CONTRA COSTA
transportation
authority

# Congestion Management Program

# 2017 Monitoring Report

Prepared by Iteris. Inc

August, 2017

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# ES Executive Summary

Originally adopted in 1991, Contra Costa County Transportation Authority (CCTA) has updated their Congestion Management Program (CMP) every other year. Monitoring traffic level-of-service (LOS) standards is one of the five elements of the CMP required by Title 7 of the California Government Code - Chapter 2.6 [65088- 65089.10]. As the designated congestion management agency for Contract Costa County, CCTA monitors LOS along its CMP network comprising state highways and principal arterials.

This report illustrates LOS results for the 2017 monitoring effort both for freeways and intersections. Similar to previous years, LOS is calculated using the average speed of vehicles for freeway segments and volume counts for arterial intersections. The methodology used for collecting the data and calculating LOS is based on the technical guidelines developed by CCTA.

A total of 23 freeway segments and 65[1] intersections were monitored in 2017. The freeway segments were monitored using commercial speed data from INRIX and the intersections were monitored with intersection counts to capture auto, bicycle and pedestrian modes. Use of commercial speed data for LOS monitoring was validated by CCTA in spring 2015 through a separate study.

The purpose of this performance evaluation is to determine the existing conditions along the CMP network, analyze trends in traffic congestion, and identify any congested freeway segments or intersections performing below the established LOS standards. Based on the analysis, two freeway segments and one[2] intersection was found to be operating below the adopted LOS standards in the AM peak. In the PM peak, three freeway segments and two[2] intersections were found to be below the adopted LOS standards. Figure ES-1 summarizes these results.

CCTA will conduct further evaluation on the intersections exceeding LOS standards through the preparation of an exclusions study, if required. Based on the results of such an exclusion study, the local jurisdiction may be required to prepare a deficiency plan per the CMP

[1] Data for CMP intersection at North Main Street/San Luis Rd and Southbound I-680 Ramps is unavailable at the time of this draft report

[2] Analysis for the identified LOS F intersections at San Pablo Avenue/John Muir Parkway and San Pablo Avenue/Rumrill Boulevard are pending additional review. CCTA requested intersection signal timing plans for these intersections from their respective jurisdictions.

legislative requirements. This deficiency plan would identify measures to improve the performance of the intersection.

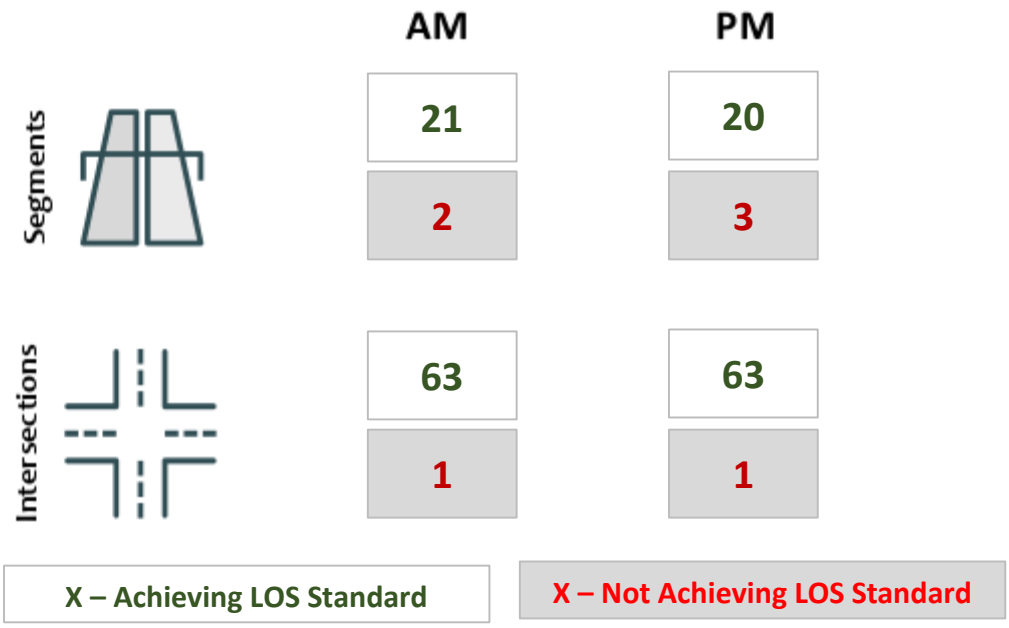


Figure ES-1: Summary of 2017 LOS Results

# 1 Introduction

Contra Costa County with a population of over one million[3] is designated as a Transportation Management Area and is mandated to develop a Congestion Management Program (CMP) per the federal [4] and California regulations[5]. Contra Costa Transportation Authority (CCTA) as a designated Congestion Management Agency is responsible for developing and updating the legislatively required CMP. The CMP is one of the components of the overall strategy to reduce congestion, improve mobility, and increase overall sustainability of the transportation system across the county. As a part of the CMP, CCTA has been performing Level of Service (LOS) monitoring every two years since 1991. This report summarizes the results of the 2017 monitoring.

The report is divided into four chapters:

- **Chapter 1 — Introduction**: describes the Contra Costa County CMP roadway network and the monitoring framework.
- **Chapter 2 — Methodology**: illustrates the systematic approach to gathering and analyzing the performance data.
- **Chapter 3 — Level of Service Monitoring Results:** presents the CMP network's LOS results.
- **Chapter 4 — Summary of Results and Recommendations**: compares and summarizes the LOS results and highlights the recommendations to improve future monitoring.

Supporting tables and additional technical information are included in the Appendices.

## 1.1 CMP Network

The CMP network covers all state highways and certain intersections along principal arterials, as designated by the appropriate regional transportation planning committee. It consists of:

- 23 freeway segments or 95 freeway miles; and
- 65 principal arterial intersections

Figure 1-1 illustrates a map of the CMP network. Table 1-1: List of CMP Segments and Intersections Monitored in 2017

[3] 2010 Census Data
[4] Congestion Management Process in Transportation Management Areas, Title 23, Sec. 450.320
[5] Congestion Management, Title 7, Ch. 2.6, Sec. 65088 - 65089.10

| Roadway Type | Name of the Facility | Number of Segments/ Intersections |
|---|---|---|
| **Freeway Segments** | | |
| Freeways | I-80 | 5 |
| | I-580 | 1 |
| | I-680 | 5 |
| | SR-4 | 7 |
| | SR-24 | 3 |
| | SR-160 | 1 |
| | SR-242 | 1 |
| **Arterial Intersections** | | |
| Arterials | Alhambra Avenue/Pleasant Hill Rd | 2 |
| | Brentwood Boulevard/State Route 4 | 2 |
| | Contra Costa Boulevard | 6 |
| | Cutting Boulevard | 3 |
| | El Portal Drive | 3 |
| | Geary Road | 1 |
| | Main Street | 4 |
| | North Main Street/San Luis Rd | 4 |
| | Pacheco Boulevard | 1 |
| | Railroad Avenue | 3 |
| | San Pablo Avenue/Barrett Avenue | 14 |
| | San Pablo Dam Road | 6 |
| | Taylor Avenue | 1 |
| | Treat Boulevard | 6 |
| | Ygnacio Valley Road | 9 |

provides a summary of these freeway segments and intersections.

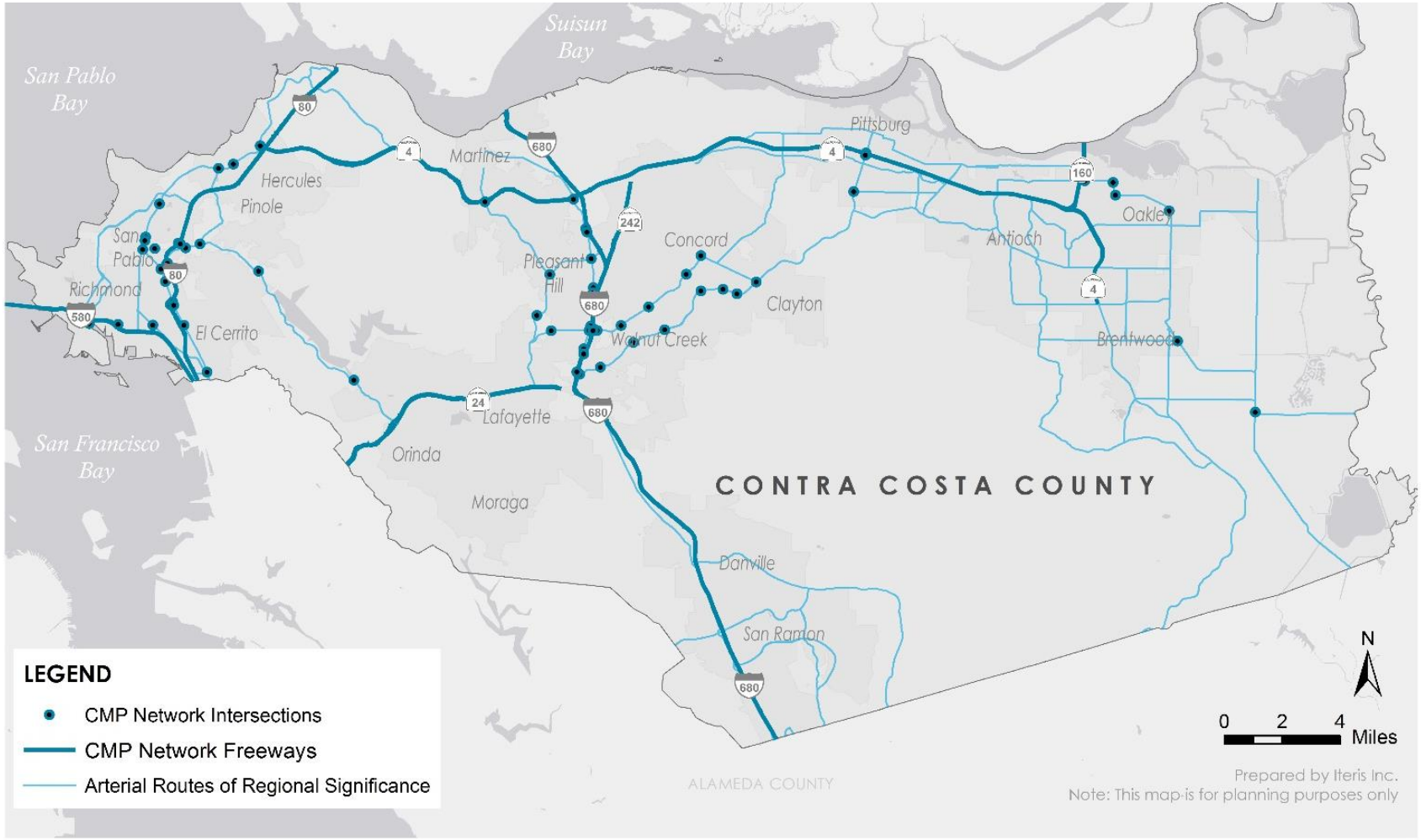


Figure 1-1: Contra Costa County CMP Network

Table 1-1: List of CMP Segments and Intersections Monitored in 2017

| Roadway Type | Name of the Facility | Number of Segments/ Intersections |
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| | Pacheco Boulevard | 1 |
| | Railroad Avenue | 3 |
| | San Pablo Avenue/Barrett Avenue | 14 |
| | San Pablo Dam Road | 6 |
| | Taylor Avenue | 1 |
| | Treat Boulevard | 6 |
| | Ygnacio Valley Road | 9 |

## 1.2 CMP Requirements

The LOS measurements are defined by CCTA for the two facility types included in the CMP network: 1) freeway segments 2) intersections. The LOS for freeways is determined by measuring the average speed of vehicles traveling through the segments. The LOS is classified based on the Highway Capacity Manual (HCM) from LOS A (average speed ≥ 60 mph) to LOS F (average speed <30 mph). The intersections are monitored by measuring the volume to capacity ratio during peak periods based on the intersection turning movement counts.

LOS F was the adopted standard for all monitored freeway segments and intersections that operated at LOS F in 1991. The standard for all other freeway segments and intersections was

adopted to be LOS E. The LOS measurement and evaluation has been conducted every two years to ensure that these adopted LOS standards are being met.

