



# **Level of Service and Performance Measure Monitoring Report - 2019**

**November 2019**

*Submitted by:*  
**CoPLAN** – *The Planning Collaborative*  
5508 Sandalwood  
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October 10, 2019

City/County Association of Governments of San Mateo County  
County Office Building  
555 County Center  
Fifth Floor  
Redwood City, California 94063  
Attention: Jeffrey Lacap, Transportation Programs Specialist

**Re: Level of Service and Performance Measure Monitoring Report - 2019**

Dear Mr. Lacap:

CoPLAN, LLC. (CoPLAN) is pleased to submit the report for the 2019 Level of Service (LOS) and Performance Measure Monitoring to support of the 2019 Congestion Management Program for the City/County Association of Governments of San Mateo County (C/CAG).

CoPLAN conducted the 2019 study for C/CAG utilizing the latest technology for performing CMP studies. Our extensive and unique experience provides a cost-effective and cutting edge process to obtain and analyze traffic data. CoPLAN has developed a methodology including GPS and GIS over the past 15 years with exciting results. The addition of GIS linear reference systems has added a component that is unique to CoPLAN for network analyses. Over the last 4 update cycles, CoPLAN staff have developed a comprehensive database for C/CAG that now is integrated in GIS for easy access and historic comparisons.

C/CAG has taken a major step forward in having the ability to take the GIS data, in addition to the historic tables, and integrate the digital data with your travel demand model. The speeds, roadway attributes, etc. can be conflated with the model to produce a very robust and comprehensive system. This was not available in the past because the methodology used with tables and charts did not produce the value-added products of this 2019 study. CoPLAN will continue to support C/CAG to produce the best value that not only meets the intended LOS monitoring requirements to allow historic comparisons of this project, but produces the results in a form that can be used by many other areas within the county and by its members.

Sincerely,  
CoPLAN, LLC

Steve Taylor  
Project Manager

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## A. EXECUTIVE SUMMARY

The City/County Association of Governments of San Mateo County (C/CAG) has an established Congestion Management Program (CMP) to monitor the transportation network within the county. All roadways included in the CMP network are evaluated for conformity at least every two years.

The goal of the monitoring program is to improve the performance of the transportation system by identifying congested areas and related transportation deficiencies. This information is then used to help prioritize transportation funding decisions based on system performance, land use factors, multimodal characteristics, and other considerations.

This year's monitoring study was conducted in the spring 2019 with data collection between April and May including INRIX data on approximately 163.3 directional miles of freeways and arterials, 72-hour counts on 21 segments representing 301.4 centerline miles of arterials, and 16 intersection turning movement counts.

This is the third monitoring cycle during which the C/CAG has used commercially available travel speed data from INRIX integrated in a geographic information system (GIS) to monitor Level of Service (LOS) on the CMP network. The primary tasks completed as part of this study include:

- Conflation of travel time data to LOS Monitoring network
- LOS Analysis

With the 2019 monitoring cycle, C/CAG is calculating LOS based on two methodologies—Highway Capacity Manual (HCM) 1994 and HCM 2010. This dual reporting facilitates historical comparisons while also reporting LOS based on the more current methodology. For freeways, only HCM 1994 LOS is reported, as the HCM 2000 methodology requires traffic volume information for all unique freeway segments and ramps. The HCM 2010 criteria was used only for the intersection LOS using the collected peak period turning movement counts analyzed in Synchro. Collection of comprehensive freeway traffic volumes is beyond the scope of the CMP monitoring effort.

## B. INTRODUCTION

### History of the Congestion Management Program

C/CAG has an established Congestion Management Program (CMP) to monitor the transportation network within the county. All roadways included in the CMP network are evaluated for conformity at least every two years by the agency, which is the designated Congestion Management Agency (CMA) for San Mateo County. The goal of the monitoring program is to improve the performance of the transportation system by identifying congested areas and related transportation deficiencies. This information is then used to help prioritize transportation funding decisions in light of system performance, land use factors, multimodal characteristics, and other considerations.

This year's study was conducted in the spring of 2019 with travel time data from INRIX being used between April and May. The most recent assessment prior to this study was performed in April - May 2017. The primary tasks completed as part of this study include:

- Conflation of travel time data to LOS Monitoring network
- Level of Service Analysis

### Study Background

This year's monitoring study was conducted in the spring 2019 with data sourced between April and May on approximately 163.3 directional miles of freeways and arterials, 72-hour counts on 21 segments representing 301.4 centerline miles of arterials, and 16 intersection turning movement counts. CMP legislation requires that state highways (including freeways) and principal arterials be included in the CMP network. The network must be useful to track the transportation impacts of land development decisions, as well as to help assess the congestion management implications of proposed transportation projects. C/CAG's network therefore includes numerous local thoroughfares since most urban traffic occurs on city arterials (rather than on the freeways). **Figure 1** shows the routes that were monitored.

All of the study roadways were evaluated during the AM and PM peak period between the hours of 7 AM - 9 AM and 4 PM - 7 PM. As in previous studies, both time periods are considered when determining the LOS to be reported. The directionality of the segment is not reported in many of the summary tables, but the worst LOS found for either direction for either AM or PM peak period is shown as the official result. In most cases, the PM period is the focus of the CMP since consistently, the PM period results in higher volumes, slower speeds, and more congestion. The methodology used included using INRIX travel time data, 72-hour traffic counts, and intersection turning movement counts.

The total directional miles and number of route segments for each roadway type are shown in **Table 1**.

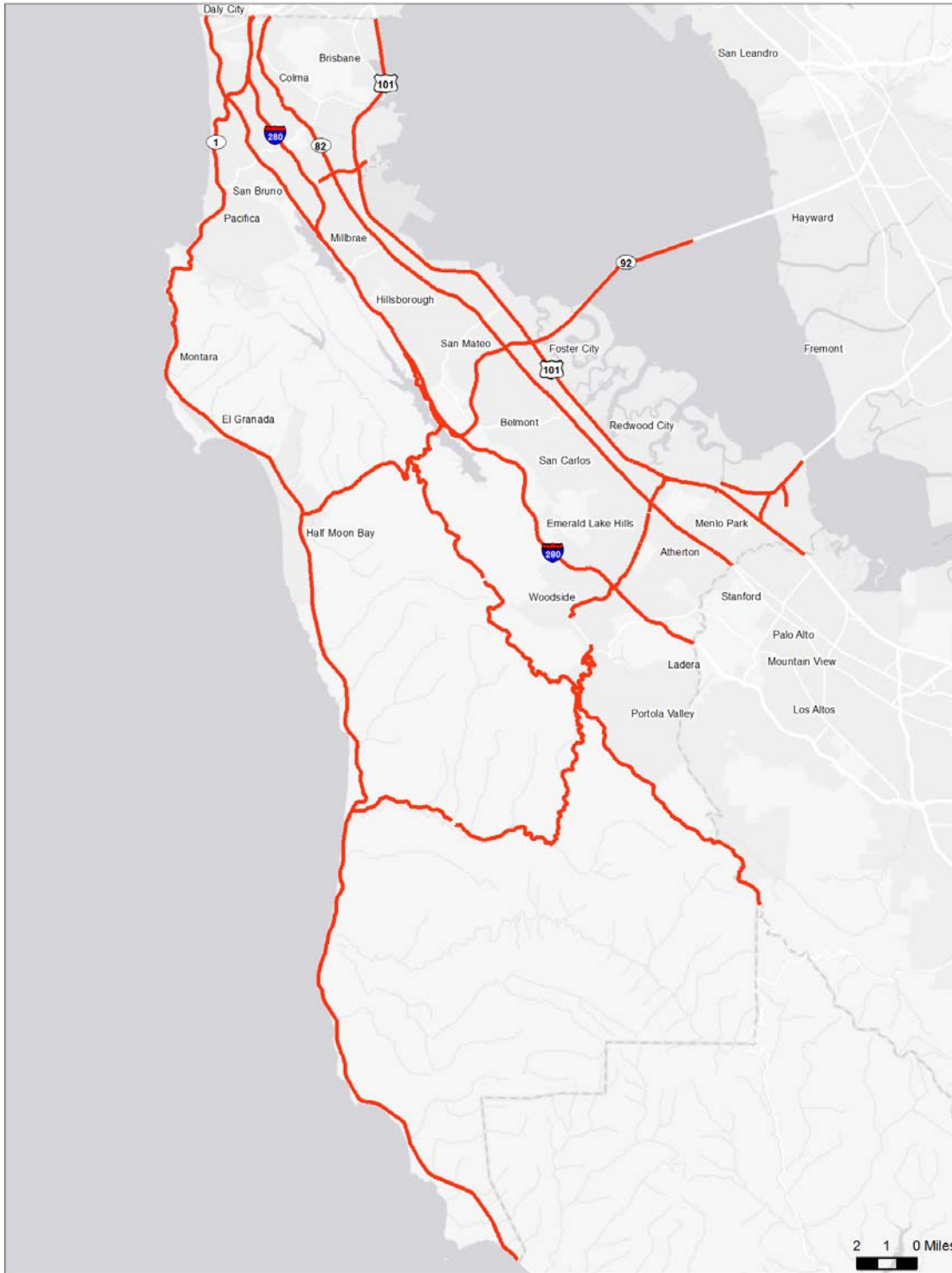


Figure 1 – Spring 2019 CMP Monitored Routes

Table 1 – Total Study Miles Summary

Roadway Type	Total Directional Miles
Arterial / State Routes	301.4
Freeway	163.3
Total	464.7

This monitoring report focused on the five performance measures established in the San Mateo County Congestion Management Program. These performance measures are:

1. Roadway Level of Service
  - a. Travel Time – Average Speed
  - b. 72-hour traffic counts – V/C for rural arterials
2. Intersection LOS
3. Travel Time for various modes (single occupant, carpools, and transit)
4. Pedestrian and Bicycle Improvements
5. Ridership / Person Throughput for Transit

As noted, the “Roadway Level of Service and Intersection LOS” are the primary CMP performance measures; therefore, a mitigation plan is required if the resulting LOS is below the established minimum standard.

