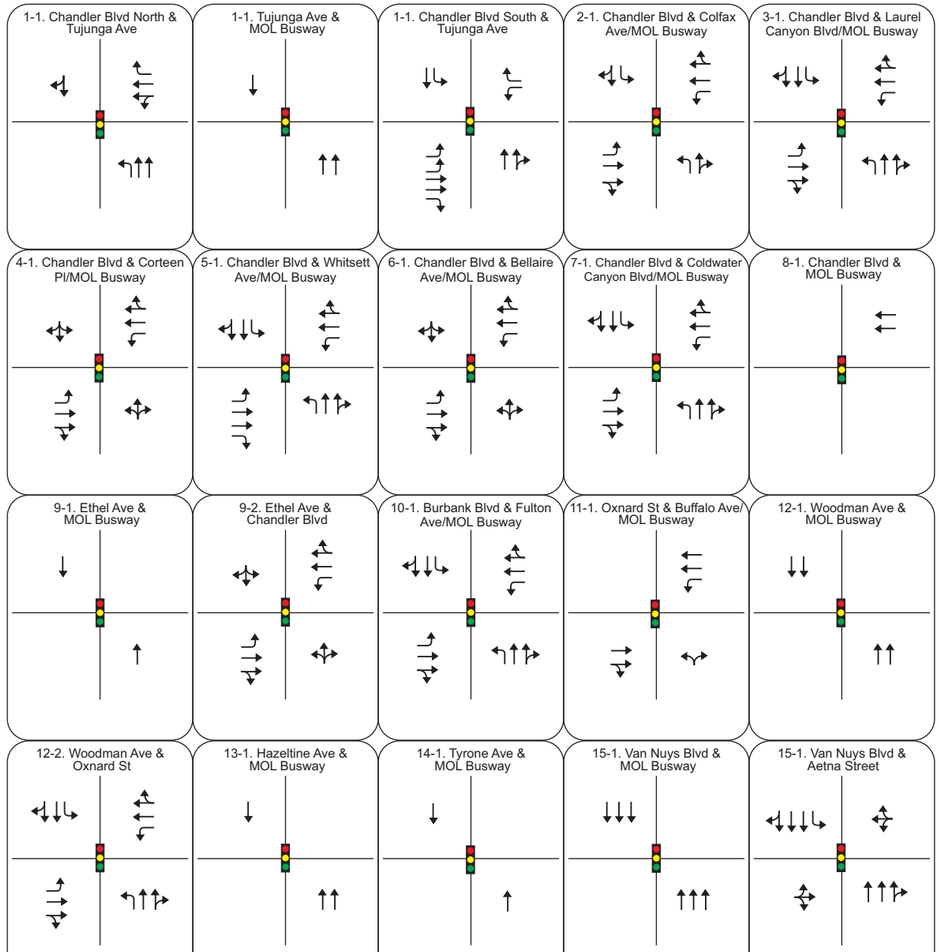
3.2.3 Future Opening Year (2025) With Project Model Inputs

In addition to the model inputs listed in Section 3.1.1, the following modifications to the existing model were completed to create the Future Opening Year (2025) With Project model:

- **Network Coding** - Future lane configurations were modified as part of the project. Gate design assumptions provided by Metro and developed by HNTB/Mott MacDonald were incorporated. Detailed design changes are detailed in **Appendix C**. The Future Opening Year (2025) With Project lane geometries in the VISSIM model are shown in **Figure 6**.
- **Signal Timing/Operations** - modified to address future design constraints such as lead-lag left turn phasing as part of the project, as well as implementation of preemption sequencing at busway intersections. The following assumptions, agreed upon with Metro and LADOT, are also detailed in Iteris' Model Design Document attached in **Appendix D**.
    - Colfax Avenue/Chandler Boulevard:
        - Northbound and southbound lead-lag left-turn phasing
        - Eastbound and westbound lead-lag left-turn phasing
    - Laurel Canyon Boulevard/Chandler Boulevard:
        - Northbound and southbound lead-lag left-turn phasing
        - Eastbound and westbound lead-lag left-turn phasing
    - Whitsett Avenue/Chandler Boulevard:
        - Northbound and southbound lead-lag left-turn phasing
        - Eastbound and westbound lead-lag left-turn phasing
    - Coldwater Canyon Avenue/Chandler Boulevard:
        - Northbound and southbound lead-lag left-turn phasing
    - Fulton Avenue/Burbank Boulevard

    - Eastbound and westbound protected left-turn phases
- **Traffic Volumes** – updated to reflect the 2025 With Project traffic forecasts described in Section 3.2.1.
- **MOL Bus Assumptions** – MOL corridor bus length was assumed to be 60 foot electric bus. The maximum operating speeds were reviewed and approved by Metro Operations staff, with the following speed limits placed on the corridor (from east to west):
    - Between North Hollywood station and Hazeltine Avenue (beginning of Van Nuys grade separation): 40 mph
    - Between Hazeltine Avenue (beginning of Van Nuys grade separation) and Vesper Avenue (end of Van Nuys grade separation): 55 mph
    - Between Vesper Avenue (end of Van Nuys grade separation) and Sepulveda station (all of Sepulveda grade separation): 45 mph
    - Between Sepulveda station and Densmore Avenue: 25 mph
    - Between Densmore Avenue and Balboa station: 45 mph
    - Between Balboa station and White Oak Avenue: 55 mph
    - Between White Oak Avenue and Chatsworth station: 45 mph

  Intersection crossing speeds were assumed to be the same as the operation speed assumptions along the corridor.
- **Platooning Assumptions** – Platooning bus service with 10 second gap between buses was agreed, in coordination with Metro.
- **Dwell Time Assumptions** – Future dwell times at individual stations were based on existing data plus 10 seconds (reduced by 5 seconds at near-side station locations to account for bus operator control), as agreed upon with Metro.
- **Headway Assumptions** – 6 minutes per direction



