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transportation
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Congestion Management Program

2015 Monitoring Report

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TABLE OF CONTENTS

ES Executive Summary

As the designated Congestion Management Agency for Contra Costa County, Contra Costa Transportation Authority (CCTA) monitors traffic performance along its Congestion Management Program (CMP) network every two years. The aim of this monitoring is to evaluate traffic level-of-service (LOS) standards on the CMP network per the state CMP legislative requirements. This LOS monitoring helps CCTA understand the congestions trends in the county, which is vital to successful implementation of the regional transportation programs and policies.

The CMP network was adopted in 1991 and comprises of all the state highways and principal arterials in the county. LOS standards were established separately for freeway segments and for intersections along principal arterials. Since the first CMP in 1991, monitoring was undertaken by measuring the average speed of the traffic for the freeways segments and by conducting traffic counts for the intersections. Using this data, LOS was determined based on the guidelines outlined in CCTA's *Technical Procedures* and the results are published in a series of monitoring reports.

This report summarizes the LOS results for the 2015 monitoring effort both for freeways and intersections. Similar to previous years, traffic speeds and intersection counts were used for calculating the LOS. Guidelines provided by the Highway Capacity Manual along with CCTA's *Technical Procedures* were used to compute the LOS. As a part of the CMP monitoring, CCTA also collects bicycle and pedestrian volumes on all the CMP intersections, which are included in this report.

New to this monitoring is the use of commercial speed data for freeways. Recently, new data technologies and performance measurement approaches have been radically transforming congestion monitoring practices nationwide. These technologies that revolve around the emerging fields of Big Data and Analytics provide more data for a lower cost and help widen the scope of congestion analysis. Use of this commercial speed data from INRIX was validated by CCTA in spring 2015 through a separate study, which is provided in Appendix C.

A total of 23 freeway segments and 65 intersections were monitored in 2015. The freeway segments were monitored with INRIX data and the intersections were monitored with manual intersection counts to capture auto, bicycle and pedestrian modes.

The purpose of the LOS monitoring is to ensure that standards are being met, or to identify where standards are being exceeded. In the AM peak, one freeway segment and one intersection were found not to achieve the adopted LOS standards. In the PM peak, two freeway segments and one intersection were found not to achieve the adopted LOS standards. The results are summarized in Table ES-1.

Table ES-1: Summary of 2015 Intersection LOS Results

CMP Component	Peak Period	Total Intersections/ Segments	Achieving LOS Standard	Not Achieving LOS Standard
Freeways	AM Peak Hour	23	22	1
	PM Peak Hour		21	2
Intersections	AM Peak Hour	65	64	1
	PM Peak Hour		64	1

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

1 Introduction

Contra Costa Transportation Authority (CCTA), the designated Congestion Management Agency (CMA) for Contra Costa County, has been performing Level of Service (LOS) monitoring every two years since 1991. This monitoring is performed on the Congestion Management Program (CMP) network to comply with California legislative requirements and to ensure that the roadway network is performing at or above the required minimum standards. This report summarizes the results of the 2015 LOS monitoring.

The report is divided into four sections:

- **Section 1 – Introduction** gives a brief overview of the CMP process and describes the Contra Costa CMP roadway network.
- **Section 2 – Methodology** presents the data collection approach and subsequent data analytics tasks.
- **Section 3 – Level of Service Monitoring Results** provides the LOS monitoring results for CMP network freeway segments and intersections.
- **Section 4 – Summary of Results and Recommendations** presents a comparison of the results, summary of future improvements and recommendations for future monitoring.

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

1.1 CMP Network

Consistent with the CMP legislation, the CMP network contains all state highways – and consequently all freeways – within Contra Costa County. The CMP network also includes certain intersections along principal arterials, as designated by the appropriate regional transportation planning committee. Since 1991 the network has expanded and now includes:

- 23 freeway segments; and
- 65 intersections, including 30 locations in Central County, 26 locations in West County and 9 locations in East County.

Figure 1-1 shows a map of the CMP network. Table 1-1 provides a summary of these freeway segments and intersections.