The following sections focus on each of the above performance measures with emphasis on the Roadway and Intersection LOS. The other items are included to provide some alternative views to help explain the changes in performance and the opportunities for improvement.

## C. METHODOLOGY

### Mapping of CMP Network

#### Global Positioning System (GPS)

Historically, CMP travel time runs were done manually. CoPLAN staff introduced the use of GPS and GIS to C/CAG in 2011.

All the roadways in the network were mapped using GPS technology in 2011 and 2013. With the introduction of INRIX datasets in 2015, the network attributes were carried over from those past cycles.

As first introduced in 2015, the travel speed data collection process was made more efficient by using data from INRIX in place of a small sample size of GPS travel time runs.

### Travel Time Data

Travel time data was assembled from INRIX and conflated to the LOS Monitoring network.

Travel time data was conflated for the morning and afternoon peak periods on all applicable roadway segments; data were only used on Tuesdays, Wednesdays, or Thursdays, and school district spring break periods were avoided.



## D. EVALUATION

### LOS Analysis – HCM 1994

The tables in the Appendix highlight the 2019 CMP route segments that had LOS lower than the established standard during the AM or PM Peak by HCM 1994 standards directly from the travel time data or 72-hour counts. The CMP legislation allows for the reduction in volume for those interregional trips for those segments that have a LOS lower than the established standard; i.e. those trips that originate from outside the county and either pass through the county or have a destination within San Mateo County.

### Other Performance Measures Results

Apart from average speeds aggregated to the CMP route segments level, intersection segment level average speeds were also calculated in 2019 for all routes. These results are available in the GIS tables provided to C/CAG.

With the use of INRIX data once again in this year's freeway travel time analyses, we have the opportunity to include various new performance measures for the region. In prior years, a small sample of travel time runs were made during a small window of time in the AM and PM peak period. One interesting new performance measure that can be evaluated is the **Duration of Congestion**, or amount of time below a certain speed / LOS within a segment. For example, **Figure 2** illustrates the 5-minute average speed for a 24-hour period between April and May of 2017 and 2019. The red line depicts the average speed, while the vertical lines represent the minimum and maximum speeds for each respective time interval (showing the variability of speed for each time slice). Further, on the horizontal axis, the shaded regions depict the corresponding LOS for the average speed for the freeway section. Therefore, one can see that the average speed in the southbound US 101 segment between SR 92 and Whipple falls into the LOS F range in the morning period around 6:30 AM both years, but remains at that LOS in 2019 for a longer period until around 11:00 AM vs. 9:00 in 2017. For the afternoon period, the average speed remains better than LOS F all afternoon, while at times over the 2 months.

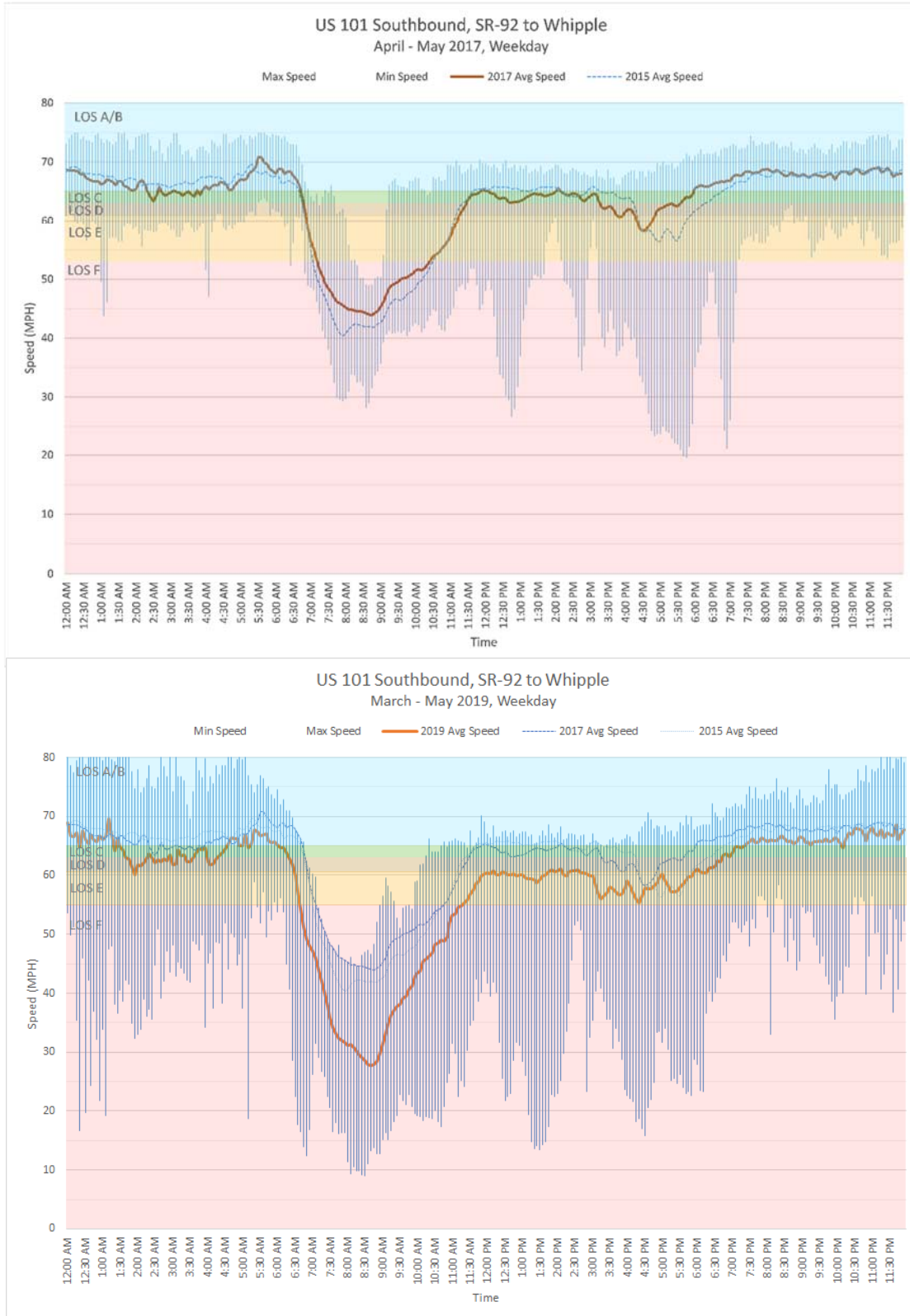


Figure 2 – Spring 2017 vs Spring 2019 Duration of Congestion

## E. ROADWAY LEVEL OF SERVICE (LOS)

### Traffic Flow

The Highway Capacity Manual (HCM) defines capacity as “...the maximum hourly rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions.”

The vehicle capacity and operational characteristics of a roadway are a function of a number of elements including: the number of lanes and lane widths, shoulder widths, roadway alignment, access, traffic signals, grades, and vehicle mix. Generally, roadways with wider travel lanes, fewer traffic control devices, straight alignments, etc. allow faster travel speeds and therefore greater vehicle flow per unit time.

### Level of Service

The HCM defines level of service (LOS) as “...a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience.”

“Six LOS are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver’s perception of those conditions.”

In accordance with CMP legislation, the county and city governments are required to show that all CMP route segments within their jurisdiction are operating at or above the CMP traffic LOS standard. Section 65089(b)(1)(B) of the California Government Code states that “In no case shall the LOS standards established be below the LOS E or the current level, whichever is farthest from LOS A. When the level of service on a segment or at an intersection fails to attain the established level of service standard, a deficiency plan shall be adopted pursuant to section 65089.4.”

All freeway segments in the network, as included in **Figure 3**, were monitored using the INRIX travel time data, which allows for determination of LOS on the basis of average operating speed. C/CAG primarily uses the 1994 and 2000 HCM methodology to monitor LOS on the CMP network, as this methodology was utilized in the baseline monitoring cycle and is necessary to maintain historical comparisons, identify exempt segments, and monitor potential network deficiencies. The specific methodologies used for monitoring freeway and arterial segments are listed below per HCM definitions:

- **Freeway Segments (HCM 1994 - Chapter 3)** – All freeway segments were evaluated using the “basic freeway sections” methodology of HCM 1994 where the LOS for each freeway segment was determined using its average travel speed.

Freeway LOS was not calculated based on HCM 2000 methodology. In order to evaluate all freeway segments using the HCM 2000 methodology, the volumes on all freeway sections (mainline) with distinct characteristics (e.g., quantity of lanes), as well as on entrances and exits would be required. Changes to the methodology will be considered along with the next update cycle when the HCM 2010 may be incorporated. Until then, the methodology of previous updates was followed to maintain the historical context for comparisons of the results.

The routes that fall into this classification include:

- SR-92 from I-280 to Alameda County Line
  - US-101
  - I-280
  - I-380 from SR-92 to US-101
- **Multilane, Two-Lane and Arterial Segments (HCM 1994 – Chapters 7, 8, and 11)** – All non-freeway surface street segments were evaluated based on the volume to capacity ratio (V/C) dependant on the local free-flow speed, cross-section, number of lanes, % no-passing zones, and functional class.

Multilane and Two-Lane highways were evaluated primarily based on the current volumes as measured through 72-hour traffic counts at 21 locations throughout the county. These counts and resulting V/C were then compared to the applicable criteria in the HCM 1994 to determine the respective LOS.