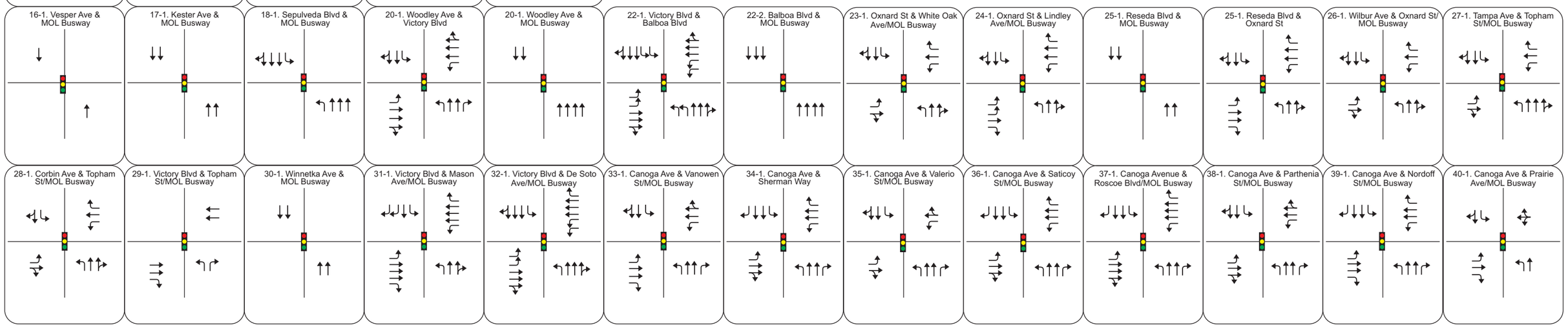
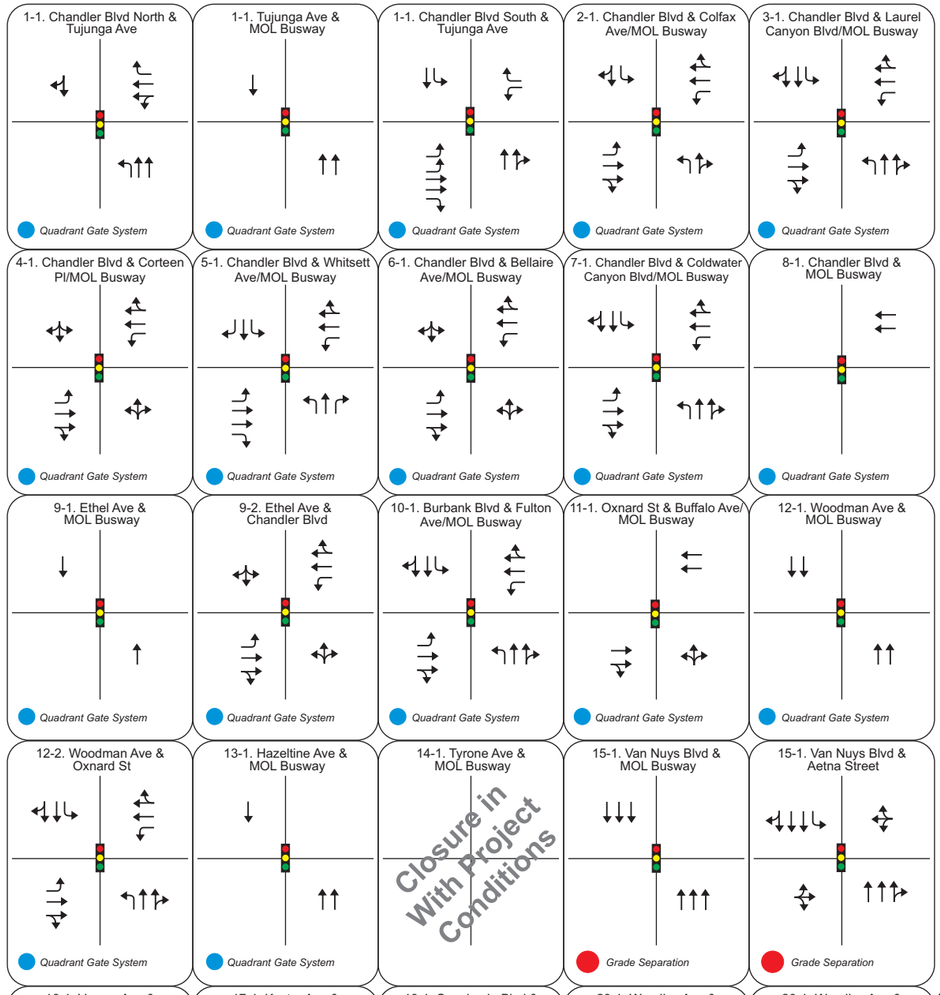


Figure 5
Future Without Project Intersection Lane Configuration



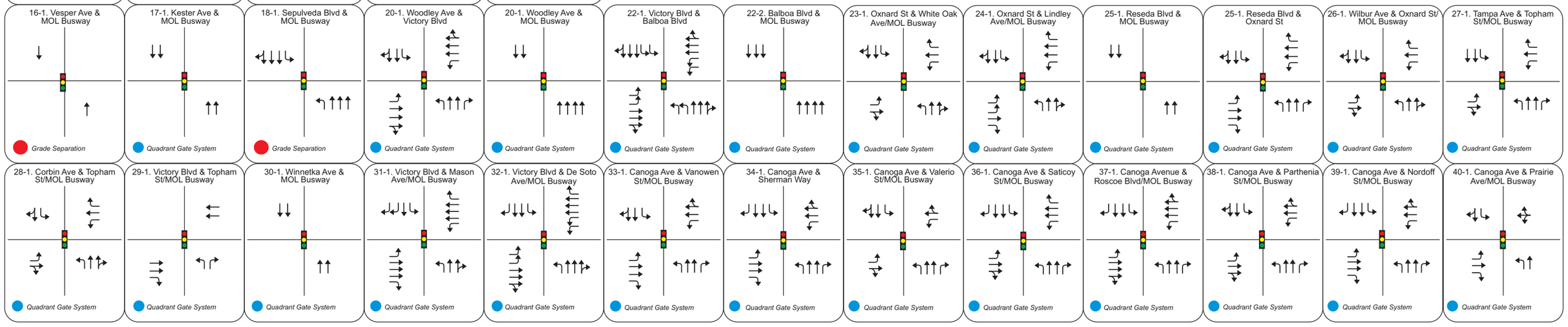
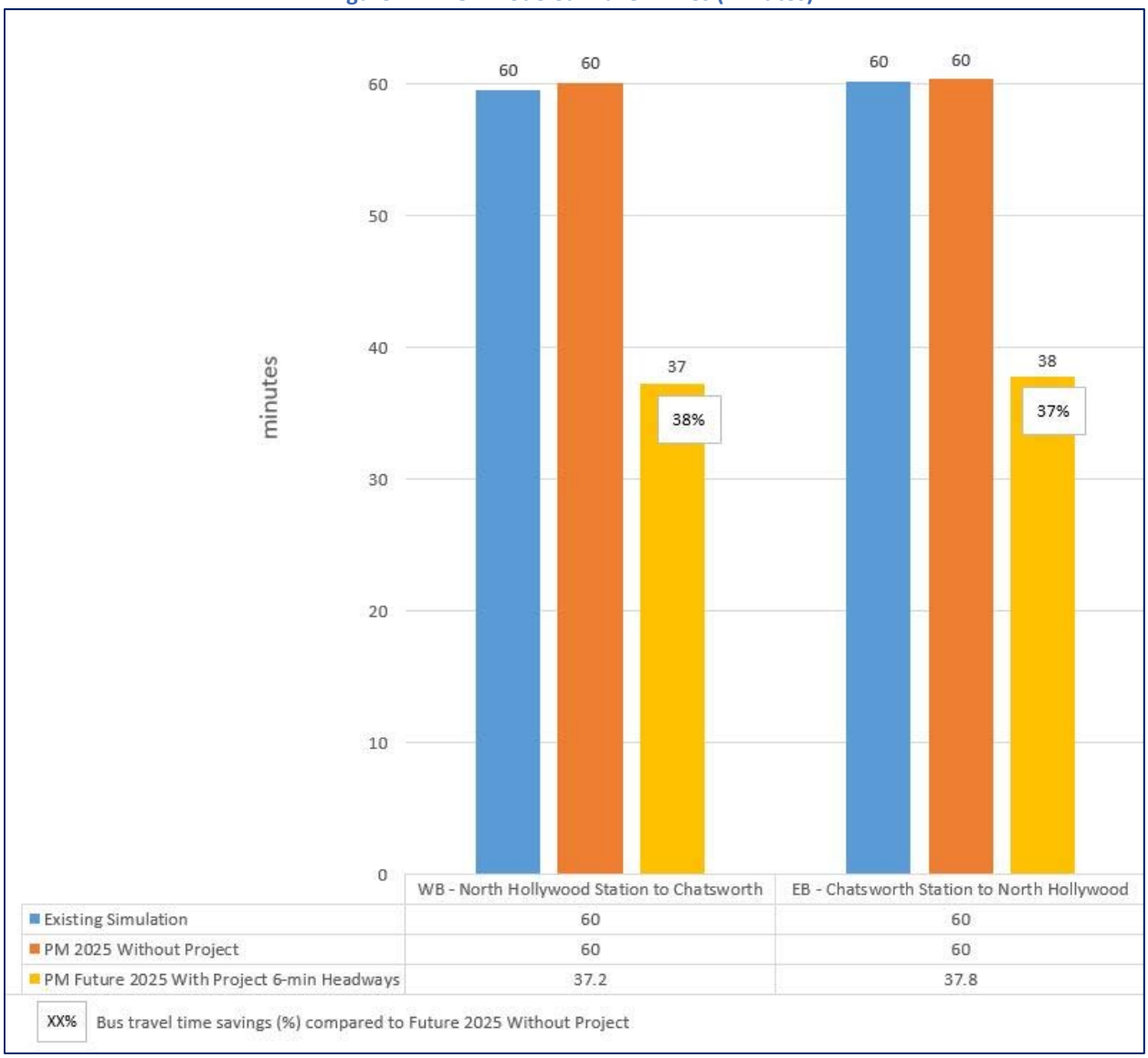