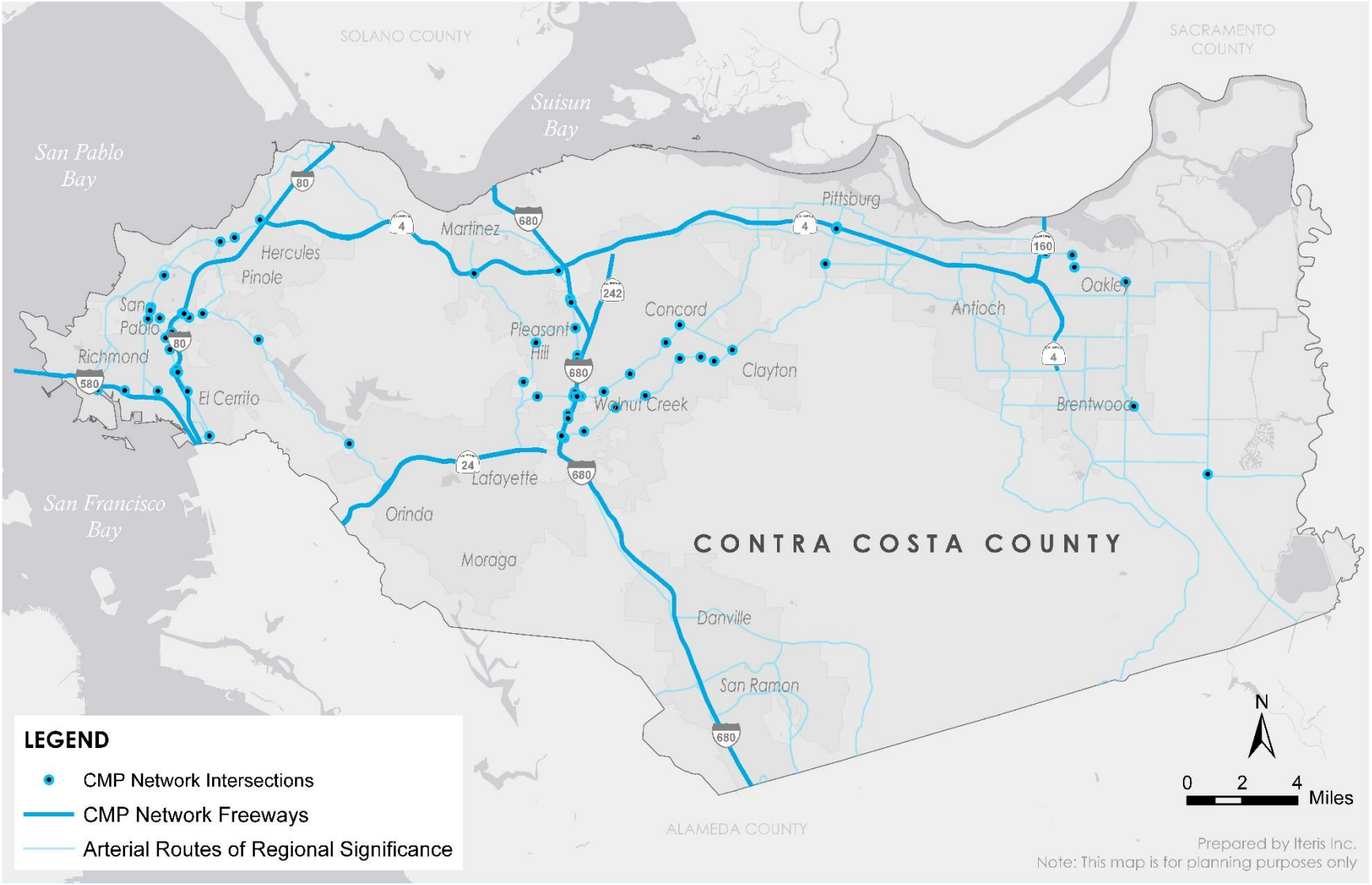

Figure 1-1: Contra Costa County CMP Network

Table 1-1: List of CMP Segments and Intersections Monitored in 2015

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

1.2 CMP Requirements

As part of the first CMP in 1991, CCTA established certain LOS standards for all freeway segments and intersections belonging to the CMP network. For freeway segments, travel speed was used as the indicator for determining the LOS based on the Highway Capacity Manual (HCM). For intersections, the LOS was calculated mainly using volume-to-capacity (V/C) ratios based on the peak hour 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.

Since 1991, LOS monitoring has been conducted biannually 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 the intersection LOS is found to exceed the adopted standard even after applying relevant exclusions, then the intersection is subject to a deficiency plan. Preparation of deficiency plans is not a part of the current CMP monitoring effort. 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.

Apart from LOS, another monitoring requirement established as a part of the CMP is to conduct bicycle and pedestrian counts at all the CMP intersections. This data is collected to support the Countywide Bicycle and Pedestrian Plan and to provide additional data for monitoring non-motorized travel.

1.3 Updates to 2015 Monitoring

To date, CCTA has performed LOS monitoring on the CMP freeway network by collecting travel time and speed data using Caltrans Performance Measurement System (PeMS) and floating car runs. In view of commercial speed data that has become increasingly available, CCTA used INRIX[1] data for the 2015 freeway LOS monitoring. In spring 2015, CCTA undertook a validation task to confirm that INRIX data was an acceptable source for LOS monitoring. Based on the results of the validation, INRIX data was used for LOS monitoring for the entire Contra Costa County freeway CMP network. The use of commercial speed data provides a cost effective approach and allows increased analysis opportunities at relatively low incremental cost. Additional information on INRIX is provided in Section 2.2 and Appendix B.