When the LOS calculated at an intersection exceeds the adopted standard, it is further evaluated by conducting additional counts and preparing an exclusions study, as required. Through an exclusion study, LOS is recalculated by accounting for traffic exclusions allowed under the CMP legislation. If a facility is found to exceed the adopted LOS standards even after conducting an exclusion study, then the intersection is subject to a deficiency plan. Preparation of deficiency plans is not a part of the current CMP monitoring effort. Also, the frequency of monitoring such CMP facilities subject to a deficiency plan could be different. Note that intersections at freeway ramps that are operated by Caltrans are not subject to this additional investigation and preparation of a deficiency plan by CCTA.

Furthermore, the CMP effort includes monitoring multi-modal system performance to track the efficiency of mobility of goods and people in the network. To obtain the volume of non-motorized modes, travel bicycle and pedestrian volumes are collected at the CMP intersections.

# 2 Methodology

This chapter provides the description of the criteria and underlying assumptions for the methodology implemented in this study for collecting data and measuring the LOS performance for intersections and freeways.

## 2.1 Intersection Level of Service

In this section, data collection criteria, data collection period and analysis methodology for intersections are described.

The LOS analysis for intersections consists of two steps - data collection and intersection operation analysis. The first step was to obtain traffic counts at the intersections. The second step was to analyze the intersection operations using Synchro software and calculate LOS based on Highway Capacity Manual.

### 2.1.1 Step 1: Data Collection

This section summarizes the monitoring days and methodology for collecting intersection count data for 2015 LOS Monitoring.

#### MONITORING DAYS

The data collection effort was based on the criteria provided in CCTA Technical Procedures[6]. The data collection procedure is established to ensure the data is collected during normal conditions and that the collected data provides reliable data points for trend comparisons. Similar to 2015 monitoring, data was collected considering the following conditions:

- ***Base Monitoring Times***: To represent normal days, data was obtained on weekdays excluding Mondays, Fridays and holiday weeks for the monitoring periods, which were 7am to 9am and 4pm to 6pm during April and May[7].
- ***Public Holidays and Spring Breaks:*** Public holidays and school spring breaks during the monitoring period were reviewed for all school districts/colleges across Contra Costa County and at major universities in adjacent counties, and were excluded from the monitoring days. Figure 2-1 shows the calendar of major holidays and spring breaks on which data collection did not occur.

[6] CCTA Technical Procedure, January 16 2013 (Appendix A)
[7] Additional data at one intersection (CMP 12) will be collected during Fall 2017 when schools are back in session.

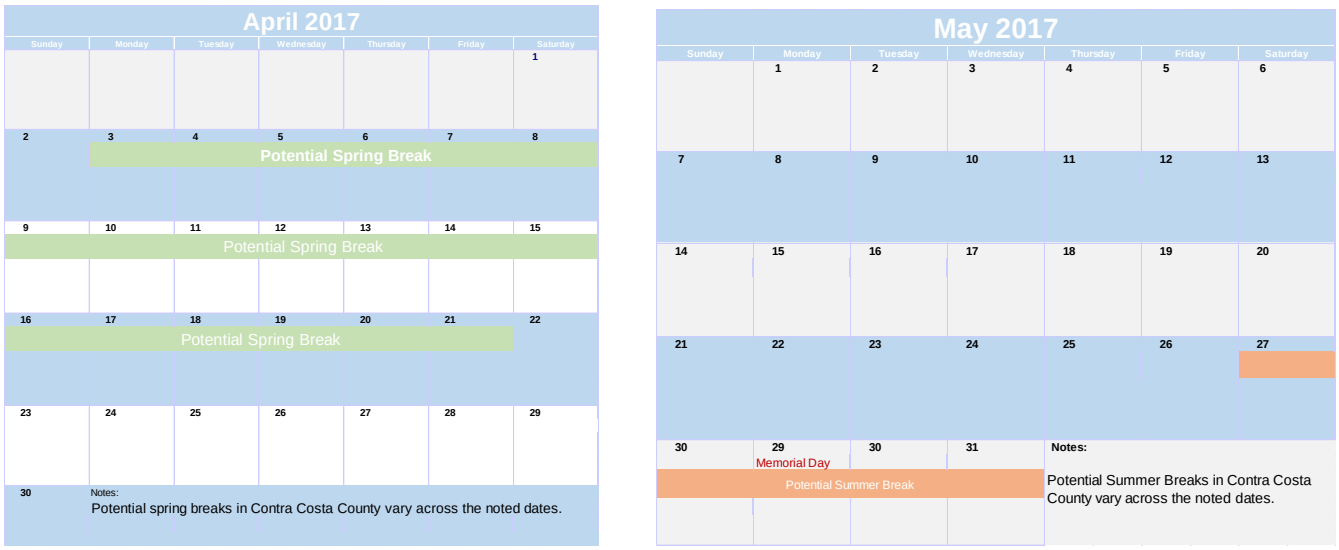



*Figure 2-1: Public Holidays and Spring Break Periods in Contra Cost County, Spring 2017*

- ***Special Events:*** In Contra Costa County, no special events were observed to impact traffic conditions during the 2017 monitoring period.
- ***Fair Weather Condition:*** Intermittent rain was observed during the early half of the 2017 monitoring period. Such rainy days that may have caused potential disruption to the traffic flow have been avoided.
- ***Incidents or Accidents:*** According to the technical protocol, data collection should be repeated if such events take place. No incident observed during data collection period.
- ***Road Closures and Construction Activities:*** In the period of data collection, there were no obstruction or lane closure in the CMP network. The following list are the sources used for identifying significant maintenance and construction events (Figure 2-2):
    - CCTA website and news feed;
    - Social media channels of the transportation agencies and the projects;
    - Caltrans District 4 website;
    - Specific construction project websites (including the Hwy 4 reconstruction project website).


*Figure 2-2: Sources of Construction Activity Information*

DATA COLLECTION METHODOLOGY

Data collection at each intersection consists of the following three primary components:

- **Vehicles** – turning movement counts
- **Bicycles** – approach counts
- **Pedestrians** – crossing counts

The data was collected by recording video at the intersections and post-processing the images to aggregate data for vehicles, bicycles, and pedestrians. The methods followed for collecting and processing the data were similar to 2015 monitoring, and are described below:

- **Video cameras with manual counting:** One of the firms used a combination of video cameras and count personnel. Video cameras were set up in the field at an optimal location that captured the entire intersection layout. Recorded video was then played back in a controlled environment from which vehicle, pedestrian and bicycles counts were manually obtained. The firm undertook a thorough quality control process to review data for accuracy.
- **Video cameras with automated processing:** The second firm used Miovision[8] video units and associated proprietary algorithms and software for automated processing of vehicle, pedestrian and bicycle counts. A multi-step quality control process was undertaken by the firm to ensure accuracy of the counts through manual review.

### 2.1.2 Step 2: Synchro Analysis

The LOS calculations was performed based on HCM methodology and utilizing Synchro application. CCTA Technical Procedure provided additional guidance for evaluating the

[8] https://miovision.com/

signalized intersection in Contra Costa County. The guideline indicate which location-specific data should be used for the analysis:

- Metadata of intersections (street names, street directions, etc.)
- Geometric information of intersections (lane width, number of lanes, etc.)
- Signal controllers configurations (signal timing information, green time, etc.)
- Throughput and count per movement for each intersection from the recent data collection
- Other input parameters in accordance with the CCTA Technical Procedure Guideline and 2010 Highway Capacity Manual.

Synchro intersection network files available from the 2015 monitoring analysis were primarily used for the 2017 monitoring as well. Where deemed appropriate and in consultation with CCTA, revisions were made to the signal timing information for certain intersections to match the most current timing plans available from member agencies.

### 2.1.3 Step 3: LOS Assignment

The LOS analysis was conducted by following the methodologies and criteria established in the CCTA Technical Procedures Guideline and HCM 2010. However, some of the intersections were analyzed using HCM 2000 methodology because of having non-conventional geometry, such as more than four legs, or not following National Electrical Manufacturers Association (NEMA) phasing plan.

The LOS of a signalized intersection is the criterion which determines the quality of the traffic service. The level of service could vary between LOS A---best condition to LOS F---worst condition. Table 2-1 shows different level of services and the corresponding delays.

*Table 2-1: HCM 2010 & 2000 Level of Service Standards for Signalized Intersections*

| Level of Service | Control Delay |
|---|---|
| A | ≤10 |
| B | <10-20 |
| C | <20-35 |
| D | <35-55 |
| E | <55-80 |
| F | >80 |

The evaluation of the signalized intersection LOS is based on the intersection control delay per vehicle for various movements within the intersection. The parameters affecting the control

delay are the pattern of arrivals, delay from queuing and over saturation. LOS A describes the state of very low delays. This means that most of vehicles arrive during the green time. On the other hand, the LOS F represents an intersection with high congestion, over saturation, and long queues.

## 2.2 Freeway Level of Service

In this section, data collection process and data analysis methodology for freeway CMP segments are described.

The LOS analysis for freeways consists of two steps: speed data collection and speed data analysis. In the data collection step, data was obtained from INRIX and PeMS to be cleansed and transformed for the analysis step. In the analysis step average peak hour speeds were calculated by following the HCM methodology.

## 2.3 Step 1: Data Collection

Similar to the previous monitoring efforts, data was collected during the months of February, March, and April 2017. The freeway data was collected on Tuesdays, Wednesdays, and Thursdays for the morning and afternoon peak periods — 6-10 a.m. and 3-7 p.m., respectively.

PeMS lane closure database & incident feeds

Data was prepared for analysis by excluding holidays, incidents, and constructions days. No public holidays were observed on these days. The construction days are identified by referring to the agencies communication channels mentioned earlier in the previous section. Furthermore, PeMS portal was used to eliminate the days experiencing lane closures and incidents. Figure 2-3 visualizes the freeway incidents obtained from PeMS dataset.

The commercial speed data used in this monitoring was provided by INRIX Inc. INRIX is a Data Service Provider which collects real-time traffic data from GPS devices utilized in mobile phones, connected cars, and commercial vehicles. The individual GPS data points aggregated on a unique set of roadway segments called Traffic Message Channels (TMCs). Each TMC link has a unique nine-digit identifier and a plus or negative sign to indicate the direction of travel.

INRIX data has two important features/parameters: average speed of vehicles travelling and the relevant TMC code. The data used in this monitoring was aggregated at the one-minute

intervals. The dataset has over 7 million data points. Note that this data was supplied free of cost to the Bay Area CMAs by MTC through a contract with INRIX.