Figure 6
Future Opening Year 2025 With Project Intersection Lane Configuration

3.3 Operational Scenarios Simulation

Figure 7 presents a summary of the modeled travel times along the MOL corridor from North Hollywood to Chatsworth, under the study scenarios listed above. The bars represent the total travel time in each direction for the different scenarios.

Figure 7 – MOL Modeled Travel Times (minutes)



The figure above shows that MOL buses are forecast to experience 37% - 38% average travel time savings in the with project scenarios compared to no project.

4 TRAFFIC OPERATIONS ANALYSIS METHODOLOGY

Senate Bill (SB) 743, signed in 2013, requires a move away from vehicle delay and level of service (LOS) under CEQA transportation analysis guidelines. It requires the Governor's Office of Planning and Research (OPR) to identify new metrics for identifying and mitigating transportation impacts. OPR identified Vehicle Miles Traveled (VMT) per capita, VMT per employee, and net VMT as new metrics for transportation analysis. As mentioned in **Section 1.1**, the project is statutorily exempt from CEQA; therefore, Analysis of traffic operations were conducted utilizing LADOT's Traffic Impact Study Guidelines.

All traffic signals along the corridor operate according to timing plans developed by the Los Angeles Department of Transportation (LADOT) during the initial construction of the line. Based on signal timing plans, the existing transit signal priority (TSP) functions along the busway. The VISSIM microsimulation model developed allowed for the evaluation of traffic operations at each crossing and provided intersection delay and p.m. peak hour level of service (LOS).

The quality of traffic operations, from a vehicular perspective, is characterized using the concept of level of service (LOS). Level of service is defined by a range of grades from A (best) to F (worst), based on measurements of vehicular delay (average seconds of delay per vehicle). At intersections, LOS "A" represents relatively free operating conditions with little or no delay. LOS "F" is characterized by extremely unstable flow conditions and severe congestion with volumes at or near the intersection's design capacity. This results in long queues backing up from all approaches to intersections.

The intersection traffic operation analyses are conducted based on the Highway Capacity Manual (HCM) methodology. The LOS criteria for HCM methodology is provided in **Table 3**. The City of Los Angeles minimum standard for intersection operations is LOS "D".

Table 3 – LOS Criteria for Intersections (Control Delay per Vehicle in seconds)

LOS	Signal Control Intersection
A	≤ 10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80 or v/c > 1

4.1 Thresholds of Significance

LADOT's threshold of significance is used in this study to identify the need for additional improvement measures that would minimize project traffic impacts. LADOT's threshold criteria determines if a project would result in substantial traffic impacts based on the criteria shown in **Table 4**.

Table 4 – LADOT Transportation Impact Thresholds for Transportation Infrastructure Projects

Level of Service	Final Delay	Project-Related Increase in Delay
C	>20-35	equal to or greater than 6.0 seconds
D	>35-55	equal to or greater than 4.0 seconds
E	>55-80	equal to or greater than 2.5 seconds
F	>80	equal to or greater than 2.5 seconds

Metro has identified the 6-minute scenario as the preferred "with project" scenario; therefore, this is the scenario used to identify project related impacts.

4.2 Intersection Operating Conditions

Table 5 summarizes the overall intersection operations for the p.m. peak hour as collected from the VISSIM model scenario output results. Detailed intersection queuing results are presented in **Appendix E**.

The following intersections perform at LOS E or worse:

- Existing Conditions:
  - No intersections operate at LOS E or worse
- Future Opening Year (2025) Without Project
  - No intersections operate at LOS E or worse
- Future Opening Year (2025) With Project 6-min headway plus bus platooning:
  - Chandler North/MOL Busway/Chandler South/Tujunga Avenue
  - Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway
  - Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway
  - Burbank Boulevard/Fulton Avenue/MOL Busway
  - Woodley Avenue/Victory Boulevard/MOL Busway
  - Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street
  - Tampa Avenue/Topham Street/MOL Busway
  - Victory Boulevard/De Soto Avenue/MOL Busway
  - Canoga Avenue/Vanowen Street/MOL Busway
  - Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue
  - Canoga Avenue/Nordhoff Street/MOL Busway