[1] INRIX website: http://inrix.com/trafficinformation.asp

Also new to 2015 is the change in LOS methodology for intersection monitoring. Until the current CMP monitoring, CCTA analyzed intersection LOS using Contra Costa Transportation Authority LOS (CCTALOS), which is a V/C modified Circular 212 planning-based methodology. As a part of its updates to the *Technical Procedures* and based on guidance from the Metropolitan Transportation Commission (MTC), CCTA transitioned to analyzing intersection LOS using a delay-based methodology provided in HCM. Thus, the LOS results reported for the current monitoring is based on HCM methodology both for intersections and freeways.

2 Methodology

This section describes the methodology for collection data and calculating the LOS performance measures for intersections and freeways.

2.1 Intersection Level of Service

This sub-section explains the steps involved in computing LOS for intersections. The steps included collecting traffic counts and using Synchro software to perform the analysis based on HCM methodology.

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

As part of the data collection effort, it was first necessary to identify days on which the LOS monitoring should take place to capture representative traffic conditions. To ensure that LOS results are representative of normal traffic conditions experienced by a daily commuter, CCTA has published guidelines for traffic count data collection in the *Technical Procedures* (*Appendix B – Traffic Counting Protocol*). The following factors were considered to ensure that these guidelines were followed:

- ***Base Monitoring Times:*** Data for LOS monitoring is typically collected in spring or fall when schools are in session. For 2015 monitoring, data was collected during April and May[2]. Weekday data was collected on Tuesdays, Wednesdays, or Thursdays for the morning and afternoon peak periods, which were 7am to 9am and 4pm to 6pm, respectively.
- ***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.

[2] Additional data at one intersection that exceeded the LOS threshold will be collected during August & September when schools are back in session.

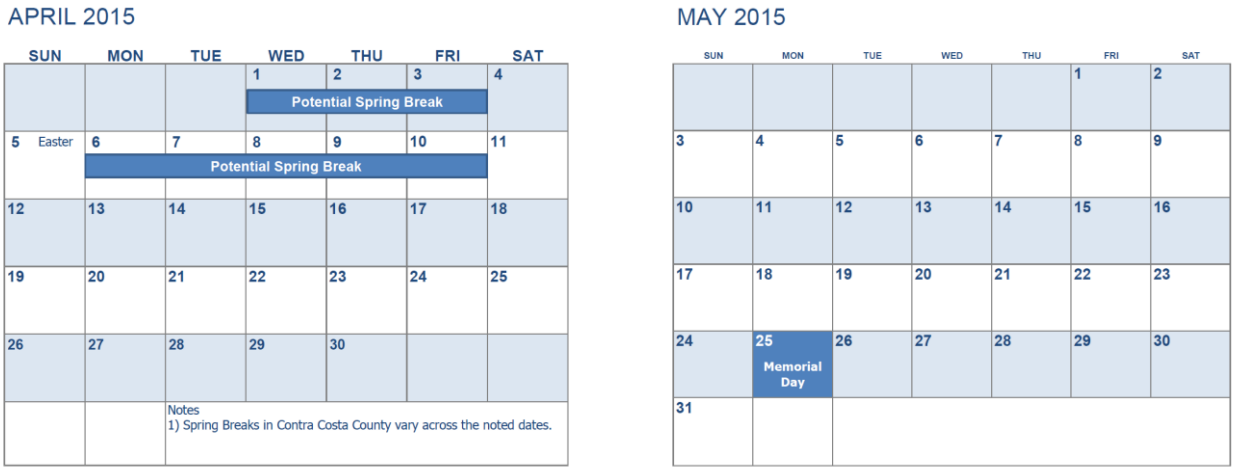

Figure 2-1: Public Holidays and Spring Break Periods in Contra Cost County, Spring 2015

- ***Special Events:*** In Contra Costa County, no special events were observed to impact traffic conditions during the 2015 monitoring period.
- ***Weather Events:*** No adverse weather conditions that disrupted traffic flow were observed during the 2015 monitoring period.
- ***Incidents or Accidents:*** Data collectors were instructed to repeat data collection if an incident or accident occurred in the vicinity of the count location and disrupted the flow of traffic during the data collection period. However, no such events occurred during the 2015 monitoring.
- ***Construction Activity:*** Various sources were reviewed to identify any construction activity that could have disrupted the flow of traffic during the monitoring period. If any construction activity was noted to affect the monitoring locations, such construction days were excluded from the monitoring days. However, if long-term construction activity prevailed at an intersection, then monitoring was conducted during construction and the LOS results were annotated accordingly. Sources of construction information reviewed for the current monitoring effort included the following (Figure 2-2):
    - CCTA internal resources and their online project pages;
    - Facebook and Twitter feeds;
    - Other government websites (including Caltrans District 4);
    - 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 included the following three primary components:

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

Data collection firms used field deployed video recording units for collecting data. The methods followed for collecting and processing the data 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[3] 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

Synchro was used to calculate intersection LOS using HCM methodology consistent with the revised 2013 CCTA *Technical Procedures*. Synchro files that included most of the monitoring intersections were available through CCTA. Since this was the first time that Synchro was used