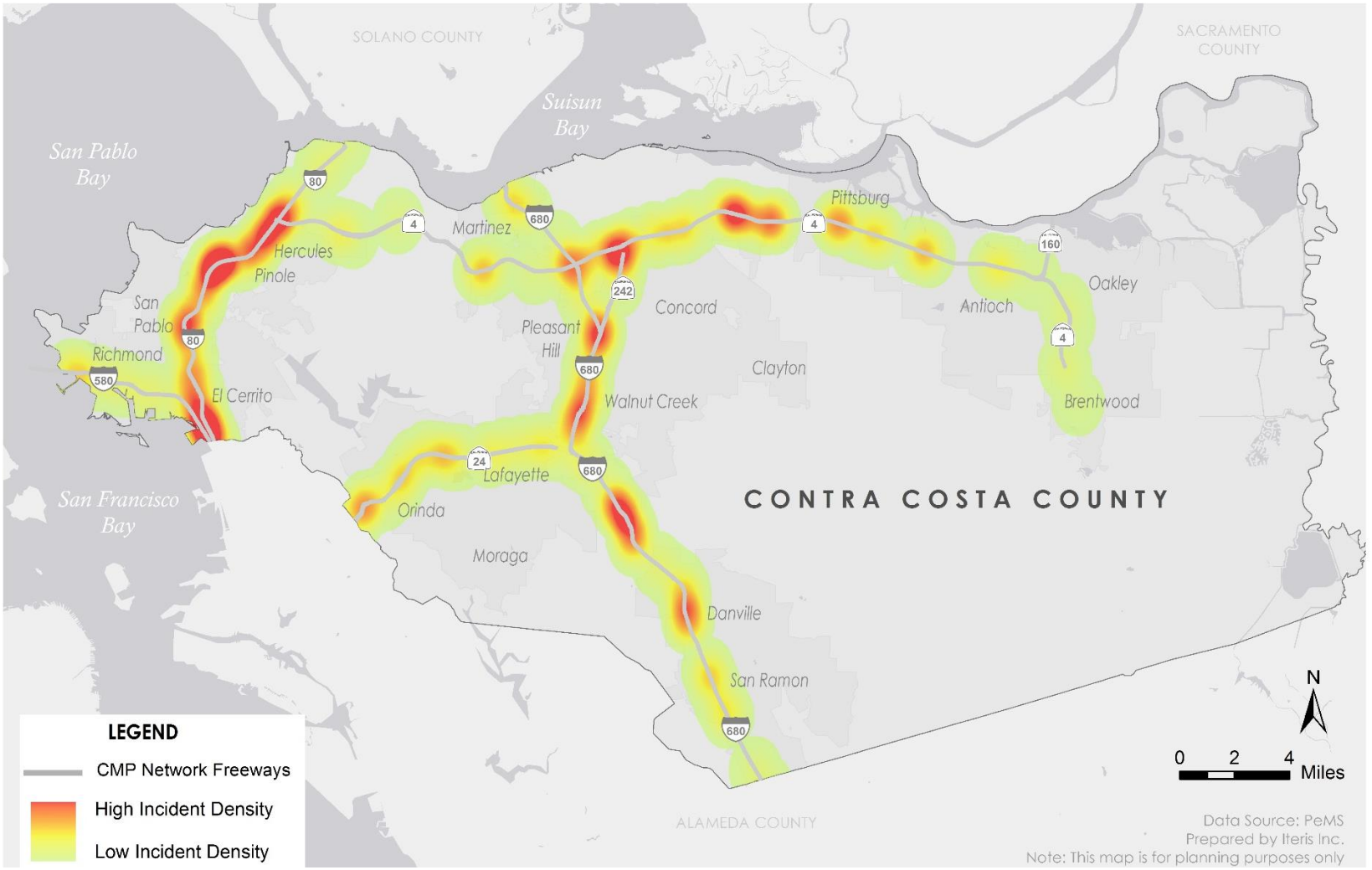



*Figure 2-3: Heat Map showing the Freeway Incident Density in Contra Costa County during 2017 Monitoring (combined morning and afternoon peak periods)*

### 2.3.1 Step 2: Data Analysis

As a first step of the INRIX data analysis, the speed data for all monitoring days and TMC segments in Contra Costa County was reviewed for data quality, accuracy, completeness and consistency. The following is the summary of the steps undertaken:

- TMCs associated with the INRIX speeds were mapped to the CMP segments. Through this step, INRIX Data was transformed to reflect the condition on CMP segments using a spatial mapping process
- In the cleansing process, data points with poor quality were dropped from the dataset and only records collected through direct observation were used
- In the last step, the average of speeds was calculated on CMP segments for every hour within each peak period, at 15-minute intervals. For example, average speed was computed from 6 a.m. to 7 a.m., 6:15 a.m. to 7:15 a.m. and so forth. The hour with lowest average speed were used as the peak hour speed.

For more information about the data analysis methodology refer to Appendix B.

### 2.3.2 Step 3: LOS Assignment

The LOS was determined on each CMP segments by categorizing the average peak hour speeds in the bins established by the HCM (Table 2-2). The level of service is categorized from LOS A to LOS F. LOS A indicates a condition on freeway segment where vehicles travel at free-flow speed and an LOS F indicates freeway capacity failure and congested conditions.

*Table 2-2: Freeway Level of Service Standards (HCM 1985)*

| Level of Service | Control Delay |
|---|---|
| A | ≥60 |
| B | ≥57 |
| C | ≥54 |
| D | ≥46 |
| E | ≥30 |
| F | <30 |

# 3 Level of Service Monitoring Results

This chapter summarizes the results of the 2017 LOS monitoring for intersections and freeway segments.

## 3.1 Intersection Level of Service

There are 65 intersections monitored for Contra Costa County's CMP study. Table 3-1 provides a breakdown of the number of intersections monitored by region.

*Table 3-1: Intersections Segmentation by Region*

| Region/county | # of intersections |
|---|---|
| West County | 26 |
| Central County | 30 |
| East County | 9 |

From the intersections monitored in 2017, two intersections operate at level of service F in peak periods, however only one intersection exceeds LOS standard. Table 3-2 summarizes the results for AM and PM peak periods.

*Table 3-2: Summary of 2015 Intersection LOS Results*

| | Total Intersections | Achieving LOS Standard | Not Achieving LOS Standard |
|---|---|---|---|
| **AM Peak Hour** | 65 | 63 | 1 |
| **PM Peak Hour** | 65 | 63 | 1 |

Note that the results for one CMP intersection are not available at this time. The team noticed discrepancy in the collected data at the following intersection. Hence, data will be conducted again during fall 2017.

- C12: North Main Street-San Luis Road/Southbound I-680 Ramps.

Based on the results, following one (1) location exceeds the adapted LOS standard both in the AM and the PM peak periods:

- W1: San Pablo Avenue/John Muir Parkway (AM and PM)

Note that analysis for CMP intersection at San Pablo Avenue/John Muir Parkway (W1) and San Pablo Avenue/Rumrill Boulevard (W5) are pending additional review. CCTA requested intersection signal timing plans for these intersections from their respective jurisdictions.

Based on the results of the pending review, recounts will be conducted during Fall 2017, as needed, to evaluate the potential deficiency at these intersections.

Figure 3-1 shows the LOS categories and the number of intersections observed in those categories. Most of intersections operate at level of service C and D. There are few intersections operating at a lower LOS (see Figure 3-1).

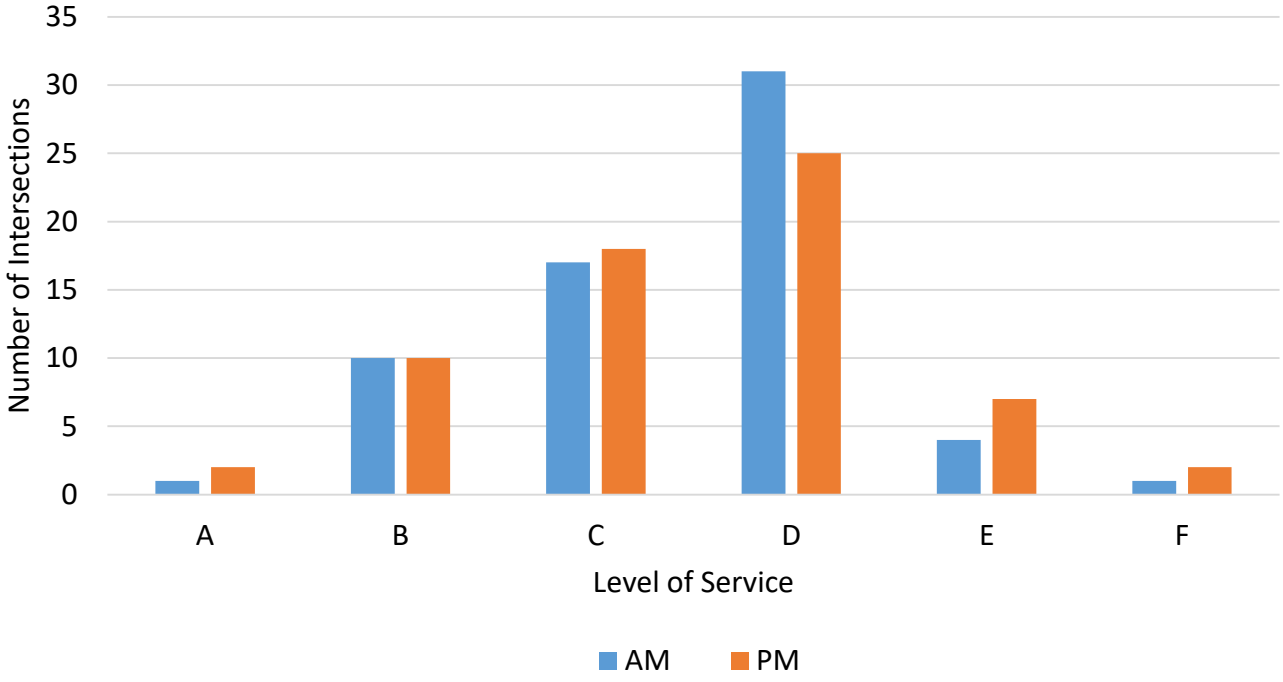



*Figure 3-1: Summary of 2017 Intersection LOS Results*

The following two intersections that exceeded the thresholds in 2015 have showed improvements in the current monitoring:

- Ygnacio Valley Road at Cowell Road in Concord – Improved from LOS F to LOS E in the PM peak period
- Ygnacio Valley Road at the Northbound I–680 Ramps in Walnut Creek - Improved from LOS F to LOS D in the AM peak period

The details of LOS measures for CMP intersections are shown in Table 3-2, Figure 3-2 and Figure 3-3. For more information, refer to Appendix C.

*Table 3-2: 2017 Intersection LOS Results*

| ID | Synchro ID | Facility | Cross Street | LOS Standard | AM Peak | | PM Peak | | HCM Methodology |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Delay | LOS | Delay | LOS | |
| W1 | 1 | San Pablo Avenue | John Muir Parkway | E | 185.8 | F | 239 | F | 2010 |
| W2 | 2 | San Pablo Avenue | Pinole Valley Road | E | 4.9 | A | 13.8 | B | 2010 |
| W3 | 3 | San Pablo Avenue | Appian Way | E | 21.6 | C | 39.6 | D | 2010 |
| W4 | 4 | San Pablo Avenue | Hilltop Drive | E | 42.5 | D | 57.7 | E | 2010 |
| W5 | 5 | San Pablo Avenue | Rumrill Boulevard | F | 37.8 | D | 98.3 | F | 2010 |
| W6 | 6 | San Pablo Avenue | El Portal Drive | E | 33.2 | C | 33.5 | C | 2010 |
| W7 | 7 | San Pablo Avenue | Road 20 | E | 42.2 | D | 47.4 | D | 2000 |
| W8 | 8 | San Pablo Avenue | San Pablo Dam Road | E | 32.5 | C | 37.2 | D | 2000 |
| W9 | 9 | San Pablo Avenue | McBryde Avenue | E | 24 | C | 27.4 | C | 2000 |
| W10 | 10 | San Pablo Avenue/Barrett Avenue | Westbound I–80 Ramps | E | 38.4 | D | 22.9 | C | 2000 |
| W11 | 11 | San Pablo Avenue | Eastbound I–80 Ramps/Roosevelt Ave | E | 16.8 | B | 30.7 | C | 2000 |
| W12 | 12 | San Pablo Avenue | Barrett Avenue | F | 33.8 | C | 34.2 | C | 2010 |
| W13 | 13 | San Pablo Avenue | Cutting Boulevard | E | 29.3 | C | 27.5 | C | 2010 |
| W14 | 14 | San Pablo Avenue | Central Avenue | E | 41.4 | D | 47.2 | D | 2000 |
| W15 | 15 | San Pablo Dam Road | Westbound I–80 Ramps | F | 24.2 | C | 35.9 | D | 2000 |
| W16 | 16 | San Pablo Dam Road | Eastbound I-80 Ramps/Amador St | F | 51.4 | D | 49.7 | D | 2000 |
| W17 | 17 | San Pablo Dam Road | El Portal Drive | E | 45.2 | D | 32 | C | 2000 |
| W18 | 18 | San Pablo Dam Road | Appian Way | E | 62.4 | E | 50.4 | D | 2010 |
| W19 | 19 | San Pablo Dam Road | Castro Ranch Road | E | 25.2 | C | 27.5 | C | 2010 |
| W20 | 20 | San Pablo Dam Road | Bear Creek Road | F | 44.1 | D | 63.6 | E | 2000 |