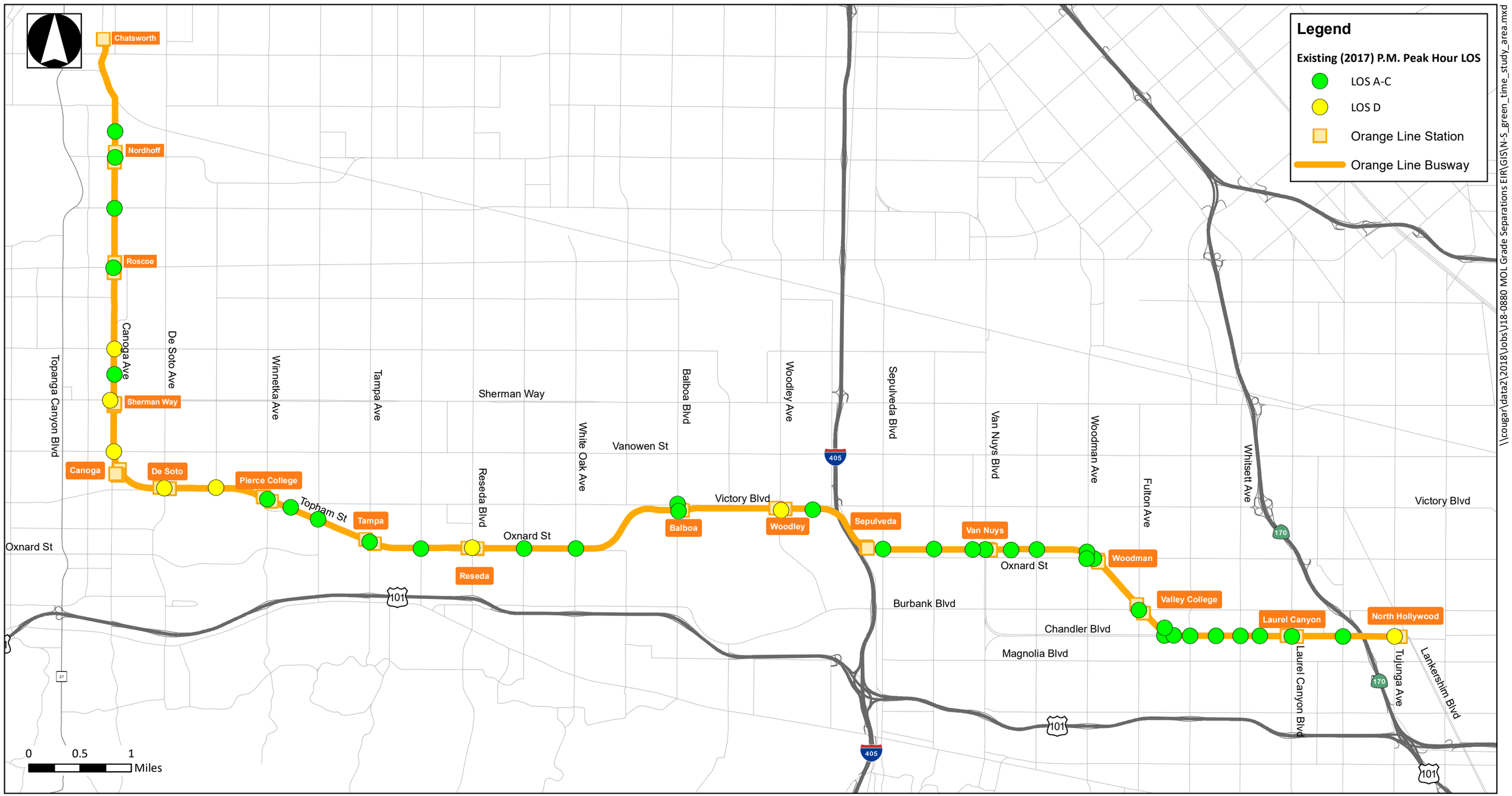
Figures 8 thru **10** present graphically the study intersection p.m. peak hour LOS.

Table 5 – P.M. Peak Hour Intersection Operations Summary

Number	Intersection Name	Existing		Future Opening Year 2025 No Project		Future Opening Year 2025 With Project 6-min Headway	
		Delay	LOS	Delay	LOS	Delay	LOS
1-1	Chandler North/MOL Busway/Chandler South/Tujunga Avenue	37.0	D	36.8	D	**55.2**	**E**
2-1	Chandler Boulevard/Colfax Avenue/MOL Busway	30.4	C	30.1	C	49.4	D
3-1	Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway	31.9	C	30.6	C	**74.9**	**E**
4-1	Chandler Boulevard/Corteen Place/MOL Busway	9.9	A	10.4	B	49.8	D
5-1	Chandler Boulevard/Whitsett Avenue/MOL Busway	30.5	C	28.7	C	51.0	D
6-1	Chandler Boulevard/Bellaire Avenue/MOL Busway	7.2	A	7.4	A	15.6	B
7-1	Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway	33.0	C	31.1	C	**55.7**	**E**
8-1	Chandler Boulevard/MOL Busway	5.3	A	5.3	A	5.8	A
9-1	Ethel Avenue/MOL Busway	9.0	A	8.7	A	11.8	B
9-2	Ethel Avenue/Chandler Boulevard	4.9	A	5.0	A	9.0	A
10-1	Burbank Boulevard/Fulton Avenue/MOL Busway	21.7	C	19.9	C	**59.3**	**E**
11-1	Oxnard Street/Buffalo Avenue/MOL Busway	3.2	A	3.2	A	14.7	B
12-1	Woodman Avenue/MOL Busway	3.0	A	3.3	A	8.8	A
12-2	Woodman Avenue/Oxnard Street	21.1	C	21.0	C	48.0	D
13-1	Hazeltine Avenue/MOL Busway	3.8	A	3.9	A	7.4	A
14-1	Tyrone Avenue/MOL Busway	2.9	A	3.1	A	1.1	A
15-1	Van Nuys Boulevard/MOL Busway/Aetna Street	8.1	A	8.0	A	7.7	A
16-1	Vesper Avenue/MOL Busway	4.7	A	5.0	A	0.7	A
17-1	Kester Avenue/MOL Busway	1.3	A	1.3	A	5.4	A
18-1	Sepulveda Boulevard/MOL Busway	3.6	A	3.9	A	4.7	A
19-1	Victory Boulevard/Densmore Avenue	4.3	A	4.5	A	10.9	B
20-1	Woodley Avenue/Victory Boulevard/MOL Busway	41.6	D	44.6	D	**59.8**	**E**
22-1	Victory Boulevard/Balboa Boulevard	29.2	C	29.0	C	41.5	D
22-2	Balboa Boulevard/MOL Busway	9.3	A	9.5	A	19.4	B

Number	Intersection Name	Existing		Future Opening Year 2025 No Project		Future Opening Year 2025 With Project 6-min Headway	
		Delay	LOS	Delay	LOS	Delay	LOS
23-1	Oxnard Street/White Oak Avenue/MOL Busway	25.3	C	26.4	C	37.9	D
24-1	Oxnard Street/Lindley Avenue/MOL Busway	29.2	C	29.5	C	33.2	C
25-1	Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street	39.7	D	39.6	D	**102.1**	**F**
26-1	Wilbur Avenue/Oxnard Street/MOL Busway	33.8	C	33.9	C	37.1	D
27-1	Tampa Avenue/Topham Street/MOL Busway	28.8	C	29.6	C	**58.4**	**E**
28-1	Corbin Avenue/Topham Street/MOL Busway	29.2	C	29.3	C	42.6	D
29-1	Victory Boulevard/Topham Street/MOL Busway	12.0	B	12.6	B	26.5	C
30-1	Winnetka Avenue/MOL Busway	3.1	A	3.5	A	3.2	A
31-1	Victory Boulevard/Mason Avenue/MOL Busway	35.2	D	37.0	C	48.0	D
32-1	Victory Boulevard/De Soto Avenue/MOL Busway	49.8	D	50.4	D	**70.4**	**E**
33-1	Canoga Avenue/Vanowen Street/MOL Busway	42.0	D	37.6	D	**86.5**	**F**
34-1	Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue	40.2	D	42.3	D	**115.6**	**F**
35-1	Canoga Avenue/Valerio Street/MOL Busway	19.0	B	19.0	B	39.5	D
36-1	Canoga Avenue/Saticoy Street/MOL Busway	36.1	D	36.9	D	40.1	D
37-1	Canoga Avenue/Roscoe Boulevard/MOL Busway	28.9	C	29.5	C	36.3	D
38-1	Canoga Avenue/Parthenia Street/MOL Busway	31.7	C	31.8	C	51.9	D
39-1	Canoga Avenue/Nordhoff Street/MOL Busway	30.4	C	30.6	C	**57.3**	**E**
40-1	Canoga Avenue/Prairie Avenue/MOL Busway	7.0	A	7.0	A	11.9	B

Note: Intersections with LOS E or F are highlighted as deficient per LADOT guidelines.