Many arterial segments used by C/CAG for CMP purposes (called "CMP Segments") span several blocks and include multiple signals and/or stop controlled intersections. If an Intersection Segment is defined as a segment from one controlled intersection to the next, the CMP segments are a collection of consecutive Intersection Segments. INRIX segmentation, known as TMC segments, are many times longer or shorter than the desired limits for the CMP Segments. CoPLAN methodology of travel time estimation can calculate average speeds at the Intersection Segment level and these data can be aggregated to calculate the average speeds at the CMP segment level. The average speed on each CMP segment is computed as the ratio of total length of the segment to the sum of average travel time on each individual intersection segment within the CMP segment. The average travel time on each intersection segment is computed as the arithmetic mean of travel times of accumulated data within the TMC segment. The average speed thus accounts for time in motion and time spent at the signals or stop signs.

The routes that fall into this classification include:

- SR-1
- SR-35
- SR-82
- SR-84

- SR-92 from SR-1 to I-280
- SR-109
- SR-114
- I-380 from US-101 to Airport Access Road
- Mission Street
- Geneva Avenue
- Bayshore Boulevard

**Table 2** shows the relationship between average travel speed and level of service for basic freeways according to HCM 1994. There are four (4) freeway categories based on the free-flow speed of the facility (ranging from 55-70 mph).

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Figure 3 –2019 Routes and LOS Methodologies



Table 2 – Example LOS from Freeway with Free-Flow Speed of 65 mph (HCM 1994)

Roadway Type	Basic Freeway
Free Flow Speed (mph) Range	65
A	≥ 65
B	≥ 65
C	≥ 64.5
D	≥ 61
E	≥ 56/53
F	< 56

### Roadway Segment LOS Analysis Results

**Table 3** summarizes the current year roadway segment LOS. Additionally, **Figures 4, 5, 6, and 7** illustrate the results graphically. As highlighted in **Table 3**, there are 19 segments found to be below the established minimum in each of the AM and PM peak periods. The 19 segments include:

- SR-35 between I-280 and SR 92 – AM and PM Periods
- SR-84 between SR-1 and Portola – PM Period
- SR-84 between I-280 and Alameda de las Pulgas – AM and PM Periods
- SR-84 between Willow and University – AM Period
- SR-92 between SR-1 and I-280 – AM and PM Periods
- SR-92 between I-280 and US 101 – AM and PM Periods
- SR-92 between US 101 and Alameda County Line – AM and PM Periods
- US-101 between SF County Line and I-380 – AM and PM Periods
- US-101 between I-380 and Millbrae – AM and PM Periods
- US-101 between Millbrae and Broadway – AM and PM Periods
- US-101 between Broadway and Peninsula – AM and PM Periods
- US-101 between SR-92 and Whipple – AM and PM Periods
- SR-109 between Kavanaugh and SR-84 – PM Period
- I-280 between SF County Line and SR-1 (north) – AM Period
- I-280 between SR-1 (north) and SR 1 (south) – AM Period
- I-280 between SR-1 (south) and San Bruno – AM and PM Periods
- I-280 between San Bruno and SR-92 – PM Period
- I-280 between SR-92 and SR-84 – AM and PM Periods
- I-280 between SR-84 and SC County Line – PM Periods

**Table 3** includes a summary of the historic results since 1999. All results included in this update have consistently used the HCM 1994 for all roadway types and the HCM 2000 for the intersections. Variations in the LOS results may be explained through capital improvements, construction, or use of transit and other modes. The values included in

Table 3 reflects the lowest LOS for either direction; the worst-case LOS for the link in either direction during the respective peak periods.

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Table 3 – CMP Roadway Segment Monitoring Results (Lowest LOS)

2019 CMP Roadway Segment Levels of Service														
Route	Roadway Segment	LOS Standard	2019 LOS				2019 LOS <sup>2</sup>	2017 LOS <sup>2</sup>	2015 LOS <sup>2</sup>	2013 LOS <sup>2</sup>	2011 LOS <sup>2</sup>	2009 LOS <sup>2</sup>	2007 LOS <sup>2</sup>	2005 LOS <sup>2</sup>
			AM Without Exemption	PM Without Exemption	AM With Exemption	PM With Exemption								
1	San Francisco County Line to Linda Mar Blvd.	E	C	A	C	A	C	A	A	F <sup>3</sup> /F <sup>4</sup>	F <sup>3</sup> /B <sup>4</sup>	F <sup>3</sup> /F <sup>4</sup>	F <sup>3</sup> /F <sup>4</sup>	F <sup>3</sup> /F <sup>4</sup>
1	Linda Mar Blvd. to Frenchmans Creek Road	E	D	D	D	D	D	D	D	D	D	D	D	D
1	Frenchmans Creek Road to Miramontes Road	E	E	E	E	E	E	E	E	E	E	E	E	E
1	Miramontes Road to Santa Cruz County Line	D	C	C	C	C	C	C	C	B	B	B	B	C
35	San Francisco county Line to Sneath Lane	E	D	B	D	B	D	C	D	B	A	C	C	C
35	Sneath Lane to I-280	F	F	F	A	F	F	F	F	F	F	E	F	F
35	I-280 to SR 92	B	C	D	A	C	C	B	C <sup>3</sup> /A <sup>4</sup>	C <sup>3</sup> /B <sup>4</sup>	C <sup>3</sup> /B <sup>4</sup>	B	B	C/C
35	SR 92 to SR 84	B	B	B	B	B	B	B	B	B	B	B	B	B
35	SR 84 to Santa Clara County Line	E	B	B	B	B	B	B	B	B	B	B	B	B
82	San Francisco County Line to John Daly Blvd	E	A	A	A	A	A	A	A	A	A	A	A	A
82	John Daly Boulevard to Hickey Boulevard	E	A	A	A	A	A	A	A	A	A	A	A	A
82	Hickey Boulevard to I-380	E	A	A	A	A	A	A	A	A	A	A	C	A
82	I-380 to Trousdale Drive	E	A	A	A	A	A	A	A	A	A	A	B	A
82	Trousdale Drive to 3 <sup>rd</sup> Avenue	E	A	A	A	A	A	A	A	A	B	A	A	A
82	3 <sup>rd</sup> Avenue to SR 92	E	A	A	A	A	A	A	A	A	A	A	A	A
82	SR 92 to Hillside Avenue	E	A	A	A	A	A	A	A	A	A	B	B	B
82	Hillside Avenue to 42 <sup>nd</sup> Avenue	E	A	B	A	B	C	C	B	B	B	B	B	B
82	42 <sup>nd</sup> Avenue to Holly Street	E	A	A	A	A	A	B	B	A	A	B	B	A
82	Holly Street to Whipple Avenue	E	A	A	A	A	A	A	B	B	C	C	D	D
82	Whipple Avenue to SR 84	E	A	A	A	A	A	A	A	A	B	C	C	C
82	SR 84 to Glenwood Avenue	E	B	A	A	A	A	B	A	B	B	B	B	B
82	Glenwood Avenue to Santa Cruz Avenue	E	B	C	A	C	C	C	C	B	B	C	D	
82	Santa Cruz Avenue to Santa Clara County Line	E	D	D	B	D	D	B	B	B	A	B	B	C
84	SR 1 to Portola Road	C	C	D	C	D	D	B	D <sup>3</sup> /B <sup>4</sup>	C	C	C	C	C
84	Portola Road to I-280	E	B	B	B	B	B	C	C	C	B	B	B	B
84	I-280 to Alameda de las Pulgas	C	E	E	E	E	E	D	D <sup>3</sup> /D <sup>4</sup>	D <sup>3</sup> /D <sup>4</sup>	D <sup>3</sup> /C <sup>4</sup>	C	D/A	C
84	Alameda de las Pulgas to U.S. 101	E	D	E	D	E	E	D	D	D	E	E	E	E
84	U.S. 101 to Willow Road	D	C	B	C	B	B	C	C	B	E/E	C	B	
84	Willow Road to University Avenue	E	F	E	A	E	E	B	F <sup>3</sup> /B <sup>4</sup>	F <sup>3</sup> /B <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F/E	F/F	F/F
84	University Avenue to Alameda County Line	F	F	F	F	F	F	F	F	F	F	F	F	F
92	SR 1 to I-280	E	F	F	E	E	E	E	E	E	E	E	E	E
92	I-280 to U.S. 101	D	F	F	E	D	E	E	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /F <sup>4</sup>	E <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /E <sup>4</sup>
92	U.S. 101 to Alameda County Line	E	F	F	A	F	F	C	F <sup>3</sup> /F <sup>4</sup>	E	F <sup>3</sup> /A <sup>4</sup>	A/B <sup>3</sup>	A/B <sup>3</sup>	A/B <sup>3</sup>

Notes:

<sup>2</sup> The first value represents LOS without exemptions, and the second value represents LOS with exemptions.

<sup>3</sup> Based on average speed from travel time surveys.

<sup>4</sup> Exemptions applied to volume-to-capacity ratios estimated from average speeds.

"-" = not applicable. LOS standard is not violated. Therefore, exemptions were not applied.

LOS Standard violations (after application of exemptions) are highlighted in red

LOS based on 1994 Highway Capacity Manual Methodology.