[3] https://miovision.com/

for CMP LOS monitoring, the following steps were taken to review and update the monitoring intersections in these files prior to analyzing the LOS:

- Updated basic intersection details such as street names and street directions consistent with field count reports;
- Revised intersection geometry using a combination of Google Maps imagery surveys, data collection videos, and field surveys, as required;
- Where deemed appropriate and in consultation with CCTA, revised the signal timing information to match the most current timing plans available from member agencies;
- Updated intersection volumes in the Synchro files using the 2015 monitoring data; and
- Updated other input parameters per the guidelines provided in the *Technical Procedures (Appendix C – Guidelines for the Use of the 2010 Highway Capacity Manual Operational Method Methodology).* Note that some exceptions to these guidelines were made in consultation with CCTA (see Appendix A).

Intersections that were not included in the available Synchro files were coded following the same general methodology described above. If current timing plans were not available for an intersection, then guidelines provided in the *Technical Procedures (Appendix C – Guidelines for the Use of the 2010 Highway Capacity Manual Operational Method Methodology)* were used to code the signal timings in Synchro.

2.1.3 Step 3: LOS Assignment

Per the guidelines available in the *Technical Procedures*, the HCM 2010 methodology was primarily used to compute intersection LOS. However, some intersections that could not be readily analyzed in Synchro using HCM 2010 methodology were analyzed per HCM 2000 procedures. Such intersections include those with more than four approaches or intersections that do not have strict National Electrical Manufacturers Association (NEMA) phasing.[4]

Both HCM 2010 and HCM 2000 calculate signalized intersection LOS as a function of intersection control delay (Table 2-1). This LOS extends from LOS A to LOS F and denotes information about the quality of service to drivers. LOS A represents the best travel conditions from the driver's perspective where most through traffic on the main street arrives during a green light and does not stop, and LOS F represents very congested conditions where most drivers wait multiple signal cycles before they are able to travel through the intersection.

[4] Note - Such intersections could be analyzed in Synchro per HCM 2010 in future monitoring with additional investigation and adjustments.

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

Level of Service	Control Delay (s/veh)
A	≤ 10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

2.2 Freeway Level of Service

This sub-section outlines the steps involved for computing the LOS for freeway CMP segments.

2.2.1 Step 1: Data Collection

As noted earlier, this is the first monitoring period in which commercial speed data was used to measure speed and LOS for freeway segments. This section summarizes the monitoring days and methodology for collecting the speed data.

MONITORING DAYS

To be consistent with previous monitoring cycles, speed data was collected during the spring months of February, March, and April 2015. Similar to intersections, freeway data was collected on Tuesdays, Wednesdays, and Thursdays for the morning and afternoon peak periods, which were 6am to 10am and 3pm to 7pm, respectively. This resulted in a total of 39 monitoring days. No public holidays were observed on these days.

However, days affected by incidents and construction events were identified and excluded from the analysis. These days were identified through various agency websites and social media sources as described earlier in Section 2.1.1. In addition to those sources, data from the PeMS lane closure database and incident feed were reviewed for additional construction and incident events. When these events were identified, the speed data records were removed for the affected time period and CMP segments. Figure 2-3 shows a heat map of freeway incidents using data from PeMS. Locations with higher densities of incidents are shown in red.