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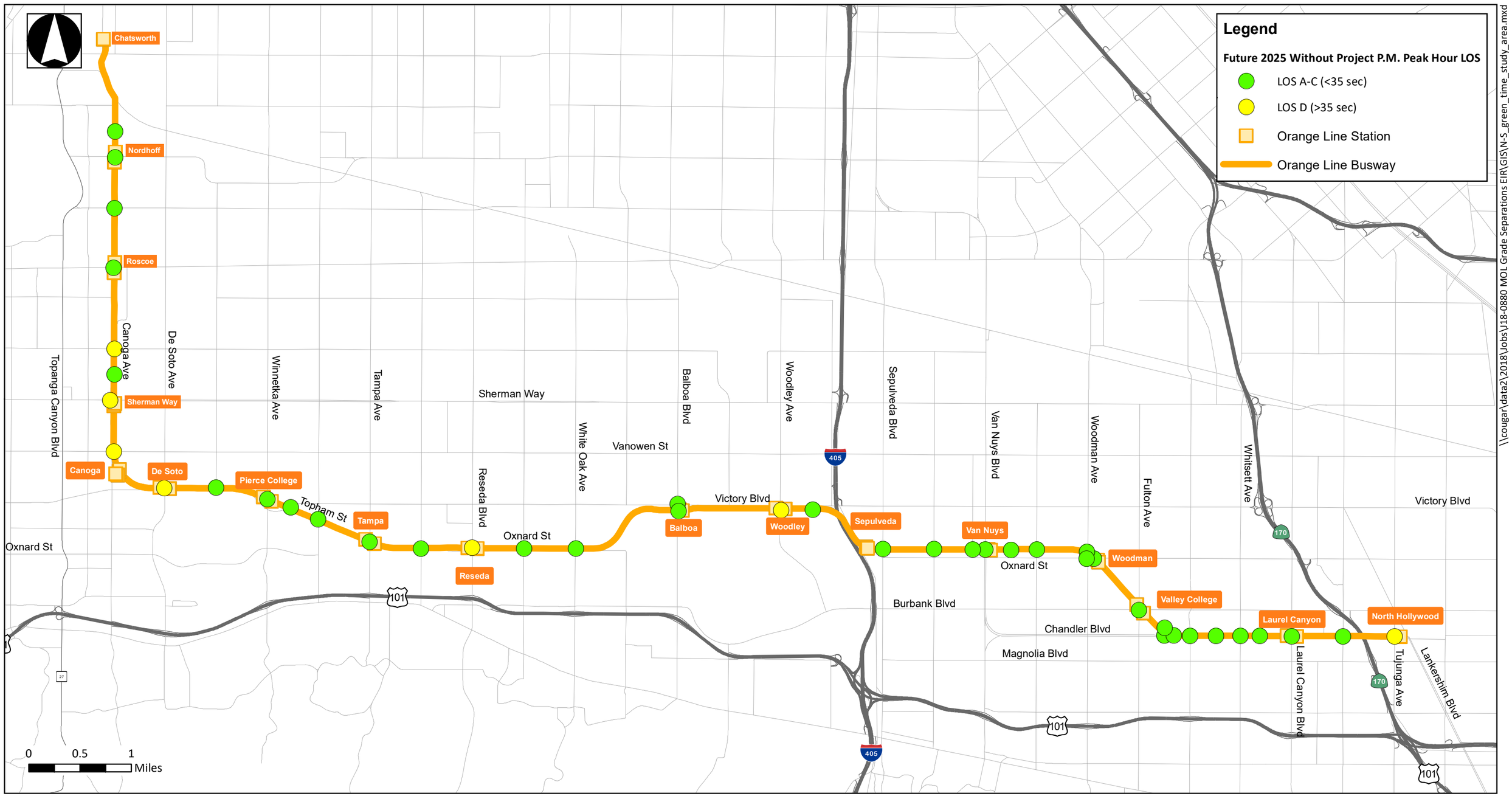
Metro Orange Line BRT Improvements Study
Traffic Analysis

Figure 8
Existing P.M. Peak Hour Intersection LOS Conditions



Metro Orange Line BRT Improvements Study
Traffic Analysis

Figure 9
Future Opening Year 2025 Without Project P.M. Peak Hour Intersection LOS