Table 3 (cont) – CMP Roadway Segment Monitoring Results (Lowest LOS)

2019 CMP Roadway Segment Levels of Service														
Route	Roadway Segment	LOS Standard	2019 LOS				2019 LOS <sup>3</sup>	2017 LOS <sup>2</sup>	2015 LOS <sup>3</sup>	2013 LOS <sup>3</sup>	2011 LOS <sup>2</sup>	2009 LOS <sup>2</sup>	2007 LOS <sup>2</sup>	2005 LOS <sup>2</sup>
			AM Without Exemption	PM Without Exemption	AM With Exemption	PM With Exemption								
101	San Francisco County Line to I-380	E	F	F	D	D	E	F <sup>3</sup> /E <sup>4</sup>	E	F <sup>3</sup> /A <sup>4</sup>	D <sup>3</sup>	E <sup>3</sup>	D <sup>3</sup>	
101	I-380 to Milbrae Avenue	E	F	F	E	D	E	D	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	D <sup>3</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>
101	Milbrae Avenue to Broadway	E	F	F	E	D	E	C	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>
101	Broadway to Peninsula Avenue	E	F	F	D	D	D	D	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>
101	Peninsula Avenue to SR 92	F	F	F	F	F	F	F	F	F	F	F <sup>3</sup>	F <sup>3</sup>	F <sup>3</sup>
101	SR 92 to Whipple Avenue	E	F	F	C	E	E	E	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /E <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /E <sup>4</sup>
101	Whipple Avenue to Santa Clara County Line	F	F	F	F	F	F	F	F	F	F	F <sup>3</sup>	F <sup>3</sup>	F <sup>3</sup>
109	Kavanaugh Drive to SR 84 (Bayfront Expwy.)	E	C	F	C	A	C	C	D	D	C	D	D	C
114	U.S. 101 to SR 84 (Bayfront Expressway)	E	B	C	B	C	C	C	C	A	B	C	C	B
280	San Francisco County Line to SR 1 (north)	E	F	E	E	E	E	E	E	E	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /A	E <sup>3</sup>	
280	SR 1 (north) to SR 1 (south)	E	F	E	E	E	E	D	E	E	A/B	E	E	E <sup>3</sup>
280	SR 1 (south) to San Bruno Avenue	D	F	F	D	C	D	D	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /D <sup>4</sup>	E <sup>3</sup> /D <sup>4</sup>	F <sup>3</sup> /C <sup>4</sup>	F <sup>3</sup> /E <sup>4</sup>
280	San Bruno Avenue to SR 92	D	D	E	D	B	D	A	C	B	D	E <sup>3</sup> /C <sup>4</sup>	A/B <sup>3</sup>	A/B <sup>3</sup>
280	SR 92 to SR 84	D	F	E	B	A	B	A	E/C	C	A/B	D <sup>3</sup>	D <sup>3</sup>	D <sup>3</sup>
280	SR 84 to Santa Clara County Line	D	D	F	D	A	D	A	F <sup>3</sup> /A <sup>4</sup>	F <sup>3</sup> /A <sup>4</sup>	E <sup>3</sup> /A <sup>4</sup>	D <sup>3</sup>	D <sup>3</sup>	E <sup>3</sup> /C <sup>4</sup>
380	I-280 to U.S. 101	F	F	F	F	F	F	F	F	F	F	F <sup>3</sup>	F <sup>3</sup>	E <sup>3</sup>
380	U.S. 101 to Airport Access Road	C	A	A	A	A	A	A	A	A	A	B <sup>3</sup>	D <sup>3</sup> /C	A <sup>3</sup>
Mission St	San Francisco County Line to SR 82	E	A	A	A	A	A	A	A	A	A	A	A	A
Geneva Ave.	San Francisco County Line to Bayshore Blvd.	E	A	A	A	A	A	A	A	A	A	A	A	A
Bayshore Blvd.	San Francisco County Line to Geneva Avenue	E	A	A	A	A	A	A	A	A	A	A	A	A

Notes:

<sup>2</sup> The first value represents LOS without exemptions, and the second value represents LOS with exemptions.

<sup>3</sup> Based on average speed from travel time surveys.

<sup>4</sup> Exemptions applied to volume-to-capacity ratios estimated from average speeds.

"-" = not applicable. LOS standard is not violated. Therefore, exemptions were not applied.

LOS Standard violations (after application of exemptions) are highlighted in red

LOS based on 1994 Highway Capacity Manual Methodology.

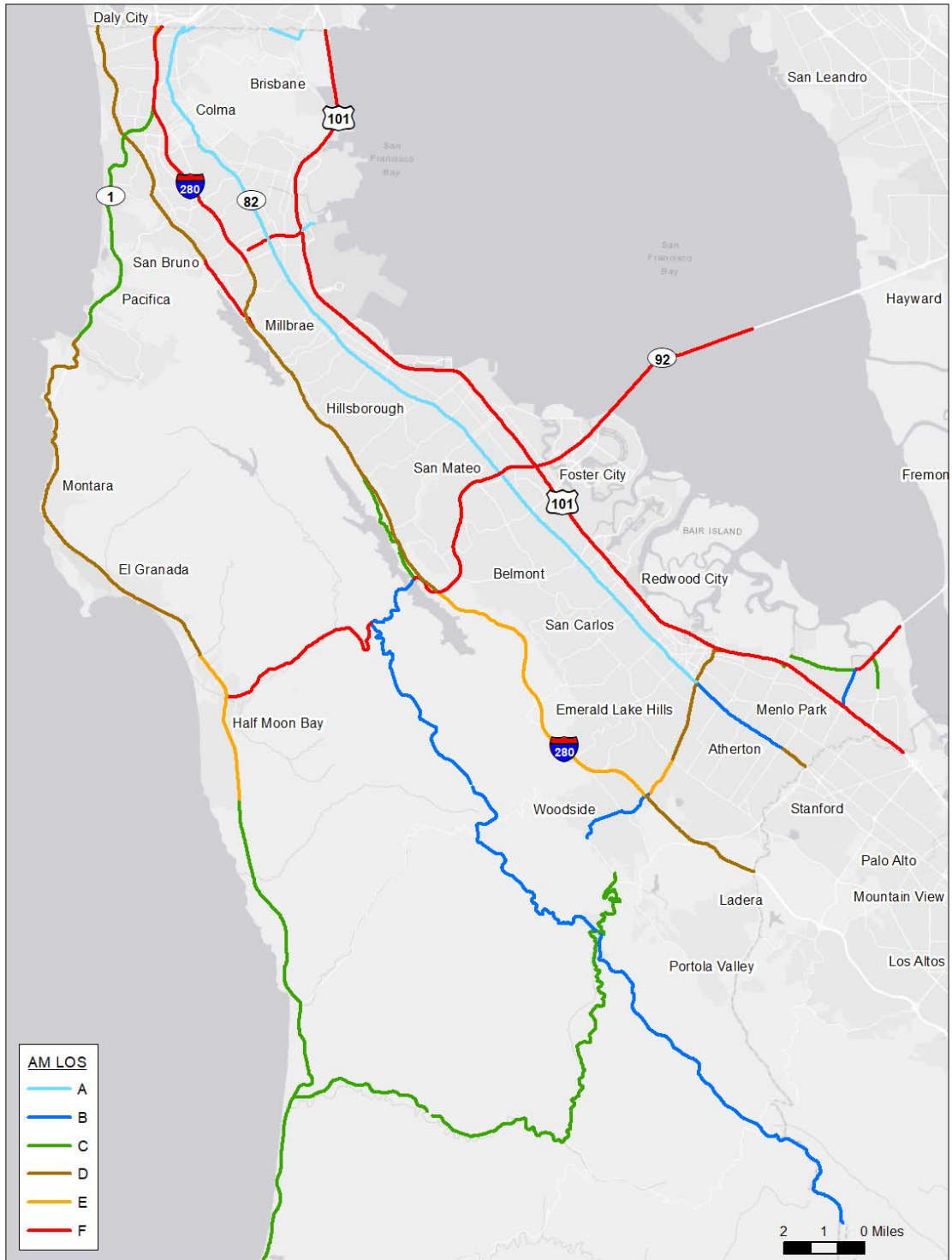


Figure 4 – AM LOS Results (before Exemptions)



Figure 5 – PM LOS Results (before Exemptions)