PeMS®

PeMS lane closure database & incident feeds

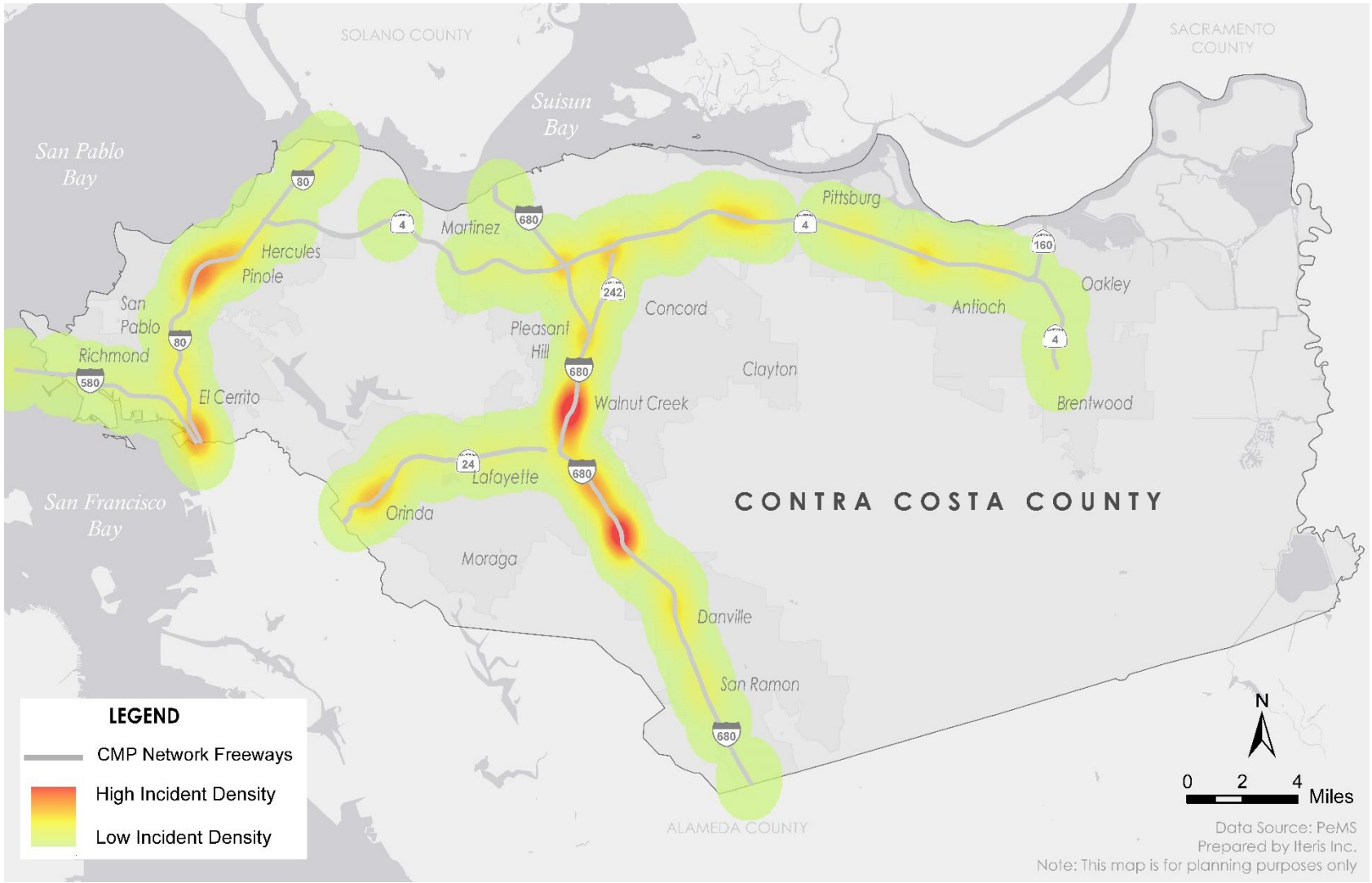

Figure 2-3: Heat Map showing the Freeway Incident Density in Contra Costa County during 2015 Monitoring (combined morning and afternoon peak periods)

DATA COLLECTION METHODOLOGY

The commercial speed data used for the current monitoring was obtained from INRIX Inc. This data was supplied free of cost to the Bay Area CMAs by MTC through a contract with INRIX.

INRIX is a private provider of speed data, which "aggregates traffic from GPS-enabled vehicles and mobile devices, traditional road sensors and hundreds of other sources"[5]. This traffic data is reported along discrete roadway links known as Traffic Message Channels (TMCs). Each TMC link is associated with a unique ID represented by a nine-digit code, where each individual number in the TMC code describes a portion of the geography including country, direction of travel and roadway segment (e.g. 105+10123).

INRIX data contains speeds aggregated at the one-minute level for each TMC code in the network. For the current monitoring, data at one minute intervals was accessed for the monitoring days and times across all of the identified TMCs in Contra Costa County. This resulted in a sample size of up to approximately 2,300 data points for the monitored CMP segments.

2.2.2 Step 2: Data Analysis

In the next step, raw speed data collected across all monitoring days and all freeway TMCs in Contra Costa was further filtered and processed to identify average peak hour speeds for CMP segments. This consisted of the following steps:

- Commercial speed data for TMCs was associated to the appropriate CMP segments through a spatial mapping process.
- Data with poor quality was removed to retain only speed data exclusively generated through direct observation.
- Data was then averaged on each CMP segment for every hour within each peak period, at 15 minute intervals. For example, average speed was computed from 6am to 7am, 6:15am to 7:15am, etc. The hour that had the lowest average speed was computed separately for each CMP segment and the corresponding speed was used as the peak hour speed.

Refer to Appendix B for technical details about INRIX data collection and analysis.

[5] INRIX website: http://inrix.com/trafficinformation.asp

During the previous monitoring cycles, 85th percentile speed was used as the metric for measurement of traffic performance along a CMP segment. However, in the 2015 monitoring the average speed was used based on the Validation Study conducted in spring 2015. This validation report is available upon request from CCTA. A summary of the recommendations from the validation report are included in Appendix C.

2.2.3 Step 3: LOS Assignment

LOS was assigned to each CMP segment based on the average peak hour speeds using the adopted standards from the HCM (Table 2-2). This LOS extends from LOS A to LOS F and denotes information about the quality of service to drivers. LOS A represents the best travel conditions from the driver's perspective where roadways are free flow, and LOS F represents congested or stop-and-go conditions.