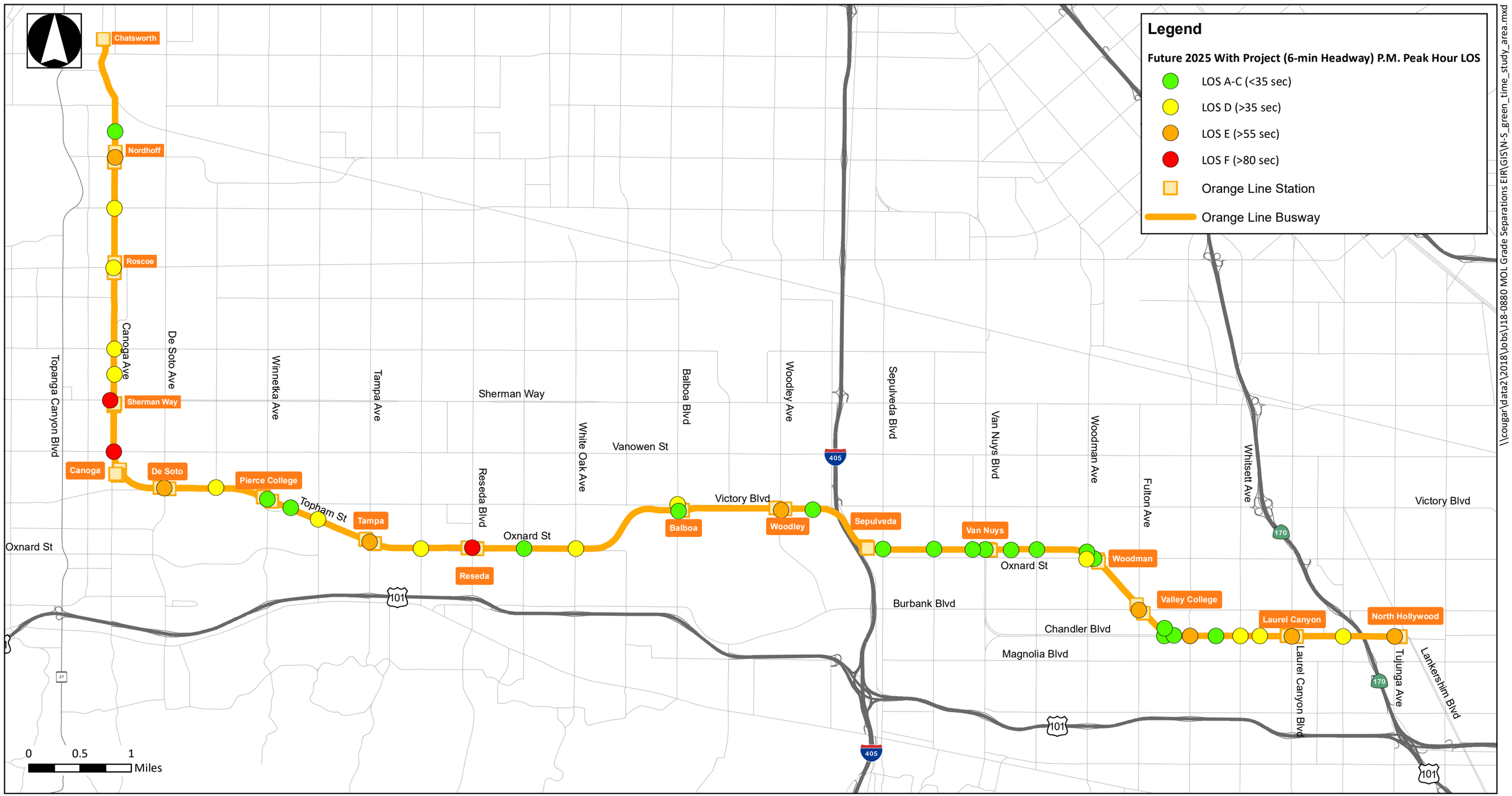


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Figure 10
Future Opening Year 2025 With Project 6-Minute Headway P.M. Peak Hour LOS Conditions

4.3 Project Related Impacts

Based on LADOT's project impact threshold criteria described in Section 4.1, a total of 23 out of 42 intersections are forecaste to result in project-related traffic impacts under the Future Opening Year (2025) With Project 6-Minute Headway:

- Chandler North/MOL Busway/Chandler South/Tujunga Avenue;
- Chandler Boulevard/Colfax Avenue/MOL Busway;
- Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway;
- Chandler Boulevard/Corteen Place/MOL Busway;
- Chandler Boulevard/Whitsett Avenue/MOL Busway;
- Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway;
- Burbank Boulevard/Fulton Avenue/MOL Busway;
- Woodman Avenue/Oxnard Street;
- Woodley Avenue/Victory Boulevard/MOL Busway;
- Victory Boulevard/Balboa Boulevard;
- Oxnard Street/White Oak Avenue/MOL Busway;
- Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street;
- Tampa Avenue/Topham Street/MOL Busway;
- Corbin Avenue/Topham Street/MOL Busway;
- Victory Boulevard/Topham Street/MOL Busway;
- Victory Boulevard/Mason Avenue/MOL Busway;
- Victory Boulevard/De Soto Avenue/MOL Busway;
- Canoga Avenue/Vanowen Street/MOL Busway;
- Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue;
- Canoga Avenue/Valerio Street/MOL Busway;
- Canoga Avenue/Roscoe Boulevard/MOL Busway;
- Canoga Avenue/Parthenia Street/MOL Busway; and
- Canoga Avenue/Nordhoff Street/MOL Busway.

Table 6 presents delay and LOS results for all study intersections.

Table 6 – Future Opening Year 2025 With Project 6-Minute Headway Traffic Impacts (P.M. Peak Hour)

Number	Intersection Name	Future Opening Year 2025 No Project		Future Opening Year 2025 With Project 6-min Headway		Delay Difference (sec)	Project Related Impact?
		Delay	LOS	Delay	LOS		
1-1	Chandler North/MOL Busway/Chandler South/Tujunga Avenue	36.8	D	**55.2**	**E**	18.4	**Yes**
2-1	Chandler Boulevard/Colfax Avenue/MOL Busway	30.1	C	49.4	D	19.3	**Yes**
3-1	Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway	30.6	C	**74.9**	**E**	44.3	**Yes**
4-1	Chandler Boulevard/Corteen Place/MOL Busway	10.4	B	49.8	D	39.4	**Yes**
5-1	Chandler Boulevard/Whitsett Avenue/MOL Busway	28.7	C	51.0	D	22.4	**Yes**
6-1	Chandler Boulevard/Bellaire Avenue/MOL Busway	7.4	A	15.6	B	8.1	No
7-1	Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway	31.1	C	**55.7**	**E**	24.7	**Yes**
8-1	Chandler Boulevard/MOL Busway	5.3	A	5.8	A	0.5	No
9-1	Ethel Avenue/MOL Busway	8.7	A	11.8	B	3.0	No
9-2	Ethel Avenue/Chandler Boulevard	5.0	A	9.0	A	4.0	No
10-1	Burbank Boulevard/Fulton Avenue/MOL Busway	19.9	C	**59.3**	**E**	39.4	**Yes**
11-1	Oxnard Street/Buffalo Avenue/MOL Busway	3.2	A	14.7	B	11.5	No
12-1	Woodman Avenue/MOL Busway	3.3	A	8.8	A	5.5	No
12-2	Woodman Avenue/Oxnard Street	21.0	C	48.0	D	27.1	**Yes**
13-1	Hazeltine Avenue/MOL Busway	3.9	A	7.4	A	3.5	No
14-1	Tyrone Avenue/MOL Busway	3.1	A	1.1	A	-1.9	No
15-1	Van Nuys Boulevard/MOL Busway/Aetna Street	8.0	A	7.7	A	-0.3	No
16-1	Vesper Avenue/MOL Busway	5.0	A	0.7	A	-4.4	No
17-1	Kester Avenue/MOL Busway	1.3	A	5.4	A	4.1	No
18-1	Sepulveda Boulevard/MOL Busway	3.9	A	4.7	A	0.8	No
19-1	Victory Boulevard/Densmore Avenue	4.5	A	10.9	B	6.4	No
20-1	Woodley Avenue/Victory Boulevard/MOL Busway	44.6	D	**59.8**	**E**	15.2	**Yes**
22-1	Victory Boulevard/Balboa Boulevard	29.0	C	41.5	D	12.5	**Yes**
22-2	Balboa Boulevard/MOL Busway	9.5	A	19.4	B	10.0	No
23-1	Oxnard Street/White Oak Avenue/MOL Busway	26.4	C	37.9	D	11.5	**Yes**