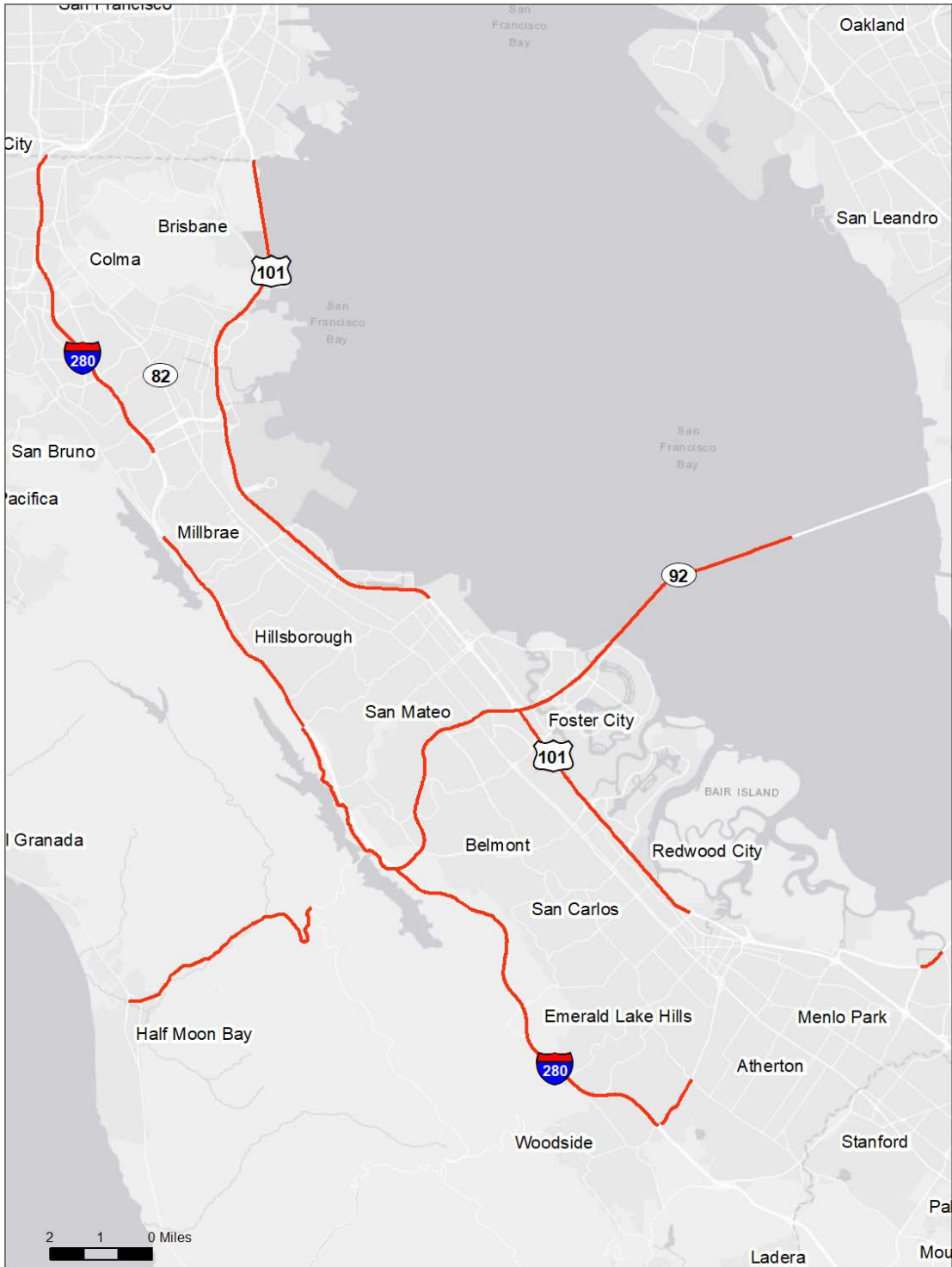


Figure 6 – AM CMP Segments with LOS Lower than Standard (before Exemptions)



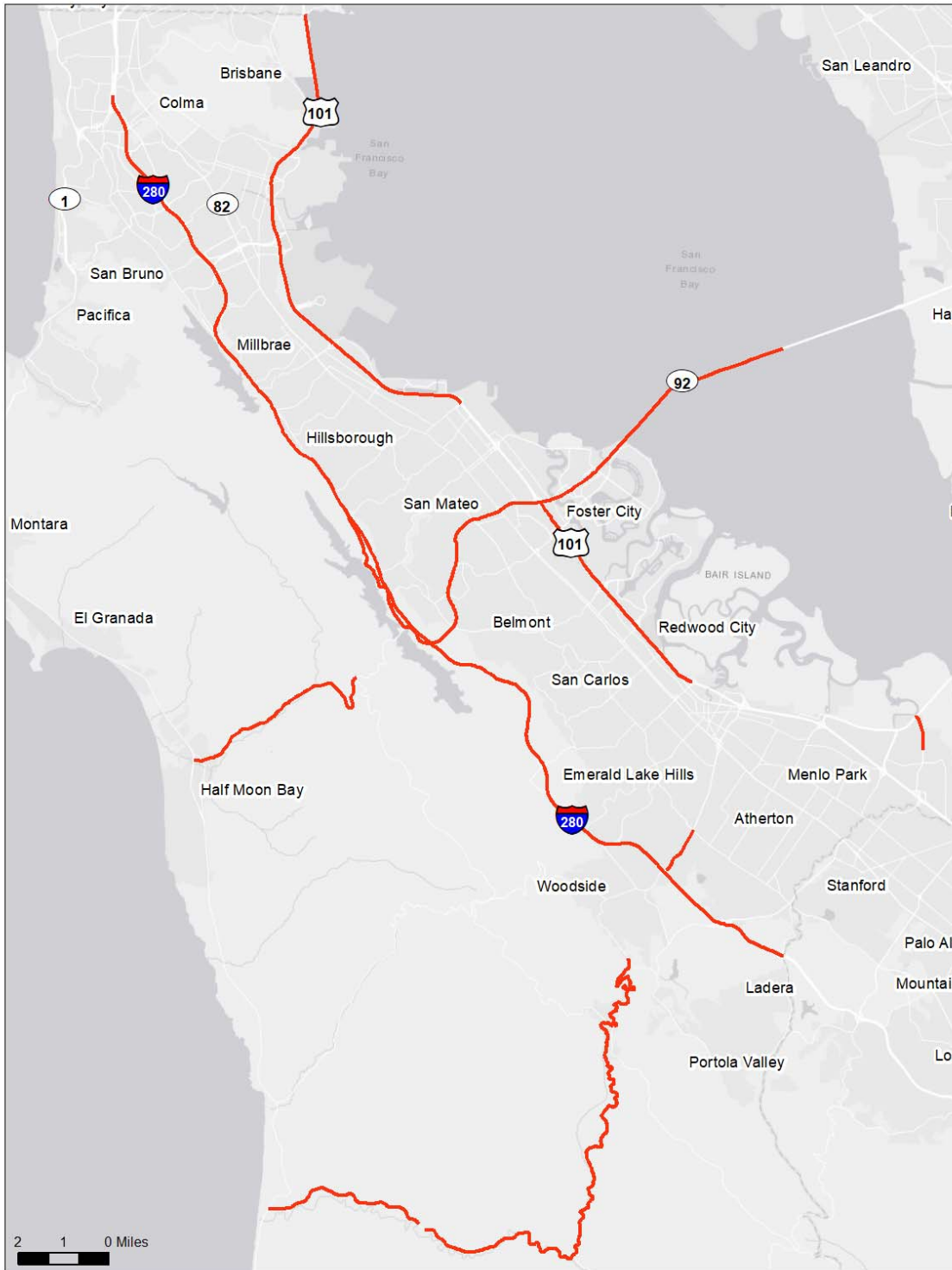


Figure 7 – PM CMP Segments with LOS Lower than Standard (before Exemptions)

## F. REDUCTION IN VOLUMES DUE TO INTERREGIONAL TRIPS

The CMP legislation allows for the reduction in volume for those trips that are interregional. In this case, “interregional” are those trips that originate from outside the county. That is those that either traverse the county or have a destination within the county. For those CMP segments found with a LOS below the standard, the county travel demand model is used to determine the proportion of the volume estimated to be from interregional travel. As shown in **Table 3**, there were 19 segments that had at least one direction in either the AM or PM peak period that had a lower LOS than the established standard. **Table 4** includes the resulting percentage of traffic from the travel demand model that is estimated to be interregional by segment.

Table 4 – Interregional Trips for Segments with LOS Lower than Standard

Link	Segment	Time Period	AM Peak		PM Peak	
			Direction	NB / WB	SB / EB	NB / WB
SR 35	I-280 to SR 92	AM NB/SB, PM NB/SB	6.5%	41.2%	36.5%	17.8%
SR 84	SR 1 to Portola Rd	PM EB/WB			0.0%	0.0%
SR 84	I-280 to Alameda de Las Pulgas	AM WB, PM EB/WB	1.4%		1.2%	62.4%
SR 84	Willow to University Av	AM WB	96.3%			
SR 92	SR 1 to I-280	AM EB/WB, PM EB/WB	25.7%	0.1%	28.1%	0.3%
SR 92	I-280 to US 101	AM EB/WB & PM EB/WB	15.8%	29.0%	14.3%	26.6%
SR 92	US 101 to Alameda Co Line	AM WB, PM EB	75.0%			7.6%
US 101	SF Co Line to I-380	AM NB/SB & PM NB/SB	21.6%	98.3%	18.7%	95.4%
US 101	I-380 to Millbrae Av	AM NB, PM NB/SB	26.4%		28.5%	60.4%
US 101	Millbrae Av to Broadway	AM NB, PM NB/SB	29.8%		31.4%	47.5%
US 101	Broadway to Peninsula Av	AM NB/SB, PM NB/SB	32.5%	54.1%	35.3%	38.5%
US 101	SR 92 to Whipple Av	AM NB/SB, PM NB	50.5%	42.6%	46.4%	
SR 109	Kavanaugh Dr to SR 84	PM NB			78.4%	
I-280	SF Co Line to SR 1 (north)	AM NB	13.7%			
I-280	SR 1 (north) to SR 1 (south)	AM NB	16.1%			
I-280	SR 1 (south) to San Bruno Av	AM SB, PM NB		83.1%	43.6%	
I-280	San Bruno Av to SR 92	PM NB			57.4%	
I-280	SR 92 to SR 84	AM SB, PM NB		59.2%	80.7%	
I-280	SR 84 to SC Co Line	PM NB			94.5%	

When applying reductions, they can be deducted directly for those where V/C is the performance measure used, but for those segments that use INRIX travel speed, a few extra steps are required to reflect the exemption. As mentioned earlier, freeway LOS is primarily determined based on density, but historically, the LOS Monitoring Study has made use of the LOS tables as included in the HCM 1994 that include reference speeds for given free-flow speeds and LOS. In order to reflect the reduction, the V/C must first be estimated from the same tables. This adds a level of error given that density is the preferred performance measure and the methodology is to use a secondary measure to estimate another secondary measure, take the reduction, and then reverse the calculation using the V/C and determine the adjusted LOS with the exemption.

## G. DEFICIENT CMP SEGMENTS

After incorporating the reduction in volume for those segments found to have a LOS lower than the standard, while the AM peak period has 5 segments deficient, the PM peak period was found to have the same 4 segments deficient, as shown in **Figures 8 and 9**. Those include the following:

- PM – Northbound and Southbound SR-35 between I-280 and SR-92
- PM – Eastbound and Westbound SR-84 between SR-1 and Portola
- AM & PM – Westbound SR-84 between I-280 and Alameda de Las Pulgas
- AM – Westbound SR-92 between I-280 and US-101
- PM – Eastbound SR-92 between US-101 and Alameda County Line

While the worst LOS of either peak period has historically been presented in the summary table, the individual peak periods have been separated for improved analysis in the body of the report this year and not just in the appendix as in the past. The segments deficient in the PM period are also highlighted in Table 3.