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

Level of Service	Speed (mph)
A	≥ 60
B	≥ 57
C	≥ 54
D	≥ 46
E	≥ 30
F	< 30

3 Level of Service Monitoring Results

This section summarizes the results of the 2015 LOS monitoring for intersections and freeway segments.

3.1 Intersection Level of Service

Intersection LOS was monitored for 65 locations: 26 locations in the West County, 30 locations in the Central County, and 9 locations in the East County. All except two intersections operate at an LOS equal to or better than the adopted LOS standard for both peak hours. LOS results for all the intersections are summarized in Table 3-1.

Table 3-1: Summary of 2015 Intersection LOS Results

	Total Intersections	Achieving LOS Standard	Not Achieving LOS Standard
AM Peak Hour	65	64	1
PM Peak Hour	65	64	1

One intersection exceeding the thresholds is located along Ygnacio Valley Road at Cowell Road in Concord. This intersection operates at LOS F in the PM peak hour. Two recounts were conducted during fall 2015 and the intersection exceeded the threshold for one of the two recounts. Further investigation is currently being conducted by CCTA and the City of Concord through an exclusions study and is being reported separately. Note that preparation of an exclusion study is not a part of the current CMP monitoring effort. Intersection count sheets and detailed analysis sheets from the Synchro software for the recounts are included in Appendix G.

The other intersection is also along Ygnacio Valley Road at the Northbound I–680 Ramps in Walnut Creek. This intersection operates at LOS F during the AM peak hour. However, this intersection also operated at LOS F in the 2013 monitoring. Further, it is located outside the jurisdiction of CCTA as it is maintained by Caltrans. Hence, recounts were not necessary for this intersection per CCTA policy.

Apart from these two intersections, one more intersection was observed to operate at LOS F: El Portal Drive and Eastbound I–80 Ramps. However, the LOS standard established for this intersection is LOS F per the operating conditions in 1991, and the intersection is under

Caltrans jurisdiction. Hence, no recounts were necessary for this intersection at this time. However, additional review shall be conducted for this intersection by CCTA upon receiving the requested signal timing plans from Caltrans.

Figure 3-4 summarizes the results by LOS category. The general trends are similar for both the AM and PM peak periods. In both cases, the majority of the intersections operate at LOS C and D, with fewer intersections operating towards either extreme LOS.

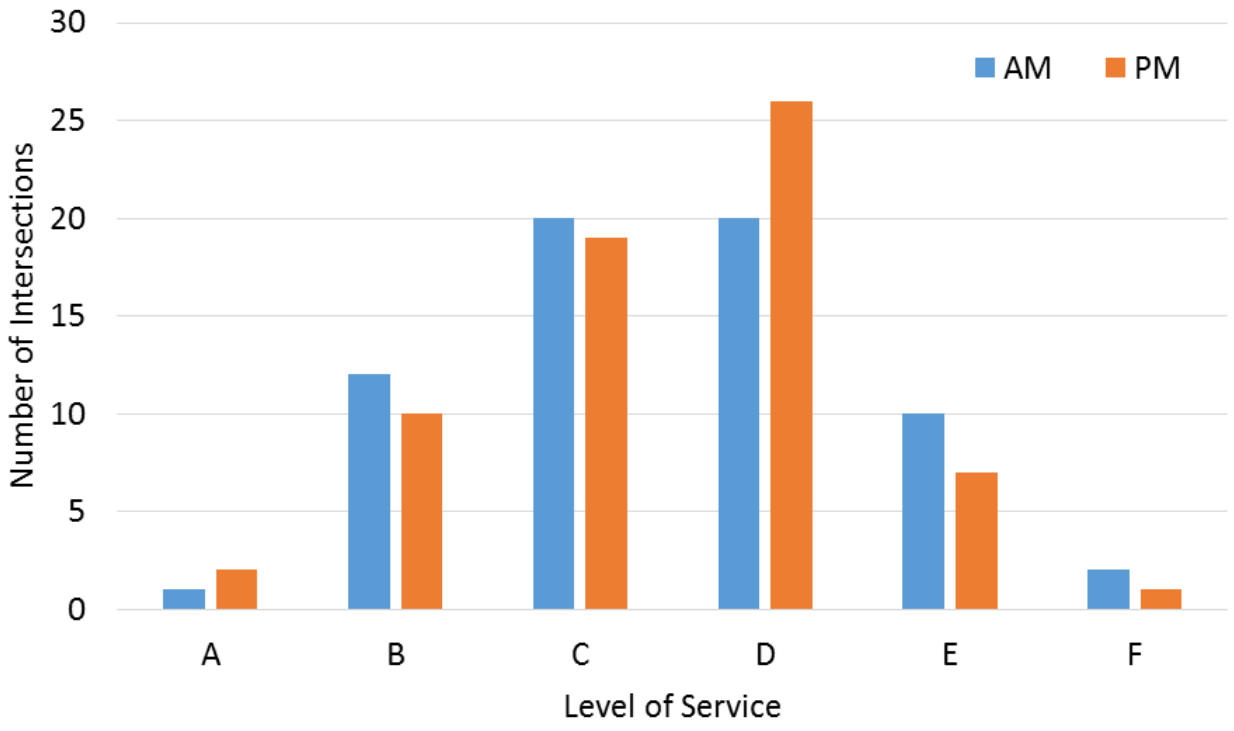

Figure 3-1: Summary of 2015 Intersection LOS Results

LOS results for all the intersections are presented in detail in Table 3-2, Figure 3-2 and Figure 3-3. Additional intersection count sheets and detailed analysis sheets from the Synchro software are included in Appendix D.