| ID | Synchro ID | Facility | Cross Street | LOS Standard | AM Peak | | PM Peak | | HCM Methodology |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Delay | LOS | Delay | LOS | |
| W21 | 21 | El Portal Drive | Road 20 | E | 17.7 | B | 14.7 | B | 2000 |
| W22 | 22 | El Portal Drive | Southbound I–80 Ramps | F | 24.9 | C | 18.9 | B | 2010 |
| W23 | 23 | El Portal Drive | Northbound I–80 Ramps | F | 35.4 | D | 23.9 | C | 2010 |
| W24 | 24 | Cutting Boulevard | Canal Boulevard | E | 11.8 | B | 12.1 | B | 2000 |
| W25 | 25 | Cutting Boulevard | Harbour Way | E | 39.7 | D | 41.8 | D | 2010 |
| W26 | 26 | Cutting Boulevard | Carlson Boulevard | E | 26.2 | C | 24.1 | C | 2010 |
| E1 | 27 | Railroad Avenue | Westbound SR-4 Ramps/ California Ave | E | 27.4 | C | 16.1 | B | 2010 |
| E2 | 28 | Railroad Avenue | Eastbound SR-4 Ramps | E | 29.7 | C | 39.8 | D | 2000 |
| E3 | 29 | Railroad Avenue | Buchanan Road | E | 48.5 | D | 23.1 | C | 2000 |
| E4 | 30 | Main Street | Neroly Road | E | 23.3 | C | 26.8 | C | 2000 |
| E5 | 31 | Main Street | Big Break Road | E | 19.7 | B | 48.5 | D | 2010 |
| E6 | 32 | Main Street | Oakley Road/Empire Rd | E | 13.7 | B | 18.3 | B | 2010 |
| E7 | 33 | Main Street | Cypress Road | E | 28.5 | C | 43.1 | D | 2010 |
| E8 | 34 | Brentwood Boulevard | Balfour Road | E | 47.8 | D | 51.3 | D | 2010 |
| E9 | 35 | Brentwood Boulevard/State Route 4 | Byron Highway | E | 41.8 | D | 29.8 | C | 2000 |
| C1 | 36 | Alhambra Avenue | Eastbound Ramps to State Route 4 | E | 22.7 | C | 18 | B | 2000 |
| C2 | 37 | Alhambra Avenue/Pleasant Hill Rd | Taylor Boulevard | F | 41.8 | D | 50.1 | D | 2010 |
| C3 [2] | 38 | Pacheco Boulevard | Muir Road | E | 32 | C | 46.7 | D | 2000 |
| C4 | 39 | Contra Costa Boulevard | Southbound Ramps to I–680 | E | 40.3 | D | 49.8 | D | 2000 |
| C5 | 40 | Contra Costa Boulevard | Concord Avenue/Chilpancingo Parkway | E | 43.6 | D | 56.5 | E | 2010 |

| ID | Synchro ID | Facility | Cross Street | LOS Standard | AM Peak | | PM Peak | | HCM Methodology |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Delay | LOS | Delay | LOS | |
| C6 | 41 | Contra Costa Boulevard | Willow Pass Road/Taylor Boulevard | E | 37.8 | D | 44.9 | D | 2010 |
| C7 | 42 | Contra Costa Boulevard | Gregory Lane/Southbound I–680 Ramp | E | 37.3 | D | 29.7 | C | 2000 |
| C8 | 43 | Contra Costa Boulevard | Monument Boulevard | F | 53.7 | D | 39.7 | D | 2010 |
| C9 | 44 | Contra Costa Boulevard | Boyd Road/Southbound I–680 Ramp | E | 18.1 | B | 18.6 | B | 2000 |
| C10 | 45 | North Main Street | Sunnyvale Avenue/Southbound I–680 Ramps | E | 37 | D | 60.7 | E | 2010 |
| C11 | 46 | North Main Street | Geary Road | E | 41.2 | D | 61.3 | E | 2000 |
| C12 [1] | 47 | North Main Street/San Luis Rd | Southbound I-680 Ramps (near San Luis) | F | 0 | 0 | 0 | 0 | 2010 |
| C13 | 48 | North Main Street | Northbound I-680 Ramps (north of Parkside) | F | 14 | B | 8.9 | A | 2000 |
| C14 | 49 | Taylor Avenue | Withers Avenue | E | 15.6 | B | 19.5 | B | 2010 |
| C15 | 50 | Geary Road | Pleasant Hill Road | E | 19.8 | B | 27.4 | C | 2000 |
| C16 | 51 | Treat Boulevard | Clayton Road | E | 49.1 | D | 48.1 | D | 2000 |
| C17 | 52 | Treat Boulevard | Cowell Road | E | 57.8 | E | 42.4 | D | 2010 |
| C18 | 53 | Treat Boulevard | Oak Grove Road | E | 68 | E | 48.6 | D | 2010 |
| C19 | 54 | Treat Boulevard | Bancroft Road | E | 48.8 | D | 46.1 | D | 2010 |
| C20 | 55 | Treat Boulevard | Oak Road | E | 40.9 | D | 28.4 | C | 2010 |
| C21 | 56 | Treat Boulevard | Buskirk Avenue/Northbound I–680 Ramps | E | 30.1 | C | 17.4 | B | 2010 |
| C22 | 57 | Ygnacio Valley Road | Clayton Road | E | 39 | D | 37.6 | D | 2010 |

| ID | Synchro ID | Facility | Cross Street | LOS Standard | AM Peak | | PM Peak | | HCM Methodology |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Delay | LOS | Delay | LOS | |
| C23 | 58 | Ygnacio Valley Road | Alberta Way | E | 46.7 | D | 34.6 | C | 2010 |
| C24 | 59 | Ygnacio Valley Road | Ayers Road | E | 51.3 | D | 57.6 | E | 2010 |
| C25 | 60 | Ygnacio Valley Road | Cowell Road | E | 50.2 | D | 62.3 | E | 2010 |
| C26 | 61 | Ygnacio Valley Road | Oak Grove Road | E | 55.3 | E | 54.6 | D | 2000 |
| C27 | 62 | Ygnacio Valley Road | Bancroft Road | E | 44.1 | D | 47.8 | D | 2000 |
| C28 | 63 | Ygnacio Valley Road | Walnut Boulevard | E | 25.8 | C | 21.4 | C | 2000 |
| C29 | 64 | Ygnacio Valley Road | Northbound I–680 Ramps | E | 46.5 | D | 47.6 | D | 2000 |
| C30 | 65 | Ygnacio Valley Road | Southbound I–680 Ramps | E | 11.1 | B | 6.9 | A | 2000 |

[1] Data is unavailable for the draft report. Iteris will collect data in fall, 2017
[2] Intersection operates at LOS F in the AM peak per HCM 2010 methodology

Note 1: Delay is reported in seconds
Note 2: Highlighted cells indicate LOS exceeds standard.