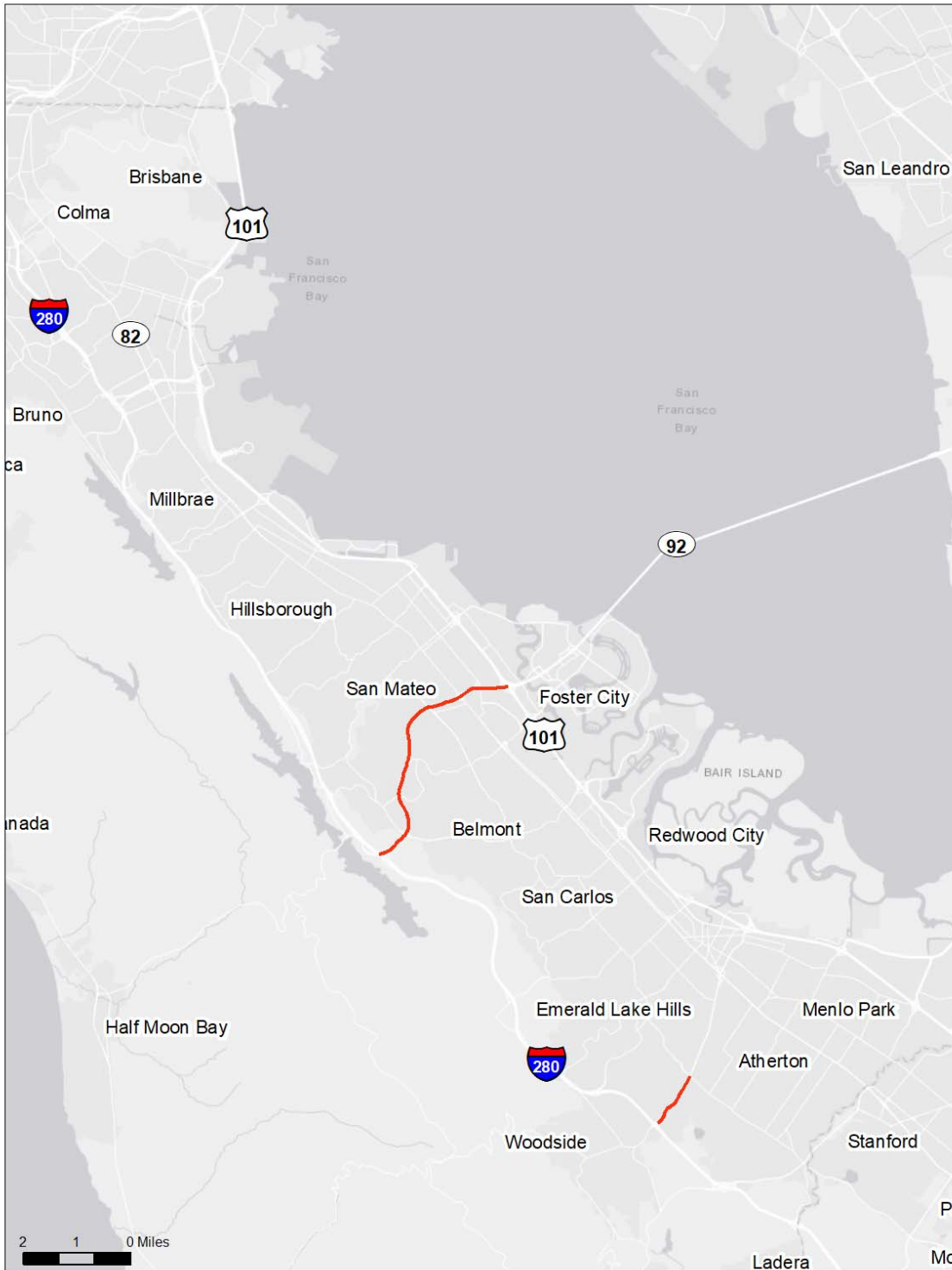


Figure 8 – AM Deficient Segments after Exemption

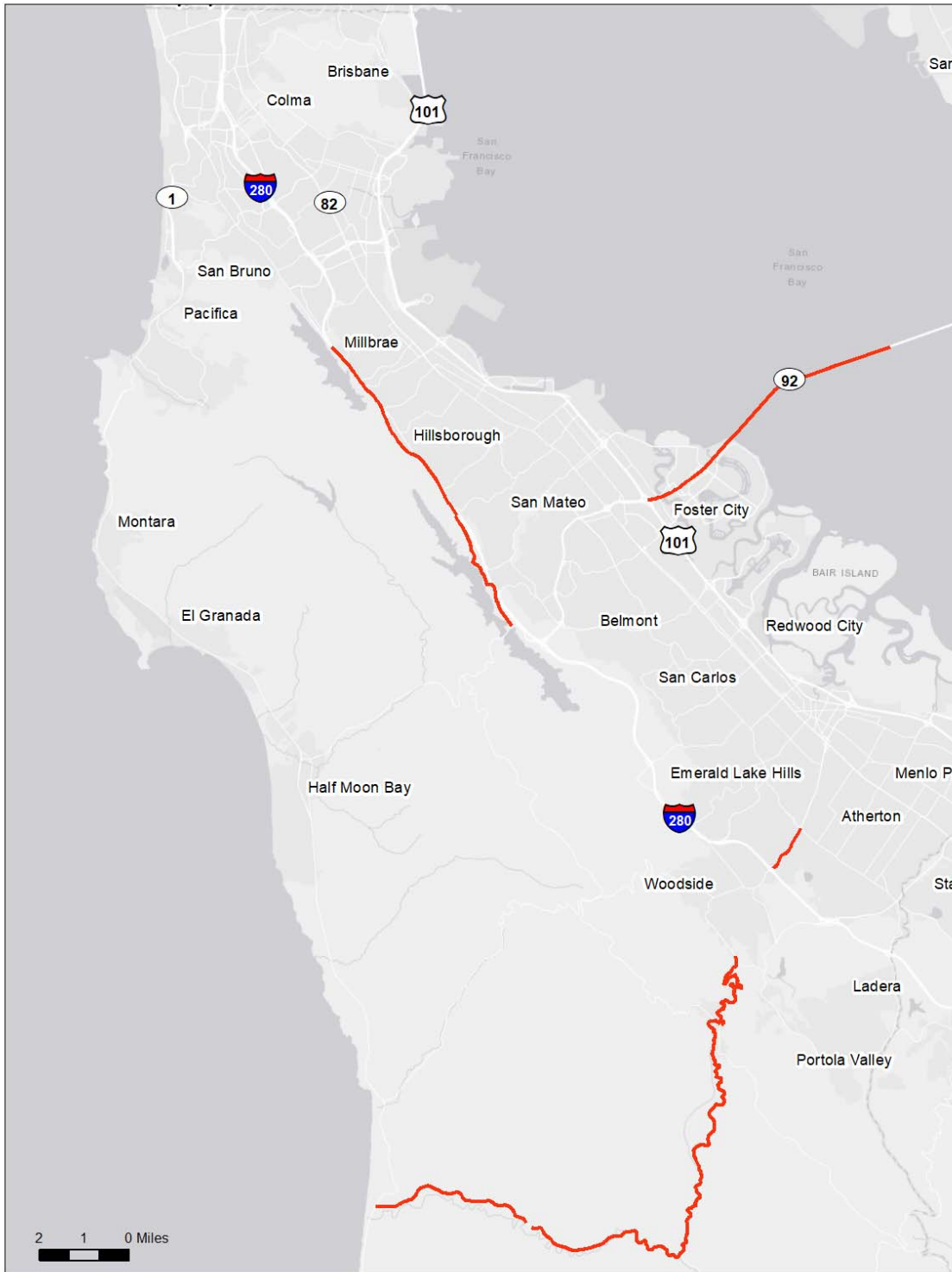


Figure 9 – PM Deficient Segment after Exemption

## H. INTERSECTIONS

Sixteen intersections were analyzed as part of the 2019 LOS Monitoring. These intersections have been included in previous studies since 1999 and are included in **Table 5** for reference. The performance measure for intersections is LOS, but different from freeways and highways, the HCM 2000 was used to determine the LOS. Turning movement counts were collected for each intersection during the AM and PM peak periods and modeled in Synchro. In addition to turning movement counts, pedestrian and bike counts were collected for the first time in 2019. The intersections were analyzed as if they were isolated (not coordinated or part of a signal system) and optimized given the current geometry. The modeled results provide an estimate of the optimized LOS and may not represent the actual conditions if the intersection is either using less than optimal phasing, splits or cycle length.

**Table 5** includes the results for the 2019 study as well as those back to 2005 using the HCM 2000 methods. As highlighted in the table, all intersections are operating (under optimized signal timing) within established LOS standards. Intersections 1, 5, and 14 are operating at standard and should be monitored to avoid exceeding the established LOS standard. Intersections 11 and 13 are operating at LOS F which is the standard at those locations but should be evaluated for possible improvements.