Table 3-2: 2015 Intersection LOS Results

ID	Synchro ID	Facility	Cross Street	Jurisdiction	LOS Standard	AM Peak		PM Peak		HCM Methodology
						Delay	LOS	Delay	LOS	
W1	1	San Pablo Avenue	John Muir Parkway	Hercules	E	43.9	D	53.4	D	2010
W2	2	San Pablo Avenue	Pinole Valley Road	Pinole	E	6	A	12.4	B	2010

ID	Synchro ID	Facility	Cross Street	Jurisdiction	LOS Standard	AM Peak		PM Peak		HCM Methodology
						Delay	LOS	Delay	LOS	
W3	3	San Pablo Avenue	Appian Way	Pinole	E	25.1	C	28.6	C	2010
W4	4	San Pablo Avenue	Hilltop Drive	Richmond	E	46	D	62	E	2010
W5	5	San Pablo Avenue	Rumrill Boulevard	San Pablo	F	31.6	C	57.9	E	2010
W6	6	San Pablo Avenue	El Portal Drive	San Pablo	E	39.6	D	37.1	D	2010
W7	7	San Pablo Avenue	Road 20	San Pablo	E	66.5	E	40.8	D	2000
W8	8	San Pablo Avenue	San Pablo Dam Road	San Pablo	E	29.1	C	36.2	D	2000
W9	9	San Pablo Avenue	McBryde Avenue	Richmond	E	25.6	C	34.7	C	2000
W10	10	San Pablo Avenue/Barrett Avenue	Westbound I–80 Ramps	Richmond	E	30.8	C	28.5	C	2000
W11	11	San Pablo Avenue	Eastbound I–80 Ramps/ Roosevelt Ave	Richmond	E	17.4	B	22.4	C	2000
W12	12	San Pablo Avenue	Barrett Avenue	Richmond	F	61.5	E	56.4	E	2010
W13	13	San Pablo Avenue	Cutting Boulevard	El Cerrito	E	31	C	40	D	2000
W14	14	San Pablo Avenue	Central Avenue	El Cerrito	E	35.4	D	45.4	D	2000
W15	15	San Pablo Dam Road	Westbound I–80 Ramps	San Pablo	F	26.4	C	51.1	D	2000
W16	16	San Pablo Dam Road	Eastbound I-80 Ramps/ Amador St	San Pablo	F	59.4	E	59.1	E	2000
W17	17	San Pablo Dam Road	El Portal Drive	Richmond, County	E	33.7	C	40.8	D	2000
W18	18	San Pablo Dam Road	Appian Way	County	E	67.1	E	42.9	D	2010
W19	19	San Pablo Dam Road	Castro Ranch Road	Richmond, County	E	25.5	C	25.6	C	2010
W20	20	San Pablo Dam Road	Bear Creek Road	Orinda, County	F	19.4	B	32	C	2000
W21	21	El Portal Drive	Road 20	San Pablo	E	14.1	B	16.6	B	2000

ID	Synchro ID	Facility	Cross Street	Jurisdiction	LOS Standard	AM Peak		PM Peak		HCM Methodology
						Delay	LOS	Delay	LOS	
W22	22	El Portal Drive	Westbound I–80 Ramps	County	F	26.4	C	25.6	C	2010
W23	23	El Portal Drive	Eastbound I–80 Ramps	Richmond, County	F	441.9	F	43.3	D	2010
W24	24	Cutting Boulevard	Canal Boulevard	Richmond	E	11.5	B	12.3	A	2000
W25	25	Cutting Boulevard	Harbour Way	Richmond	E	38.6	D	43.8	D	2010
W26	26	Cutting Boulevard	Carlson Boulevard	Richmond	E	23.9	C	23.4	C	2010
E1	27	Railroad Avenue	Westbound SR-4 Ramps/ California Ave	Pittsburg	E	21.3	C	15.7	B	2010
E2	28	Railroad Avenue	Eastbound SR-4 Ramps	Pittsburg	E	28	C	15.5	B	2000
E3	29	Railroad Avenue	Buchanan Road	Pittsburg	E	27.2	C	21	C	2000
E4	30	Main Street	Neroly Road	Oakley	E	25.4	C	35.4	D	2000
E5	31	Main Street	Big Break Road	Oakley	E	12.2	B	21.3	C	2010
E6	32	Main Street	Oakley Road/Empire Rd	Oakley	E	19.3	B	27.8	C	2010
E7	33	Main Street	Cypress Road	Oakley	E	22.7	C	24	C	2010
E8	34	Brentwood Boulevard	Balfour Road	Brentwood	E	46.3	D	75.9	E	2010
E9	35	Brentwood Boulevard/ State Route 4	Byron Highway	County	E	34.9	C	29.4	C	2000
C1	36	Alhambra Avenue	Eastbound Ramps to State Route 4	Martinez	E	21.7	C	17.8	B	2000
C2	37	Alhambra Avenue/ Pleasant Hill Rd	Taylor Boulevard	Pleasant Hill	F	43.6	D	55	D	2010
C3	38	Pacheco Boulevard	Muir Road	County	E	45.6	D	30	C	2010
C4	39	Contra Costa Boulevard	Southbound Ramps to I–680	Pleasant Hill	E	41.2	D	64.2	E	2000