Number	Intersection Name	Future Opening Year 2025 No Project		Future Opening Year 2025 With Project 6-min Headway		Delay Difference (sec)	Project Related Impact?
		Delay	LOS	Delay	LOS		
24-1	Oxnard Street/Lindley Avenue/MOL Busway	29.5	C	33.2	C	3.8	No
25-1	Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street	39.6	D	**102.1**	**F**	62.5	**Yes**
26-1	Wilbur Avenue/Oxnard Street/MOL Busway	33.9	C	37.1	D	3.2	No
27-1	Tampa Avenue/Topham Street/MOL Busway	29.6	C	**58.4**	**E**	28.8	**Yes**
28-1	Corbin Avenue/Topham Street/MOL Busway	29.3	C	42.6	D	13.3	**Yes**
29-1	Victory Boulevard/Topham Street/MOL Busway	12.6	B	26.5	C	13.9	**Yes**
30-1	Winnetka Avenue/MOL Busway	3.5	A	3.2	A	-0.3	No
31-1	Victory Boulevard/Mason Avenue/MOL Busway	37.0	C	48.0	D	11.0	**Yes**
32-1	Victory Boulevard/De Soto Avenue/MOL Busway	50.4	D	**70.4**	**E**	20.0	**Yes**
33-1	Canoga Avenue/Vanowen Street/MOL Busway	37.6	D	**86.5**	**F**	48.8	**Yes**
34-1	Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue	42.3	D	**115.6**	**F**	73.3	**Yes**
35-1	Canoga Avenue/Valerio Street/MOL Busway	19.0	B	39.5	D	20.5	**Yes**
36-1	Canoga Avenue/Saticoy Street/MOL Busway	36.9	D	40.1	D	3.2	No
37-1	Canoga Avenue/Roscoe Boulevard/MOL Busway	29.5	C	36.3	D	6.8	**Yes**
38-1	Canoga Avenue/Parthenia Street/MOL Busway	31.8	C	51.9	D	20.2	**Yes**
39-1	Canoga Avenue/Nordhoff Street/MOL Busway	30.6	C	**57.3**	**E**	26.7	**Yes**
40-1	Canoga Avenue/Prairie Avenue/MOL Busway	7.0	A	11.9	B	4.9	No

Note: Intersections with LOS E or F are highlighted as deficient per LADOT guidelines.

5 POTENTIAL MITIGATION MEASURES

As described in Section 4.2, the proposed improvements to the MOL busway are forecasted to result in traffic impacts (as defined by LADOT thresholds of significance). The following is a list of potential improvement and mitigation measure types that were considered in order to address traffic impacts:

- **Restriping lanes** on a roadway's approach to an intersection to increase capacity for certain vehicle movements. This can be accomplished either through conversion of an existing lanes or, where right-of-way (ROW) permits, creating an additional lane. Roadway width and impacts on competing vehicle movements, parking, access to properties, circulation, and others need to be considered when restriping.
- **Modifying traffic signal patterns** to give a dedicated phase and/or additional time to certain vehicle movements. Impacts on competing vehicle movements and coordination with other traffic signals or modes of transportation need to be considered when modifying traffic signal patterns.
- **Roadway widening** to create additional ROW and increase capacity for vehicle movements. This is a costly mitigation tool that is best applied when impacts on intersection performance are severe. Additional ROW may not be available depending on locational context along the Orange Line corridor.

Based on the considerations, an in coordination with LADOT, the following feasible mitigation measures, shown by impacted intersection, were proposed, implemented and tested in the VISSIM model:

- Chandler North/MOL Busway/Chandler South/Tujunga Avenue;
  - Eliminate NBL/SBL turn movements along Tujunga NB/SB to Chandler
  - Modify preemption exit phasing to Phases 3 (WBL) and 8 (WBT)
- Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway;
  - Modify traffic signal patterns (switch lead/lag so that EBL leads and WBL lags)
  - Increase EBL phase time and reduce WBT phase time
- Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway;
  - Optimize EBL/WBL timings
  - Switch NBT/NBL to lead instead of SBT/SBL
- Burbank Boulevard/Fulton Avenue/MOL Busway;
  - Convert NBL/SBL to protected/permissive phases
- Woodley Avenue/Victory Boulevard/MOL Busway;
  - Modify preemption dwell phasing for Phase 7 (SBL) to be active
  - Increase SBL phase time and reduce NBT phase time
- Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street;
  - Re-striping to add a 2nd NBL lane at Reseda/Oxnard
  - Optimize timing primarily to improve NBL/SBL operations
  - Modify preemption scheme to allow Phase 3 (NBL) to run during preemption
- Tampa Avenue/Topham Street/MOL Busway;
  - Modify traffic signal patterns to allow the NB approach to be exit phase
- Corbin Avenue/Topham Street/MOL Busway;
  - Add a 100' NBR right-turn pocket along Corbin
- Victory Boulevard/Mason Avenue/MOL Busway;

    - Modify traffic signal patterns (switch EBL/WBL lead/lag so that EBL leads and WBL lags)
    - Add a 100' NB right-turn pocket along Mason and NBR overlap phase when the WBL phase is active
- Victory Boulevard/De Soto Avenue/MOL Busway;
    - Modify traffic signal patterns (switch EBL/WBL lead/lag so that EBL leads and WBL lags)
    - Increase WBL phase time and reduce EBT phase time
- Canoga Avenue/Vanowen Street/MOL Busway;
    - Add an EBR overlap and optimize timing primarily to improve NBL/SBL operations
    - Modify preemption scheme to allow Phases 4 (WBT) and 7 (WBL) to alternate with Phases 3 (EBL) and 8 (EBT) during exit phasing
    - Increase SBL phase time and reduce NBT phase time
    - Add Phase 3 (EBL) to preemption dwell
- Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue;
    - Modify preemption scheme to allow Phases 4 (WBT) and 7 (WBL) to alternate with Phases 3 (EBL) and 8 (EBT) during exit phasing
    - Increase SBL phase time and reduce NBT phase time
    - Add Phase 3 (EBL) to preemption dwell
- Canoga Avenue/Valerio Street/MOL Busway;
    - Extend SBL turn pocket an extra 100'
    - Re-stripe WBL to remove the striped buffer between the busway and Deering
    - Modify preemption scheme to allow Phase 1 (SBL) during exit phasing
- Canoga Avenue/Roscoe Boulevard/MOL Busway;
    - Modify preemption scheme to allow Phase 1 (SBL) during exit phasing
    - Modify preemption exit phasing to Phases 3 (EBL) and 8 (EBT)
    - Add Phase 3 (EBL) to preemption dwell
- Canoga Avenue/Parthenia Street/MOL Busway;
    - Modify preemption scheme to allow Phase 1 (SBL) during exit phasing
    - Modify preemption exit phasing to Phases 1 (SBL) and Phases 3 (EBL) and 8 (EBT) (alternating)
    - Add Phase 3 (EBL) to preemption dwell
- Canoga Avenue/Nordhoff Street/MOL Busway
    - Re-stripe roadway to add a 2nd SBL pocket and a 2nd EBL pocket
    - Modify preemption scheme to allow Phase 1 (SBL) during exit phasing
    - Modify preemption exit phasing to Phases 4 (WBT) and 7 (WBL) and 3 (EBL) and 8 (EBT) (alternating)
    - Add Phase 3 (EBL) to preemption dwell
    - Increase WBL phase time and reduce EBT phase time

Table 7 presents the LOS results at the intersections where feasible improvement measures were implemented.