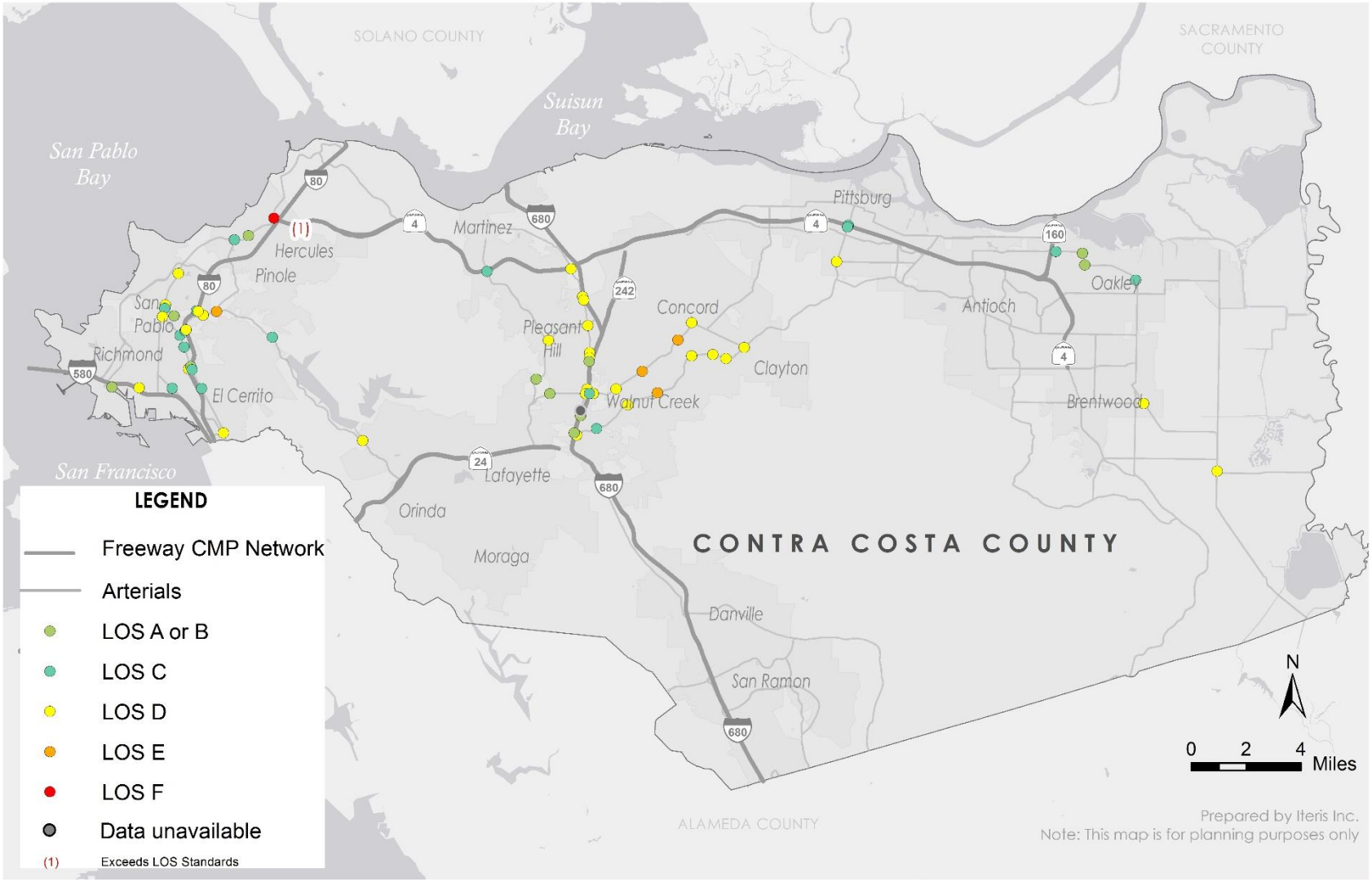



*Figure 3-2: 2017 Intersection LOS Results during AM Peak Period*

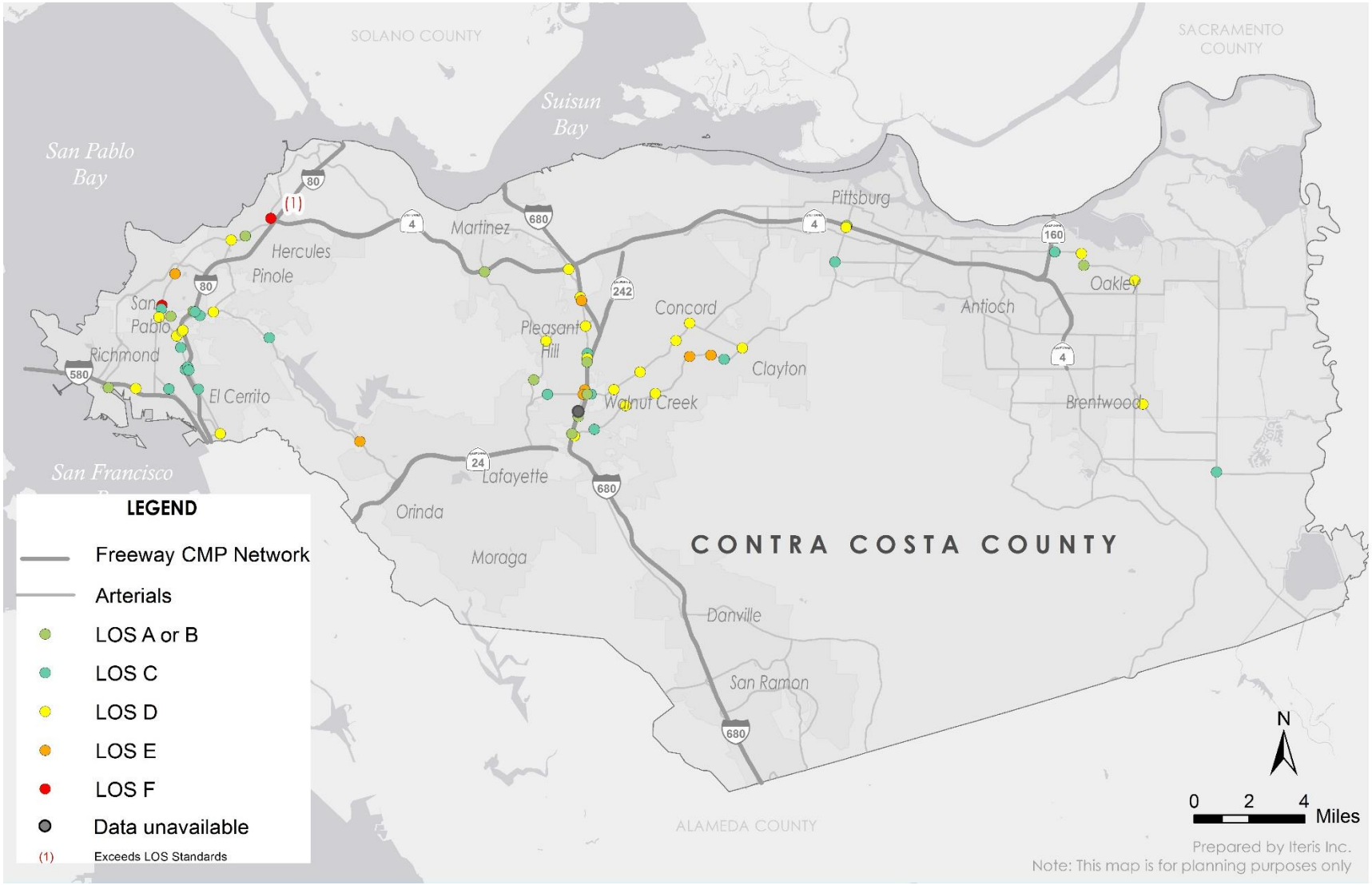



*Figure 3-3: 2017 Intersection LOS Results during PM Peak Period*

## 3.2 Freeway Level of Service

There are 23 freeway segment defined in CMP for monitoring the level of service. Table 3-3 represents number of intersections meets LOS standard for AM and PM peak hours.

*Table 3-3: Summary of 2015 Freeway LOS Results*

| | Total Segments | Achieving LOS Standard | Not Achieving LOS Standard |
|---|---|---|---|
| **AM Peak Hour** | 23 | 21 | 2 |
| **PM Peak Hour** | 23 | 20 | 3 |

During 2017 CMP Monitoring, 21 segments met the LOS standard in the AM peak and 20 segments met the standard in the PM peak. The five segments that do not meet the LOS standard are noted below:

- SR-24 between Oak Hill Road and I-680 in the Westbound direction during the AM peak (same as 2015 results)
- I-580 between Richmond Bridge and Alameda County Line in the Westbound direction during the AM peak (new to 2017)
- SR-4 between I-680 and State Route 242 in the Eastbound direction during the PM peak (same as 2015 results)
- SR-24 between Alameda County Line and Camino Pablo in the Eastbound direction during PM peak (new to 2017)
- SR-242 between I-680 and State Route 4 in the Northbound direction during the PM peak (new to 2017)

Other notable changes were observed along SR 4 between State Route 160 to Loveridge Road. SR 4 in the westbound direction during the AM peak and SR 4 in the eastbound direction during the PM peak improved significantly from LOS F in 2015 to LOS B and LOS A in 2017, respectively. Additionally, I-680 between El Cerro Blvd and Bollinger Canyon Road in the northbound direction improved from LOS F in 2015 to LOS E in 2017, during the PM peak hour.

Figure 3-4 and Figure 3-5 present the LOS calculated for each freeway CMP segment. Additional tables comparing the results with 2015 monitoring report are included in Appendix D.

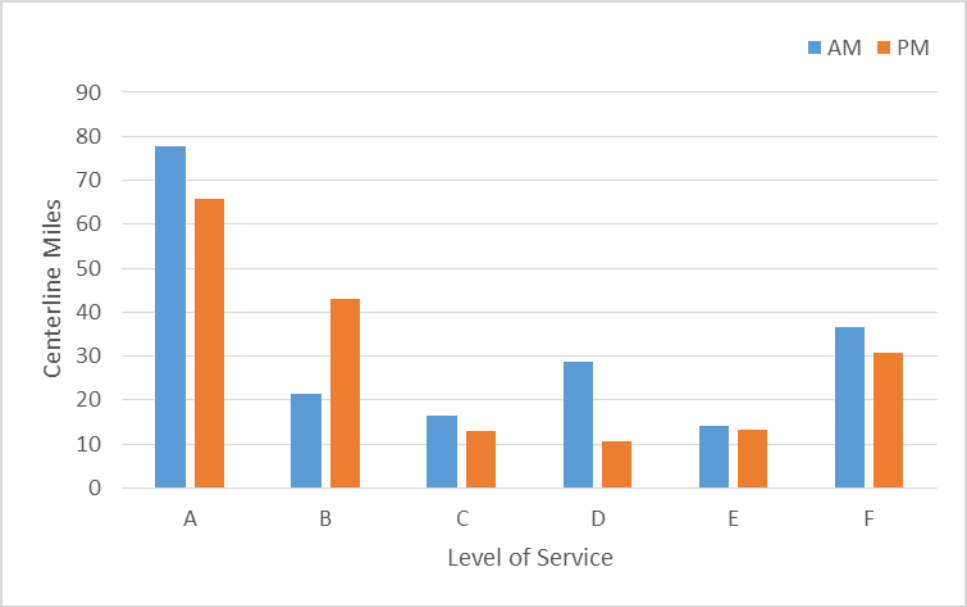



*Figure 3-4: Centerline Miles of the CMP Network Performing at each LOS*

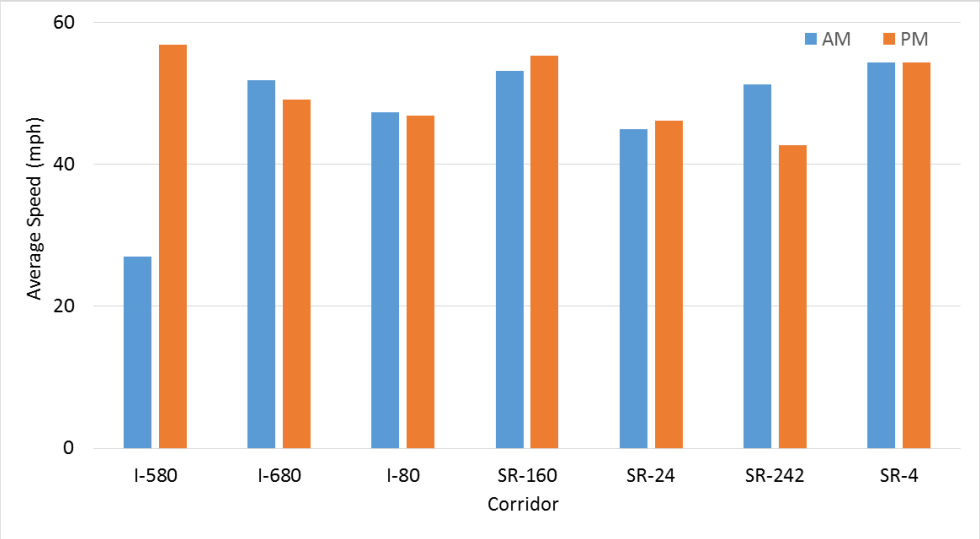



*Figure 3-5: Average Bi-directional Speed by Corridor in the CMP Network*

*Table 3-4: 2017 CMP Freeway Segments LOS Results*

| Segment Information | | | | AM Peak | | PM Peak | | LOS Standard |
|---|---|---|---|---|---|---|---|---|
| ID | Route | Limits | Dir. | AM Speed | AM LOS | PM Speed | PM LOS | |
| F80-1 | I-80 | Carquinez Bridge to Cummings Skyway | EB | 55.5 | C | 59.7 | B | F |
| F80-1 | I-80 | Carquinez Bridge to Cummings Skyway | WB | 62.4 | A | 65 | A | E |
| F80-2 | I-80 | Cummings Skyway to State Route 4 | EB | 65.4 | A | 62.6 | A | F |
| F80-2 | I-80 | Cummings Skyway to State Route 4 | WB | 50.2 | D | 66.7 | A | E |
| F80-3 | I-80 | State Route 4 to San Pablo Dam Road | EB | 62.1 | A | 23.8 | F | F |
| F80-3 | I-80 | State Route 4 to San Pablo Dam Road | WB | 21.6 | F | 57.5 | B | F |
| F80-4 | I-80 | San Pablo Dam Road to Cutting Blvd. | EB | 75 | A | 20.8 | F | F |
| F80-4 | I-80 | San Pablo Dam Road to Cutting Blvd. | WB | 22.4 | F | 57.9 | B | F |
| F80-5 | I-80 | Cutting Blvd. to Alameda County | EB | 66 | A | 18.6 | F | F |
| F80-5 | I-80 | Cutting Blvd. to Alameda County | WB | 17.3 | F | 64.3 | A | F |
| F680-1 | I-680 | Benicia Bridge to State Route 4 | NB | 62.7 | A | 59.6 | B | F |
| F680-1 | I-680 | Benicia Bridge to State Route 4 | SB | 50.4 | D | 69.1 | A | F |
| F680-2 | I-680 | State Route 4 to State Route 242 | NB | 75.3 | A | 57 | B | E |
| F680-2 | I-680 | State Route 4 to State Route 242 | SB | 51.7 | D | 63.4 | A | F |
| F680-3 | I-680 | State Route 242 to El Cerro Blvd. | NB | 57.6 | B | 24.1 | F | F |
| F680-3 | I-680 | State Route 242 to El Cerro Blvd. | SB | 26.5 | F | 52.8 | D | F |
| F680-4 | I-680 | El Cerro Blvd. to Bollinger Canyon Road | NB | 55.3 | C | 37.8 | E | E |
| F680-4 | I-680 | El Cerro Blvd. to Bollinger Canyon Road | SB | 57.8 | B | 56.3 | C | F |
| F680-5 | I-680 | Bollinger Canyon Rd. to Alameda County Line | NB | 55.1 | C | 66.5 | A | E |
| F680-5 | I-680 | Bollinger Canyon Rd. to Alameda County Line | SB | 66 | A | 52.9 | D | E |
| F580-1 | I-580 | Richmond Bridge to Alameda County Line | EB | 32 | E | 59.6 | B | E |
| F580-1 | I-580 | Richmond Bridge to Alameda County Line | WB | 22.1 | F | 54.3 | C | E |
| F4-1 | SR-4 | I-80 to Cummings Skyway | EB | 48 | D | 59.9 | B | F |
| F4-1 | SR-4 | I-80 to Cummings Skyway | WB | 60 | A | 61.4 | A | F |
| F4-2 | SR-4 | Cummings Skyway to I-680 | EB | 62.1 | A | 30.9 | E | E |

| Segment Information | | | | AM Peak | | PM Peak | | LOS Standard |
|---|---|---|---|---|---|---|---|---|
| ID | Route | Limits | Dir. | AM Speed | AM LOS | PM Speed | PM LOS | |
| F4-2 | SR-4 | Cummings Skyway to I-680 | WB | 62.8 | A | 62.5 | A | E |
| F4-3 | SR-4 | I-680 to State Route 242 | EB | 60 | A | 9.5 | F | E |
| F4-3 | SR-4 | I-680 to State Route 242 | WB | 40.2 | E | 56.1 | C | E |
| F4-4 | SR-4 | State Route 242 to Bailey Road | EB | 63.8 | A | 26.6 | F | F |
| F4-4 | SR-4 | State Route 242 to Bailey Road | WB | 23.7 | F | 66.3 | A | F |
| F4-5 | SR-4 | Bailey Road to Loveridge Road | EB | 65.7 | A | 59.5 | B | F |
| F4-5 | SR-4 | Bailey Road to Loveridge Road | WB | 13.8 | F | 57.6 | B | F |
| F4-6 | SR-4 | Loveridge Road to State Route 160 | EB | 61.7 | A [1] | 61.8 | A [1] | F |
| F4-6 | SR-4 | Loveridge Road to State Route 160 | WB | 59.8 | B [1] | 67.9 | A [1] | F |
| F4-7 | SR-4 | State Route 160 to Sand Creek Road | EB | 58.3 | B | 58.2 | B | E |
| F4-7 | SR-4 | State Route 160 to Sand Creek Road | WB | 63.1 | A | 63.3 | A | E |
| F24-1 | SR-24 | Alameda County Line to Camino Pablo | EB | 61.1 | A | 28.9 | F | E |
| F24-1 | SR-24 | Alameda County Line to Camino Pablo | WB | 37.3 | E | 63.1 | A | F |
| F24-2 | SR-24 | Camino Pablo to Oak Hill Road | EB | 60.9 | A | 27.5 | F | F |
| F24-2 | SR-24 | Camino Pablo to Oak Hill Road | WB | 29 | F | 66.7 | A | F |
| F24-3 | SR-24 | Oak Hill Road to I-680 | EB | 60.7 | A | 23.6 | F | F |
| F24-3 | SR-24 | Oak Hill Road to I-680 | WB | 21.5 | F | 64.8 | A | E |
| F160-1 | SR-160 | SR-4 to County Line | EB | 50.5 | D [1] | 52.2 | D [1] | E |
| F160-1 | SR-160 | SR-4 to County Line | WB | 56.2 | C | 58.9 | B | E |
| F242-1 | SR-242 | I-680 to State Route 4 | NB | 65.4 | A | 19.1 | F | E |
| F242-1 | SR-242 | I-680 to State Route 4 | SB | 37.3 | E | 66.4 | A | F |

[1] 95% TMC coverage used for analysis. See Appendix B for additional details.