Table 5 – Intersection LOS

Int #	Intersection	LOS Standard	Peak Hour	2000 HCM Method								2019 Standard Exceeded
				2019 LOS	2017 LOS	2015 LOS	2013 LOS	2011 LOS	2009 LOS	2007 LOS	2005 LOS	
1	Bayshore & Geneva	E	AM	E	B	B	B	B	C	B	C	No
			PM	B	A	B	B	B	C	C	C	No
2	SR 35 & John Daly Blvd	E	AM	B	C	D	C	C	B	B	B	No
			PM	B	B	E	C	C	C	B	C	No
3	SR 82 & Hillside/John Daly	E	AM	B	B	C	C	B	C	C	C	No
			PM	C	C	C	C	C	D	C	D	No
4	SR 82 & San Bruno Ave	E	AM	C	B	C	C	C	C	C	C	No
			PM	C	C	C	C	C	D	D	D	No
5	SR 82 & Milbrae Ave	E	AM	E	D	D	E	F/D	E	E	E	No
			PM	E	D	E	D	E	D	E	E	No
6	SR 82 & Broadway	E	AM	B	A	B	B	B	B	B	B	No
			PM	A	A	B	B	B	A	B	B	No
7	SR 82 & Park-Peninsula	E	AM	C	B	C	C	C	B	B	B	No
			PM	C	B	C	C	C	B	B	B	No
8	SR 82 & Ralston	E	AM	C	C	C	C	C	D	D	E	No
			PM	C	C	C	D	C	D	D	E	No
9	SR 82 & Holly	E	AM	C	C	C	C	C	C	C	C	No
			PM	C	C	C	C	C	D	C	C	No
10	SR 82 & Whipple Ave	E	AM	C	C	C	C	C	C	C	D	No
			PM	D	D	C	C	C	D	D	D	No
11	University & SR 84	F	AM	C	F	C	E	C	B	B	B	No
			PM	F	F	F	F	F	F	F	E	No
12	Willow & SR 84	F	AM	D	C	D	D	C	C	C	C	No
			PM	E	F	F	F	E	F	F	E	No
13	SR 84 & Marsh Rd	F	AM	F	F	F	D	D	C	C	C	No
			PM	F	F	F	D	E	F	D	C	No
14	Middlefield & SR 84	E	AM	D	E	C	D	C	D	D	D	No
			PM	E	E	D	D	D	D	D	D	No
15	SR 1 & SR 92	E	AM	B	B	C	C	D	C	D	D	No
			PM	C	C	C	C	C	D	D	D	No
16	Main St & SR 92	F	AM	B	B	C	B	C	C	C	C	No
			PM	B	B	B	B	B	C	C	C	No

Figures 10 and 11 illustrate the finding for the intersection LOS. Each intersection is represented with two shapes. The larger one is the base and is the LOS Standard. The smaller shape in the middle is the resulting peak period LOS for the respective time period.

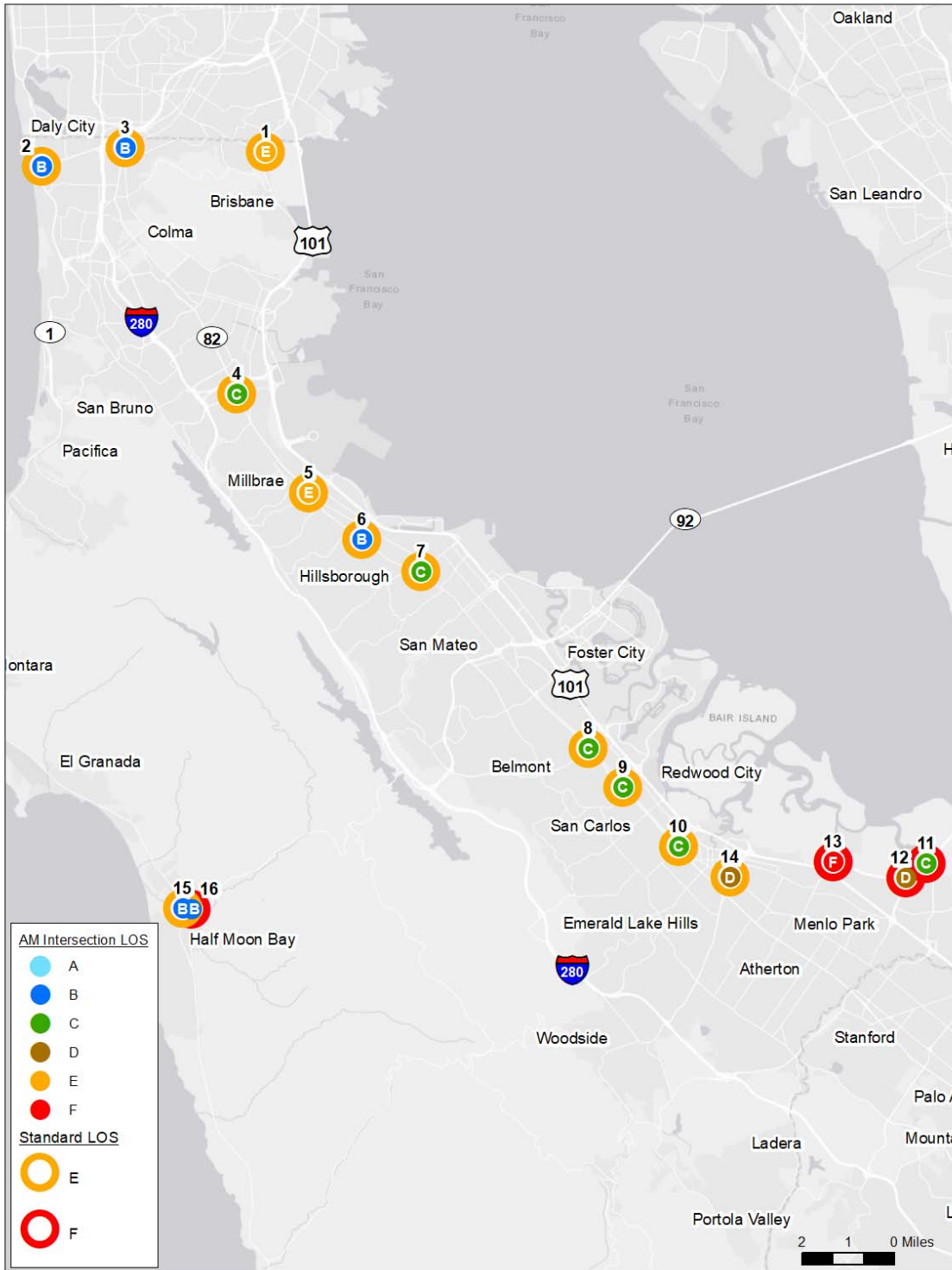


Figure 10 – AM Intersection LOS (Underlying Color is LOS Standard)

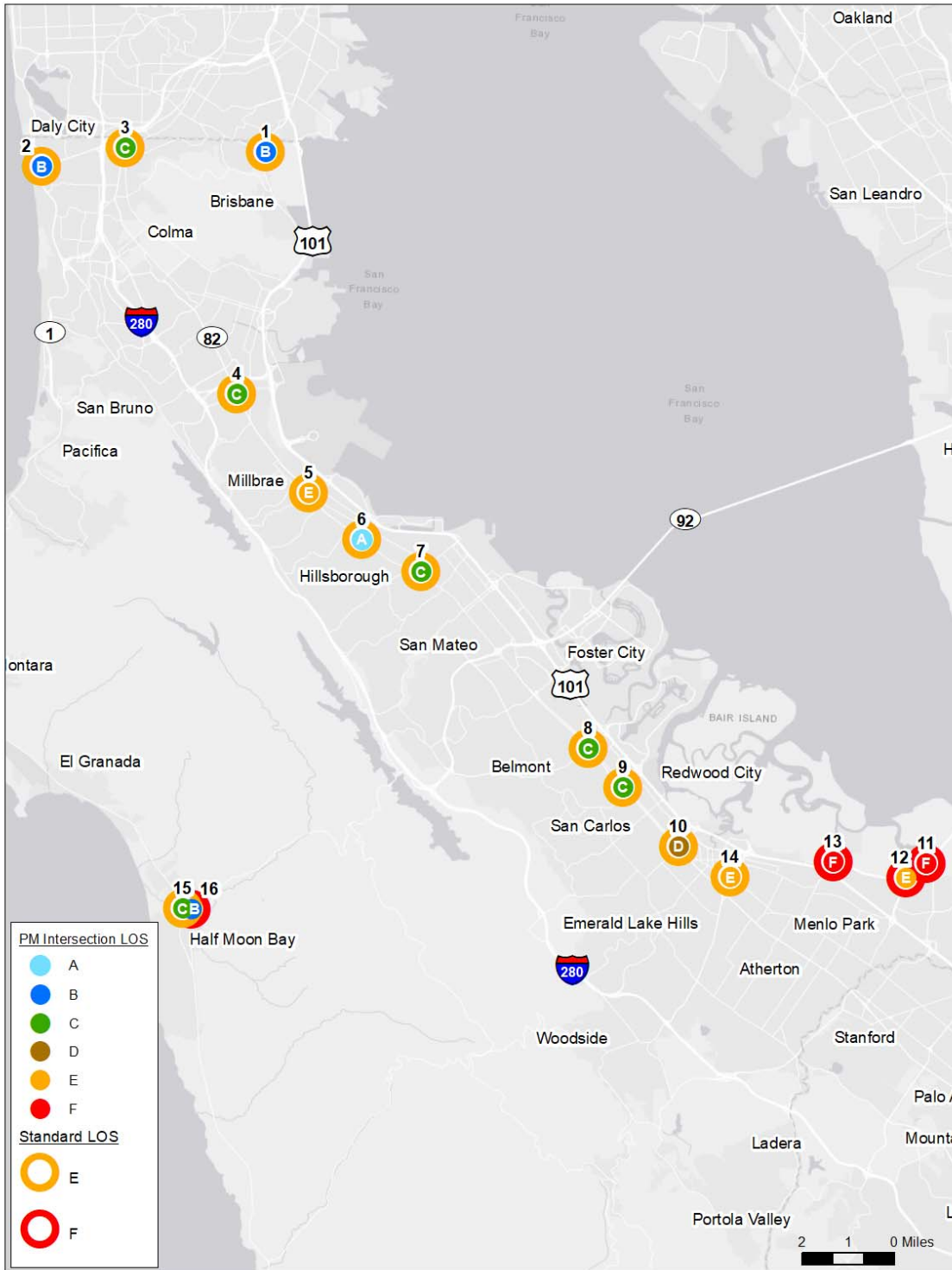


Figure 11 – PM Intersection LOS (Underlying Color is LOS Standard)



## I. 2017 MULTI-MODAL PERFORMANCE MEASURE MONITORING PROGRAM

Beginning in 1995, the Transit LOS Standard element of the San Mateo County CMP was replaced with the Performance Measure element. Four Performance Measures were selected and incorporated in the 1997 CMP Update and used each update cycle through 2009. The four measures are used to measure the performance of the overall multi-modal transportation system, including non-automotive modes. They are:

- Level of service,
- Travel times from single-occupant automobiles, carpools, and transit,
- Pedestrian and bicycle improvements, and
- Ridership / person throughput for transit.