Table 7 – Future Opening Year 2025 With Project With Improvements 6-Minute Headway Traffic Impacts (P.M. Peak Hour)

Number	Intersection Name	Future Opening Year 2025 No Project		Future Opening Year 2025 With Project With Improvements 6-min Headway		Delay Difference (sec)	Project Related Impact?
		Delay	LOS	Delay	LOS		
1-1	Chandler North/MOL Busway/Chandler South/Tujunga Avenue	36.8	D	**55.4**	**E**	18.6	**Yes**
3-1	Chandler Boulevard/Laurel Canyon Boulevard/MOL Busway	30.6	C	**65.1**	**E**	34.5	**Yes**
7-1	Chandler Boulevard/Coldwater Canyon Boulevard/MOL Busway	31.1	C	46.9	D	15.8	Yes
10-1	Burbank Boulevard/Fulton Avenue/MOL Busway	19.9	C	**60.2**	**E**	40.3	**Yes**
20-1	Woodley Avenue/Victory Boulevard/MOL Busway	44.6	D	**55.8**	**E**	11.2	**Yes**
25-1	Reseda Boulevard/Bessemer Street/MOL Busway/Oxnard Street	39.6	D	**93.5**	**F**	53.9	**Yes**
27-1	Tampa Avenue/Topham Street/MOL Busway	29.6	C	35.2	D	5.5	**Yes**
28-1	Corbin Avenue/Topham Street/MOL Busway	29.3	C	43.4	D	14.1	**Yes**
31-1	Victory Boulevard/Mason Avenue/MOL Busway	37.0	C	34.9	C	-2.1	No
32-1	Victory Boulevard/De Soto Avenue/MOL Busway	50.4	D	**69.1**	**E**	18.6	**Yes**
33-1	Canoga Avenue/Vanowen Street/MOL Busway	37.6	D	**82.1**	**F**	44.4	**Yes**
34-1	Canoga Avenue/Sherman Way/MOL Busway/Deering Avenue	42.3	D	**86.5**	**F**	44.2	**Yes**
35-1	Canoga Avenue/Valerio Street/MOL Busway	19.0	B	37.1	D	18.1	**Yes**
37-1	Canoga Avenue/Roscoe Boulevard/MOL Busway	29.5	C	36.7	D	7.2	**Yes**
38-1	Canoga Avenue/Parthenia Street/MOL Busway	31.8	C	52.2	D	20.4	**Yes**
39-1	Canoga Avenue/Nordhoff Street/MOL Busway	30.6	C	46.5	D	15.9	**Yes**

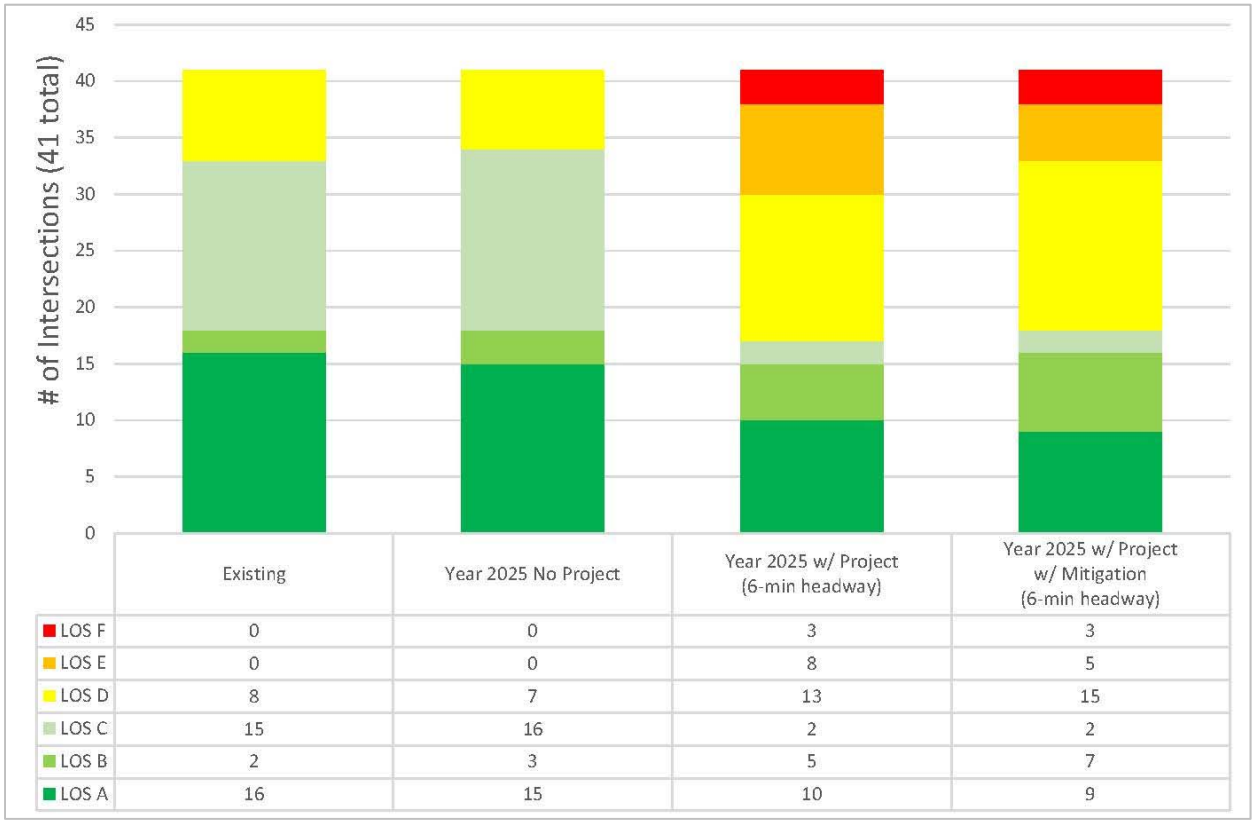
Note: Intersections with LOS E or F are highlighted as deficient per LADOT guidelines.

6 CONCLUSIONS

The MOL BRT Improvements Traffic Analysis evaluated traffic operations at 42 intersections along the MOL busway during existing and future opening year 2025 conditions. The project, as approved by Metro Board, consists of up to 35 four-quadrant gates, four gate and a swing gate combination at pedestrian crossings along the busway, closure of Tyrone Avenue, and grade separation improvements.

Figure 11 presents a summary of intersection operating conditions for each scenario as presented in previous sections. In the existing conditions scenario, no intersections are operating at LOS E or worse. Under the future opening year (2025) without project scenario, no intersections are forecast to operate at LOS E or worse. With the implementation of the project (6-minute bus headway), eleven intersections are forecat to operate at LOS E or worse. With implementation of the improvement measures, eight intersections are forecast operate at LOS E or worse.

Figure 11 – Summary of Intersection Level of Service (LOS) Conditions



	Existing	Year 2025 No Project	Year 2025 w/ Project (6-min headway)	Year 2025 w/ Project w/ Mitigation (6-min headway)
LOS F	0	0	3	3
LOS E	0	0	8	5
LOS D	8	7	13	15
LOS C	15	16	2	2
LOS B	2	3	5	7
LOS A	16	15	10	9