Note 1: Average speed is reported in mph

Note 2: Highlighted cells indicate LOS exceeds standard.

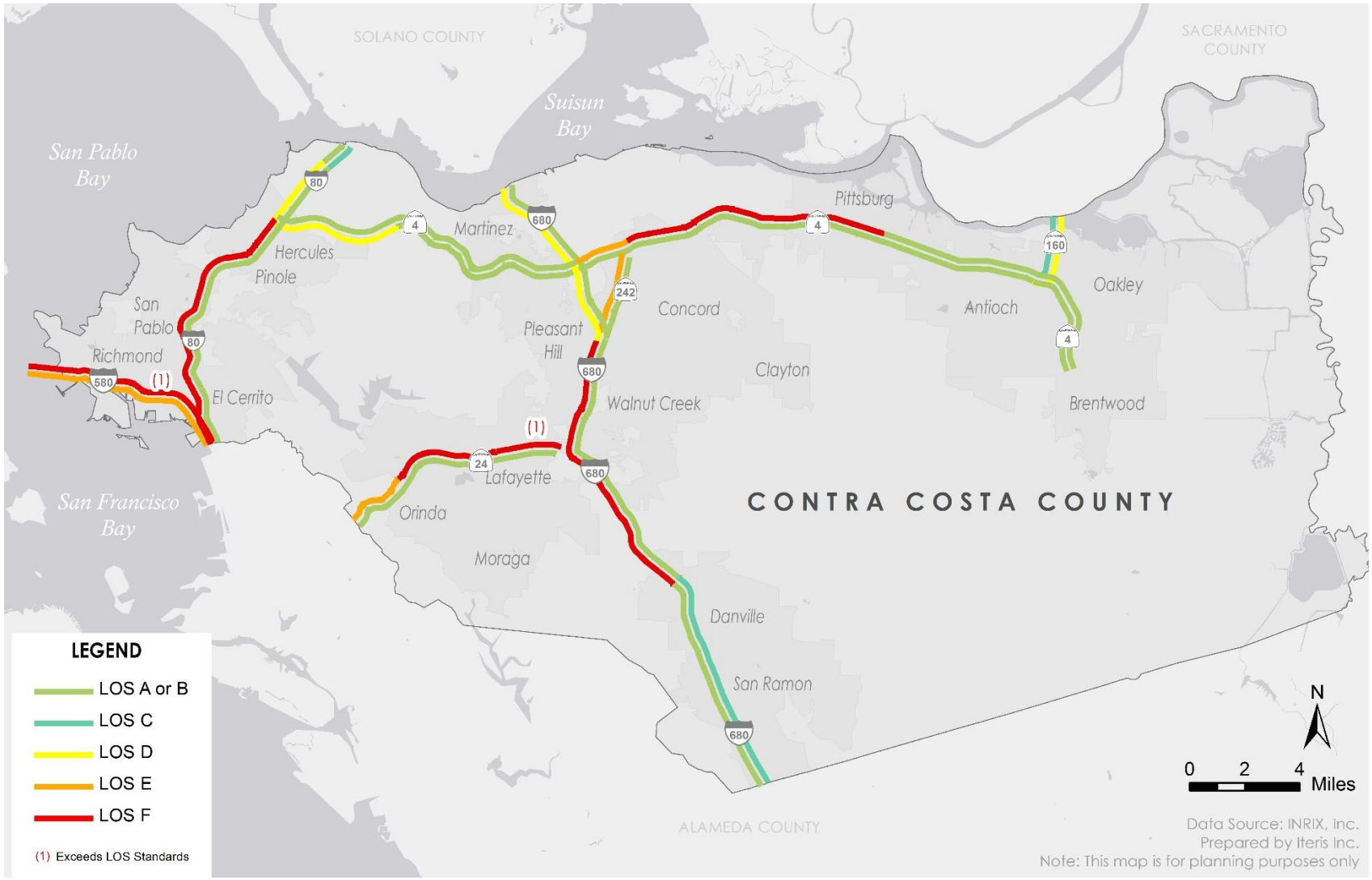



*Figure 3-6: 2017 Freeway LOS Results during AM Peak Period*

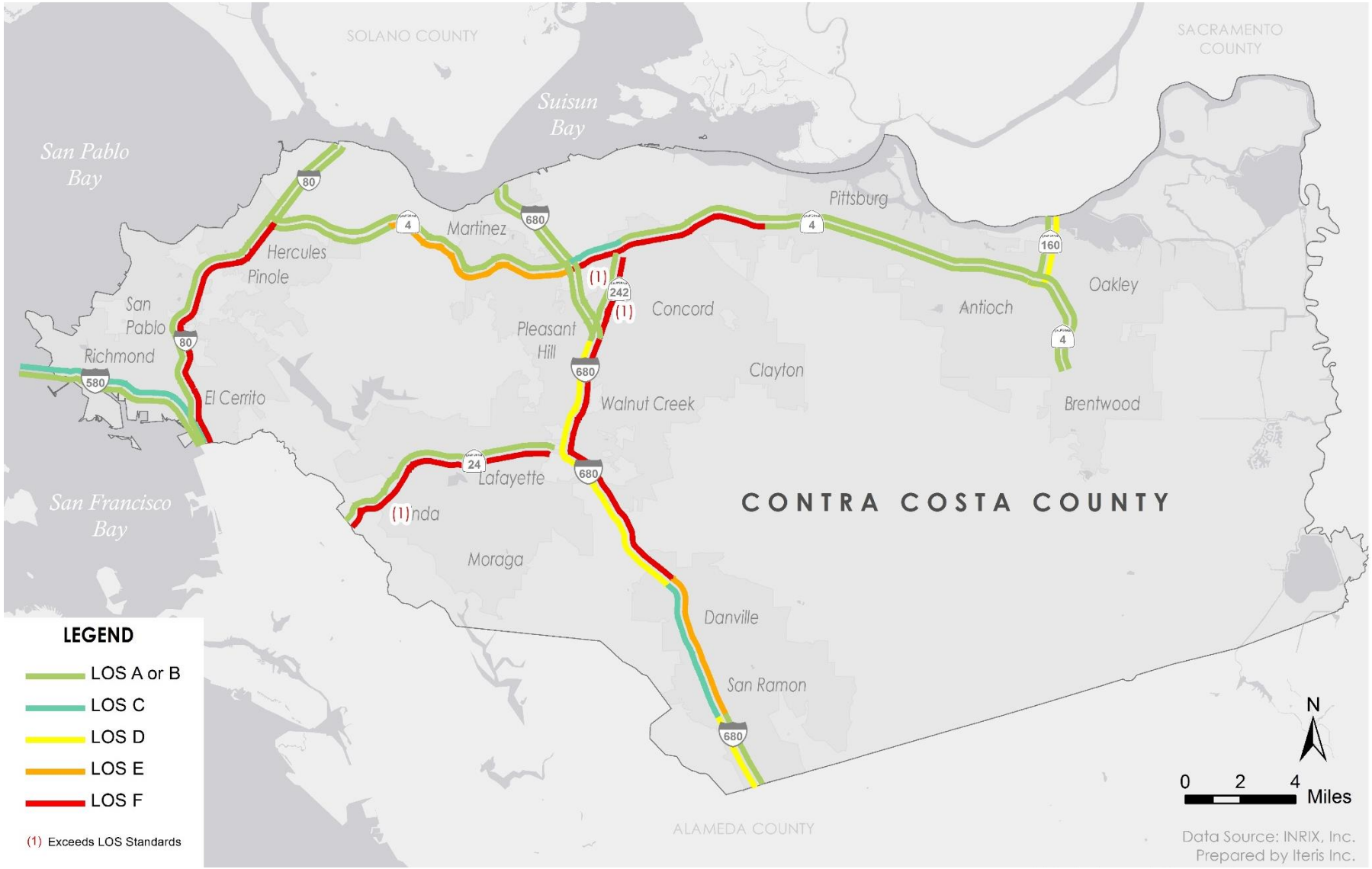



*Figure 3-7: 2017 Freeway LOS Results during PM Peak Period*

# 4 Conclusions and Recommendations

An overview of the trends, future projects, and recommendations for future monitoring are discussed in this chapter.

## 4.1 Trend Analysis

Traffic congestion on the CMP network overall has stayed stable even as average speeds at a few monitoring locations showed significant reductions. The following sections illustrate the trends in more detail.

## 4.2 Intersection LOS Trend

The comparison of the intersection LOS between 2015 and 2017 monitoring periods shows the number of intersections operating in LOS A-D increased in AM peak but decreased in PM peak. The number of intersections operating at LOS E or worse decreased in AM peak but increased in PM peak (see Figure 4-1).

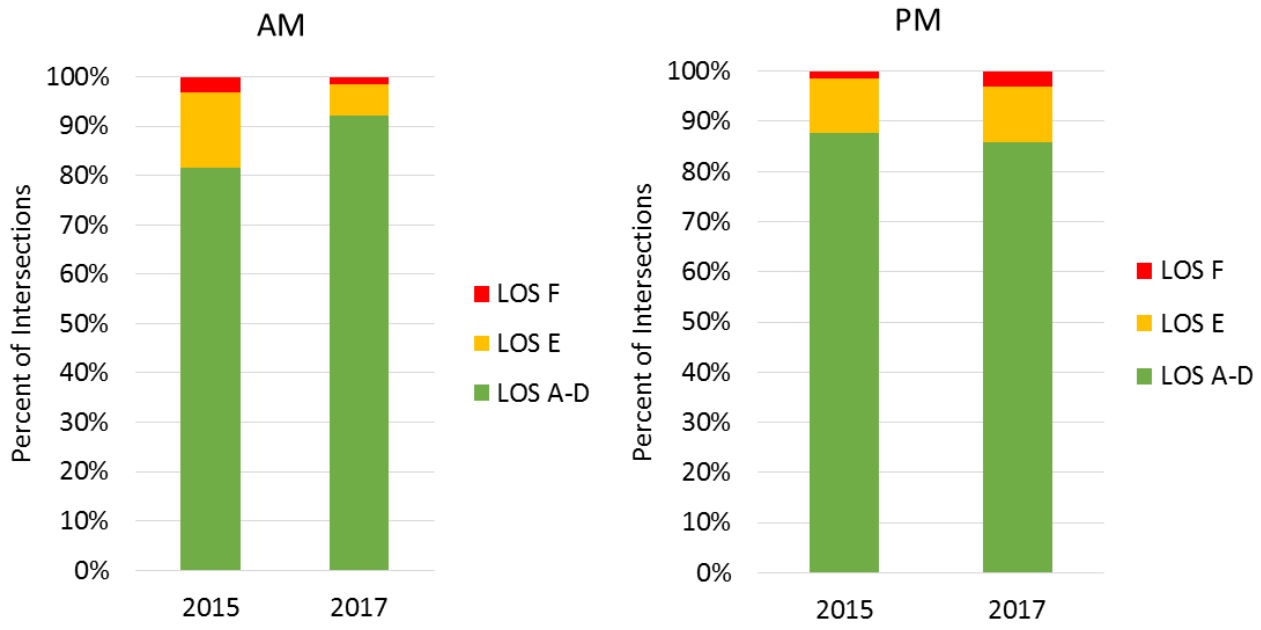



*Figure 4-1: Intersection LOS Comparison between 2015 and 2017 LOS Monitoring*

Figure 4-2 provides the change in LOS scores from 2015 to 2017. The negative score represents a situation which the LOS is getting worse and a positive score represents achieving a better level of service in 2017. For instance, a change of negative two (-2) indicates the level of service

degraded by two levels. Assume an intersection with level of service A in 2015 worsen to level of service C in 2017.