This section presents the 2019 measurements of these performance measures and includes the historic results for context.

### Level of Service

The levels of service of the CMP corridors and segments are included in the previous sections of this monitoring report. The results show that two roadway segments exceeded the respective LOS standard following reflection of the interregional trips. For the 16 intersections included in the CMP network, all intersections were found to operate at or better than the established standard after incorporating exemptions.

### Travel Times for Single-Occupant Automobiles, Carpools, and Transit

This multi-modal performance measure compares the travel time of the various modes available in the US 101 corridor from the Santa Clara County line to the San Francisco County line. Those include using the general purpose lanes, using the carpool lane for the limits available, or using transit via SamTrans or Caltrain.

The general-purpose travel times previously presented early in this report were the result of a 2-month average between April and May. Those included in Table 6 for the single occupant vehicle represent the calculated INRIX travel time using the average speed over each TMC segment for each 5-minute interval during each respective AM and PM peak period. The HOV travel times are based on 5 runs in the field for the limits of the HOV between the county line and Whipple summed with the INRIX results for the balance of the route to the San Francisco county line on the north. Therefore, the HOV portion represents a far smaller sample size than an average for the peak period over 2 months.

The current limits of the carpool lane in San Mateo County are from the Santa Clara County line to Whipple Avenue. For those that are able to use this lane during the peak hours, the remainder of the run will take place in the general purpose lane.

Travel times for those using transit include the option to access SamTrans route 398 along the US 101 corridor or Caltrain. The travel times for the transit options are represented based on the published

schedules. Actual data collection for these routes was not performed but is shown consistent with methods used in previous LOS monitoring studies.

The travel times for the various mode options are included in **Table 6** below. The table includes the respective travel times, listed by direction and peak periods, for the current reporting period as well as previous years back to 2009.

Table 6 – Average Travel Time in US 101 Corridor (in minutes)  
Between San Francisco and Santa Clara County Lines

Mode	AM - Morning Commute Peak Period												PM - Evening Commute Peak Period											
	Northbound						Southbound						Northbound						Southbound					
	2019	2017	2015	2013	2011	2009	2019	2017	2015	2013	2011	2009	2019	2017	2015	2013	2011	2009	2019	2017	2015	2013	2011	2009
Auto - Single Occ. <sup>1</sup>	28	32	32	28	29	30	40	35	36	41	34	28	40	36	39	30	32	33	32	32	32	33	40	29
Carpool - HOV Lane <sup>2</sup>	26	32	32	32	28	30	38	34	35	37	30	26	40	36	42	37	30	32	31	32	32	32	35	27
Caltrain (Baby Bullet b/n Palo Alto and Menlo and Approximate north county line near Bayshore Station - but not stop on Baby Bullet) <sup>3</sup>	40	40	39	23	35	35	43	44	43	27	31	31	40	40	38	24	34	34	39	36	38	23	35	35
SamTrans Route KX (b/n Palo Alto Station and SFO then transfer to BART at SFO to County Line) <sup>4</sup>	57	80	80	68	76	79	74	-	-	73	81	85	83	-	-	72	81	83	74	91	91	74	78	89

<sup>1</sup> - 2015, 2017, and 2019 Results based on Inrix avg speeds over each TMC for the full 3 month (March-May)  
<sup>2</sup> - 2015, 2017, and 2019 HOV results are based on HOV field runs south of Whipple + Inrix avg speed for TMC north to SF county line  
<sup>3</sup> - Baby Bullet b/n Palo Alto and Menlo and Approximate north county line near Bayshore Station - but not stop on Baby Bullet.  
<sup>4</sup> - Route KX b/n RWC and SF(AM NB Only, PM SB Only) & 398 (b/n Palo Alto and Redwood City).

The AM and PM auto travel times in the general-purpose lanes have fluctuated slightly since 2009, while mixed results with some improving while others getting longer for 2019 as compared to 2017. In general the travel times have increased other than the northbound AM.

The carpool travel times also show mixed results as compared to 2017 from Whipple to the county line. The northbound AM has similarly improved as in the general-purpose lanes while the travel times for the others are either mostly unchanged or increased.

Caltrain has made minor changes to its schedules since 2009 on the Baby Bullet express that was introduced in 2005, thus the travel times have not changed too much since 2013 between the Limited-Stop, Local, and Baby Bullet lines traveling along the 14 Caltrain stations within San Mateo County.

Established in August 2019, SamTrans Route 398 provides service from the Redwood City Transit City to San Francisco via El Camino Real and US-101 in the AM and PM peak periods, with small detours to the San Bruno Bart Station and San Francisco International Airport. The route will run hourly from 5:07 a.m. to just after midnight on weekdays, and 5:50 a.m. to 11:10 p.m. on weekends.



## Pedestrian and Bicycle Improvements

The purpose of this performance measure is to maintain a focus on non-vehicular alternatives. This should be reflected in connectivity to transit and other modes to not only make connections convenient, but safe and attractive. During the CMP update process, seven-year Capital Improvement Program (CIP) projects are identified and evaluated. The top-ranked projects are forwarded to MTC to be evaluated in the regional process for State and Federal funding.

C/CAG developed the San Mateo County Comprehensive Bicycle and Pedestrian Plan to address the planning, design, funding, and implementation of bicycle and pedestrian projects of countywide significance. The Plan includes a policy framework to guide and evaluate implementation of projects identified by the local implementing cities and the County. To maximize funding available for bikeway projects, the Plan emphasizes projects that improves safety, promote access to jobs, and located within high population as well as employment densities. The Plan also establishes geographical focus areas for countywide investment in pedestrian infrastructure. An update to the Plan is currently under development. The San Mateo County Comprehensive Bicycle and Pedestrian Plan will be updated in 2019.

### Ridership / Person Throughput for Transit

The purpose of this performance measure is to document the number of patrons using the available transit options. Within San Mateo County, there are three options including SamTrans, Caltrain, and BART. BART has six stations within San Mateo County: Daly City, Colma, South San Francisco, San Francisco International Airport, San Bruno, and Millbrae.

The 2019 transit ridership data for SamTrans, Caltrain, and BART (Bay Area Rapid Transit) is included in **Table 7**. As shown in Table 7 below, the 2019 transit ridership data indicates annual total ridership for SamTrans has decreased by 10% and Caltrain ridership is stable when compared to the CMP update 2017. Annual total ridership for BART was also stable for most stations while the SFO and Millbrae stations decreased about 10% when compared with the previous 2017 CMP Update

Table 7 – Transit Ridership

Transit Agency	Annual Total			Average Weekday		
	FY 2019	FY 2017	FY 2015	FY 2019	FY 2017	FY 2015
SamTrans <sup>1</sup>	10,670,850	11,816,760	13,158,703	35,150	38,700	42,981
Caltrain <sup>2</sup>	18,486,509	18,743,189	18,156,173	63,597	64,114	58,245
BART (Colma, Daly City, South Francisco, San Bruno) <sup>3</sup>	7,741,549	7,818,023	8,155,340	26,483	25,269	28,050
BART (SFO & Millbrae) <sup>3</sup>	11,261,768	12,102,872	12,614,731	37,687	39,989	40,741
<b>Combined Transit</b>	<b>48,160,676</b>	<b>50,480,844</b>	<b>52,084,947</b>	<b>162,917</b>	<b>163,090</b>	<b>170,201</b>

<sup>1</sup> Source: SamTrans End-of-Year Performance Report FY2019

<sup>2</sup> Source: Caltrain Website

<sup>3</sup> Source: BART Staff

## J. TRENDS AND NEXT STEPS

Overall between 2017 and 2019 there was just one area that showed improvements while there were a larger number of segments in other areas that worsened especially in the AM Peak Period. A few specifics to highlight that either improved a letter grade in LOS or over 10 mph faster travel time include the following:

- SR 84 between Portola and I-280

Similarly, for those that worsened a letter grade in LOS or slower by more than 10 mph include:

- SR 92 between SR-1 and I-280
- SR-109 between Kavanaugh Drive to SR 84 (Bayfront Expwy.)
- I-280 between SR 1 (north) to SR 1 (south)
- I-280 between San Bruno Avenue to SR 92

The LOS and Performance Measure Monitoring Report for many years has continued to use the 1994 Highway Capacity Manual as the basis for determining LOS for freeways, arterials and intersections. There have been a couple substantial updates to this manual over the years that not only changed the thresholds for determining LOS but also the methodology to be used over the last 15 years. With these changes have come new data sources that allow additional performance measures to be evaluated included travel time reliability and duration of congestion. Nationally, these performance measures are many times of more interest not only to planners and engineers but to drivers. A driver, many times is more concerned with the consistency or reliability with their travel time than they are with the actual conditions. That allows the driver to better plan their trip, departure time, and arrival time with some level of reliability.

It is recommended for the next update cycle, C/CAG transition to the current 2010 HCM.

**APPENDIX A**

AM and PM Roadway LOS Tabular Results

DRAFT

## **APPENDIX B**

### **TECHNICAL APPENDIX**

- The technical details, database and support documents are included in a separate geographic information system (GIS) deliverable