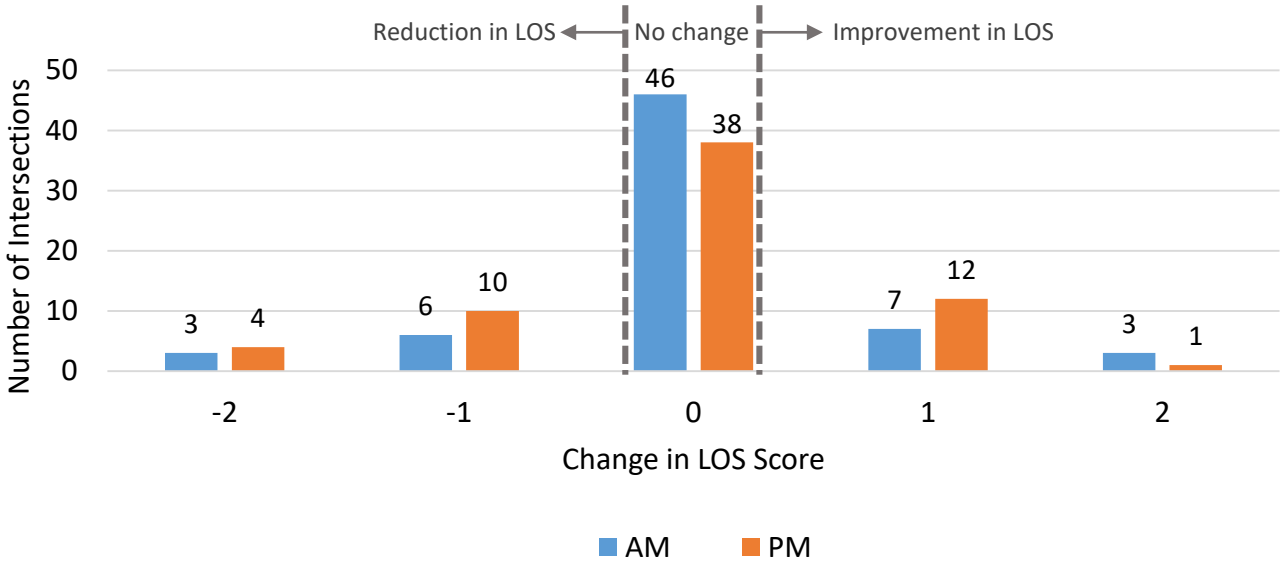



*Figure 4-2: Change in LOS Score from 2015 to 2017*

Most of intersections did not experience any change in level of service. This compromises of approximately 70% in the AM and 60% in the PM peak periods. For both AM and PM, most intersections worsened by one or two LOS scores.

### 4.2.1 Freeway LOS Trends

Freeway has remained steady in comparison with 2015 monitoring (see Figure 4-3). The number of freeways operating at LOS E or worse dropped slightly from 15 to 13 and from 13 to 12, in the AM and PM peak, respectively. Additionally, the freeway operating at LOS A-D showed a similar trend.

Figure 4-4 shows changes in average speed combined for both directions between 2015 and 2017, along with a comparison between 2015 and 2013. Overall, the reduction of average speeds on the freeways has seen a steady decline in the past few years. The freeways experiencing slower traffic speeds saw a reduction in average speed of 2 MPH, compared to 2015. In comparison with the trends identified in the last monitoring cycle, SR-4 and SR-242 in the AM peak showed significant improvements. However, the reduction in speeds along SR-24 in the AM peak got aggravated since 2013.

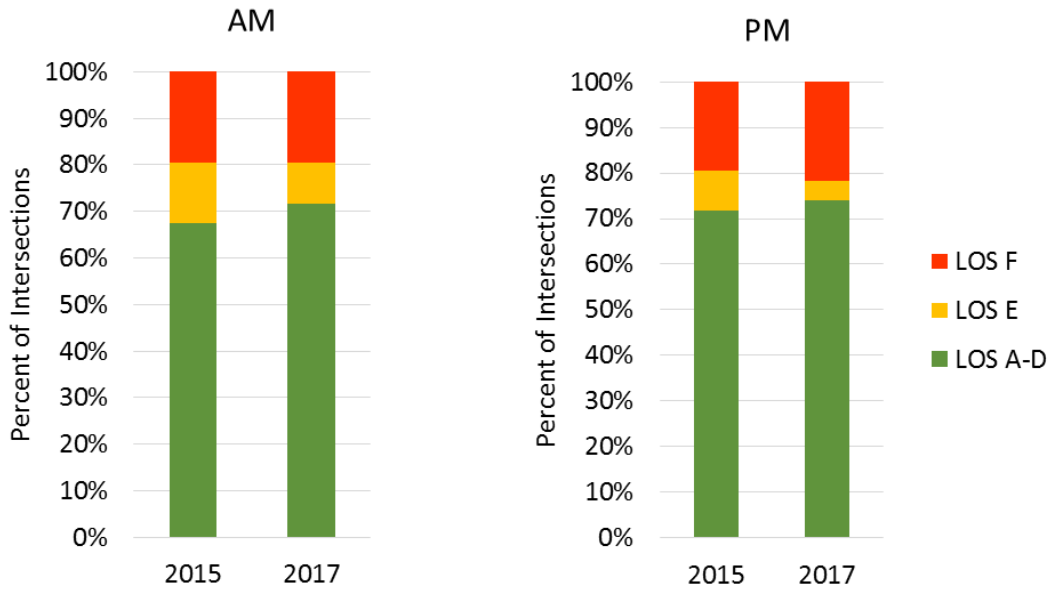



*Figure 4-3: Freeway Segment LOS Comparison between 2015 and 2017 LOS Monitoring*

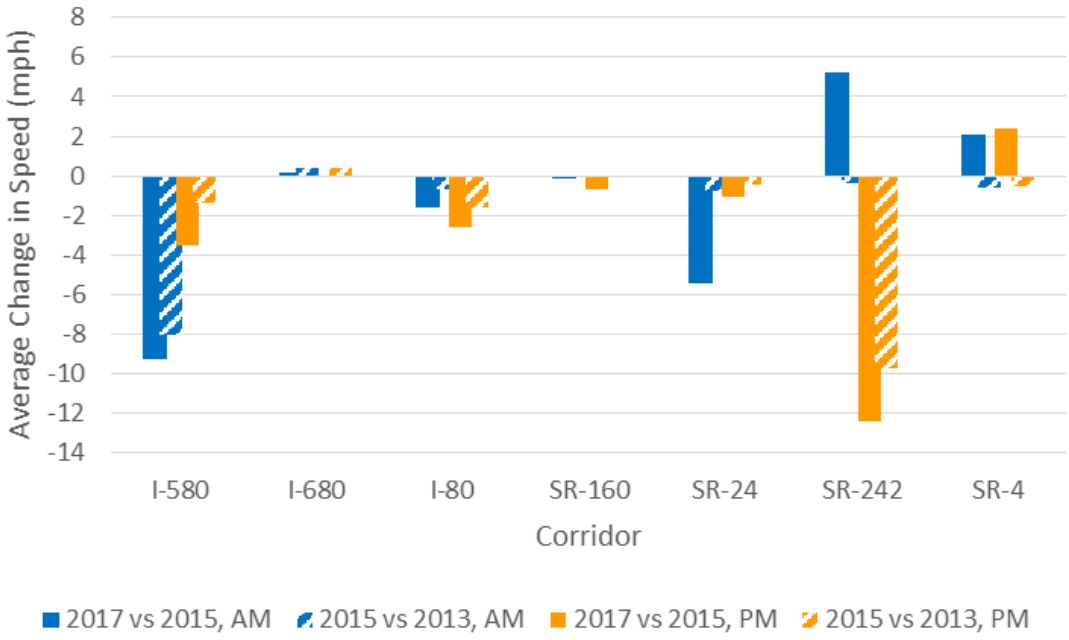



*Figure 4-4: Change in Freeway Corridor Speed from 2015 Monitoring Results to 2017, compared with changes from 2013 to 2015*

### 4.2.2 Employment Trends

2013 and 2017 indicates a close correlation between employment growth and delay growth (see Figure 4-5). The employment data is obtained from Bureau of Labor Statistics for Oakland-Hayward-Berkeley metropolitan area from January 2013 to May 2017. The freeway delay is collected from PeMS for the speed threshold of 35 mph for the same period. PeMS computes delay as the amount of extra time spent by all of the vehicles travelling at a speed lower than threshold speed. This figure shows an overall trend of increasing employment and delay from 2013 to 2017.

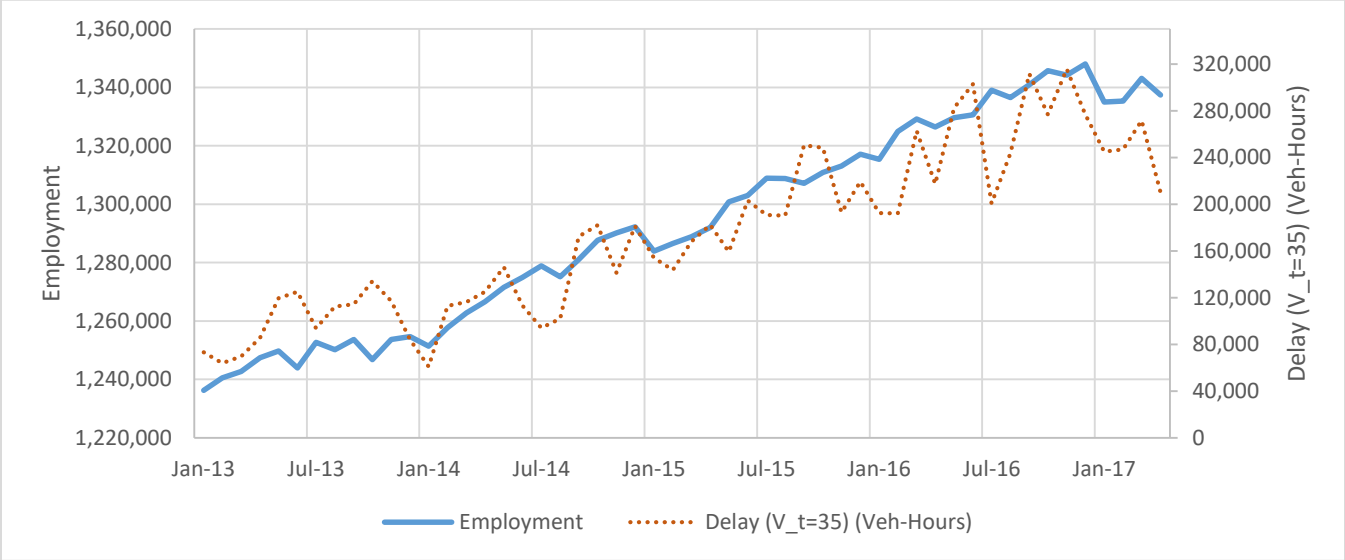



*Figure 4-5: Trends in Employment and Freeway Delay between 2013 to 2017*

## 4.3 Current and Future Improvements and Projects

In 2017, INRIX data collected along the CMP segments impacted by construction activities is identified and excluded from the analysis, to ensure that the data is representative of typical traffic condition experienced by a daily commuter. Major ongoing construction throughout the entire monitoring affects the flow of traffic due to heavy equipment at the site, modification to road geometry, and construction-related traffic, even though these work do not directly cause temporary traffic disruptions during the peak hours. Table 4-1 presents active major construction projects in the Contra Costa County during the entire monitoring period.

*Table 4-1: Active Long-term Projects along the CMP Network during Spring 2017*

| Impacted Roads | Extents | Description of Work |
|---|---|---|
| I-80 | San Pablo Avenue to San Pablo Dam Road | I-80/San Pablo Dam Road Interchange Reconstruction |
| SR-4 | SR-4/Balfour Road | SR-4/Balfour Road Interchange |
| I-680 Southbound | Rudgear Road to Alcosta Blvd | Express Lanes |
| I-580/Richmond-San Rafael Bridge Eastbound | Sir Francis Drake Blvd on-ramp to Marine Street exist | Richmond-San Rafael Bridge Access Improvement |

San Pablo Dam Road/I-80 Interchange Improvement Project, Richmond-San Rafael Bridge Access Improvement and SR-4/Balfour Road Interchange construction project aim to relieve congestion, address major delay and improve access for pedestrian and bicycle traffic. I-680 Express Lane project is anticipated to maximize the efficiency of the current roadway network, enhance reliability and encourage carpools.

In addition to these current construction projects, the following planned projects are anticipated to be in-progress or completed prior to the next CMP monitoring:

- I-680 Northbound express lanes from N. Main St. in Walnut Creek to the Benicia Bridge
- SR-4/I-680 Project from Glacier Drive to Port Chicago Hwy

It is anticipated that some of these completed projects can have a positive impact on the freeway operations in the next monitoring cycle.

# 5 Recommendations for Future Monitoring

The significant changes made in 2015, such as the use of commercial speed data, HCM methodology and Synchro Software for calculating LOS, were carried into the 2017 monitoring. For future monitoring, specific intersection and freeway monitoring recommendations outlined in the 2015 monitoring report may be considered for implementation. Some of those key recommendations include:

- Reporting LOS for all the CMP intersections using HCM 2010
- Expanding the freeway monitoring to include advanced reliability metrics, additional monitoring time periods or additional arterial segments (in lieu of the intersection LOS)

To pursue further improvements, following additional enhancements may be considered:

## 5.1 Extend the Use of Big Data Analytics

For the 2019 monitoring cycle, CCTA could consider expanding big data analytics. It is recommended that CCTA could improve the reliability of transportation network and increase its efficiency in ways that expands big data analytics to other modes of transportation and special lanes. In recent years, commercial speed data providers have improved their data availability and quality. INRIX and other commercial providers periodically expand their TMC network. Therefore, it is recommended that CCTA review the availability of data along ramp connectors, HOV and express lanes, in the future and include them in the monitoring network.

For transit, Automated Passenger Counter (APC) or Automatic Vehicle Location (AVL) data could be processed to calculate transit speed and reliability measurements, such as schedule adherence along the roadway segments at a more granular level, such as 15-minute interval. In the future monitoring cycle, CCTA could consider Strava Metro for bicycle and pedestrian crowdsourced data. This can provide valuable insights into multi-modal transportation system.

## 5.2 Support Expansion of Data Visualization Techniques

In 2017, CMP LOS is reported in a text-based report with basic tables and charts. CCTA may leverage further opportunities for incorporating other graphics and summary snapshots. For example, LOS time series plot can better inform the roadway performance over time. Figure 5-

1 relates LOS to density of vehicle on freeway according to HCM 2000. For each freeway, this plot illustrates the percentage of vehicle experiences certain LOS at a particular time. The processing task involves computing density at each CMP, number of vehicle along a CMP with a resulting LOS, and plotting the distribution of LOS along one freeway. Using this snapshot plot, CCTA and its stakeholders can gain deeper insights on the performance of the roadway segment/corridor for different times of the day.

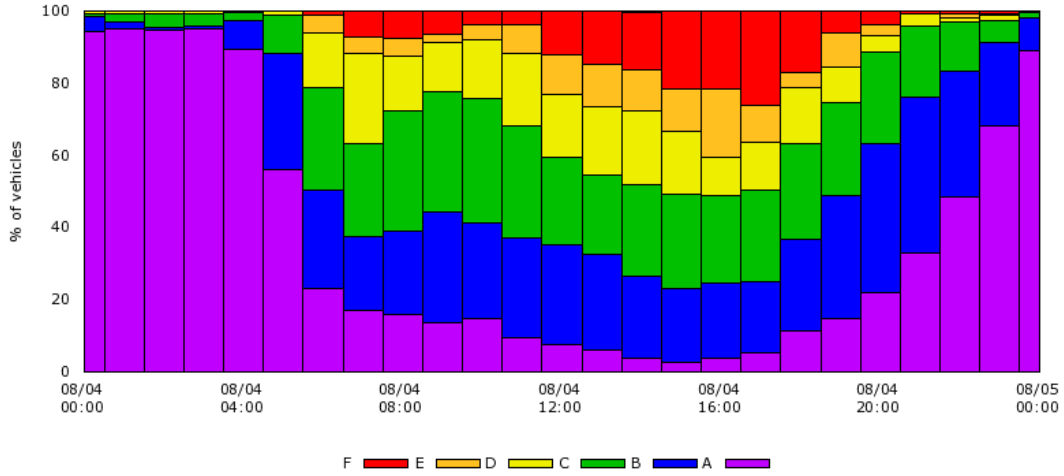


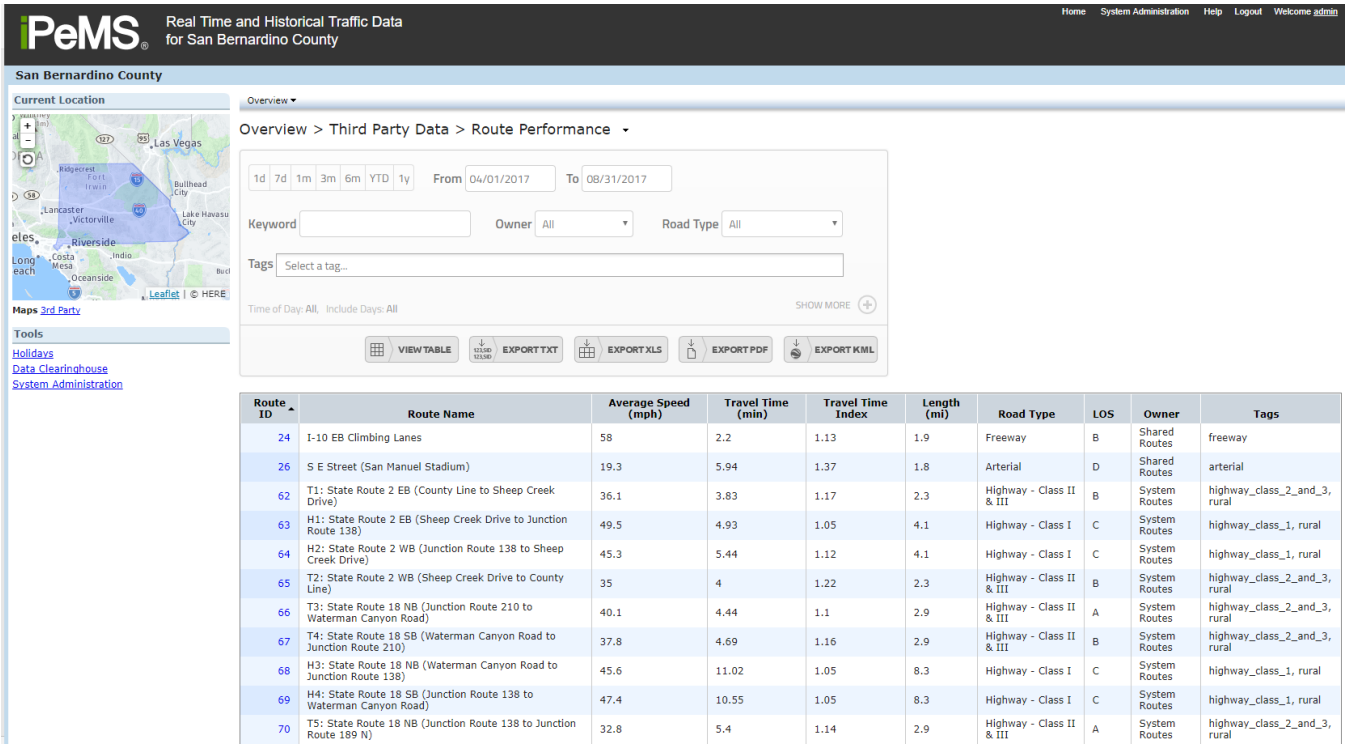

*Figure 5-1. Data Visualization Example – LOS Time Series Plot*

## 5.3 Incorporate Web-based Reporting and Tools

Currently, static report serves as a core form of communication for the monitoring results. In the future cycles, CCTA may consider delivering monitoring results in a more interactive way, such as a dashboard, or web-based tool. In the last few years, many agencies have initiated moving away from the print-centric reporting toward publishing web-based reports that include rich imagery, interactive elements, and enhanced sharing capabilities. The web offers far more ways to engage with the public and its stakeholders.

Furthermore, CMP intersection counts and processed CMP segment speeds are stored in spreadsheets. For the next cycle, CCTA could consider alternative ways of storage such as a database, which could form a foundation for implementing online tools and dashboards. One such example is iPeMS platform, a real-time data monitoring tool, which is currently used by San Bernardino County Transportation Authority (SBCTA) in part to meet the state CMP legislative requirements. The tool allows users to define each CMP segment and automatically aggregates the commercial speed data for a user-defined date and time range. CMP

performance reports (see Figure 5-2) can be generated as needed for the selected network category or city / planning area automatically.




| Route ID | Route Name | Average Speed (mph) | Travel Time (min) | Travel Time Index | Length (mi) | Road Type | LOS | Owner | Tags |
|---|---|---|---|---|---|---|---|---|---|
| 24 | I-10 EB Climbing Lanes | 58 | 2.2 | 1.13 | 1.9 | Freeway | B | Shared Routes | freeway |
| 26 | S E Street (San Manuel Stadium) | 19.3 | 5.94 | 1.37 | 1.8 | Arterial | D | Shared Routes | arterial |
| 62 | T1: State Route 2 EB (County Line to Sheep Creek Drive) | 36.1 | 3.83 | 1.17 | 2.3 | Highway - Class II & III | B | System Routes | highway_class_2_and_3, rural |
| 63 | H1: State Route 2 EB (Sheep Creek Drive to Junction Route 138) | 49.5 | 4.93 | 1.05 | 4.1 | Highway - Class I | C | System Routes | highway_class_1, rural |
| 64 | H2: State Route 2 WB (Junction Route 138 to Sheep Creek Drive) | 45.3 | 5.44 | 1.12 | 4.1 | Highway - Class I | C | System Routes | highway_class_1, rural |
| 65 | T2: State Route 2 WB (Sheep Creek Drive to County Line) | 35 | 4 | 1.22 | 2.3 | Highway - Class II & III | B | System Routes | highway_class_2_and_3, rural |
| 66 | T3: State Route 18 NB (Junction Route 210 to Waterman Canyon Road) | 40.1 | 4.44 | 1.1 | 2.9 | Highway - Class II & III | A | System Routes | highway_class_2_and_3, rural |
| 67 | T4: State Route 18 SB (Waterman Canyon Road to Junction Route 210) | 37.8 | 4.69 | 1.16 | 2.9 | Highway - Class II & III | B | System Routes | highway_class_2_and_3, rural |
| 68 | H3: State Route 18 NB (Waterman Canyon Road to Junction Route 138) | 45.6 | 11.02 | 1.05 | 8.3 | Highway - Class I | C | System Routes | highway_class_1, rural |
| 69 | H4: State Route 18 SB (Junction Route 138 to Waterman Canyon Road) | 47.4 | 10.55 | 1.05 | 8.3 | Highway - Class I | C | System Routes | highway_class_1, rural |
| 70 | T5: State Route 18 NB (Junction Route 138 to Junction Route 189 N) | 32.8 | 5.4 | 1.14 | 2.9 | Highway - Class II & III | A | System Routes | highway_class_2_and_3, rural |

*Figure 5-2. Example Web-based CMP Performance Report (SBCTA iPeMS)*