ID	Synchro ID	Facility	Cross Street	Jurisdiction	LOS Standard	AM Peak		PM Peak		HCM Methodology
						Delay	LOS	Delay	LOS	
C5	40	Contra Costa Boulevard	Concord Avenue/ Chilpancingo Parkway	Pleasant Hill	E	54.9	D	49	D	2010
C6	41	Contra Costa Boulevard	Willow Pass Road/ Taylor Boulevard	Pleasant Hill, Concord	E	37.2	D	48.1	D	2010
C7	42	Contra Costa Boulevard	Gregory Lane/ Southbound I–680 Ramp	Pleasant Hill	E	62.6	E	31	C	2000
C8	43	Contra Costa Boulevard	Monument Boulevard	Pleasant Hill	F	56.6	E	53.4	D	2010
C9	44	Contra Costa Boulevard	Boyd Road/ Southbound I–680 Ramp	Pleasant Hill	E	17.5	B	19.1	B	2000
C10	45	North Main Street	Sunnyvale Avenue/ Southbound I–680 Ramps	Walnut Creek	E	52.7	D	54.6	D	2010
C11	46	North Main Street	Geary Road	Walnut Creek	E	36.5	D	69.5	E	2000
C12	47	North Main Street/ San Luis Rd	Southbound I-680 Ramps (near San Luis)	Walnut Creek	F	12.9	B	20.5	C	2000
C13	48	North Main Street	Northbound I-680 Ramps (north of Parkside)	Walnut Creek	F	12.7	B	10.3	B	2000
C14	49	Taylor Avenue	Withers Avenue	Lafayette, County	E	18	B	15.5	B	2010
C15 [1]	50	Geary Road	Pleasant Hill Road	Walnut Creek	E	18.5	B	24.2	C	2000
C16	51	Treat Boulevard	Clayton Road	Concord	E	51.4	D	47.6	D	2000
C17	52	Treat Boulevard	Cowell Road	Concord	E	65	E	46.8	D	2010
C18	53	Treat Boulevard	Oak Grove Road	Concord	E	67.8	E	45.7	D	2010
C19	54	Treat Boulevard	Bancroft Road	Walnut Creek	E	51.4	D	46.2	D	2010

ID	Synchro ID	Facility	Cross Street	Jurisdiction	LOS Standard	AM Peak		PM Peak		HCM Methodology
						Delay	LOS	Delay	LOS	
C20	55	Treat Boulevard	Oak Road	Walnut Creek, County	E	44.8	D	30.6	C	2010
C21	56	Treat Boulevard	Buskirk Avenue/ Northbound I–680 Ramps	Walnut Creek, County	E	29.2	C	15.4	B	2010
C22	57	Ygnacio Valley Road	Clayton Road	Concord	E	46.6	D	45.6	D	2010
C23	58	Ygnacio Valley Road	Alberta Way	Concord	E	63.9	E	30.9	C	2010
C24	59	Ygnacio Valley Road	Ayers Road	Concord	E	66.3	E	49.2	D	2010
C25	60	Ygnacio Valley Road	Cowell Road	Concord	E	43.7	D	85.4	F	2010
C26	61	Ygnacio Valley Road	Oak Grove Road	Walnut Creek	E	48.8	D	36.4	D	2000
C27	62	Ygnacio Valley Road	Bancroft Road	Walnut Creek	E	38.5	D	42.5	D	2000
C28	63	Ygnacio Valley Road	Walnut Boulevard	Walnut Creek	E	34.9	C	19.7	B	2000
C29	64	Ygnacio Valley Road	Northbound I–680 Ramps	Walnut Creek	E	101.2	F	53.3	D	2000
C30	65	Ygnacio Valley Road	Southbound I–680 Ramps	Walnut Creek	E	11	B	7	A	2000

[1] Ongoing construction occurred at this intersection during monitoring. The intersection was analyzed based on the configuration during this construction period.
Note 1: Delay is reported in seconds
Note 2: Highlighted cells indicate LOS exceeds standard.

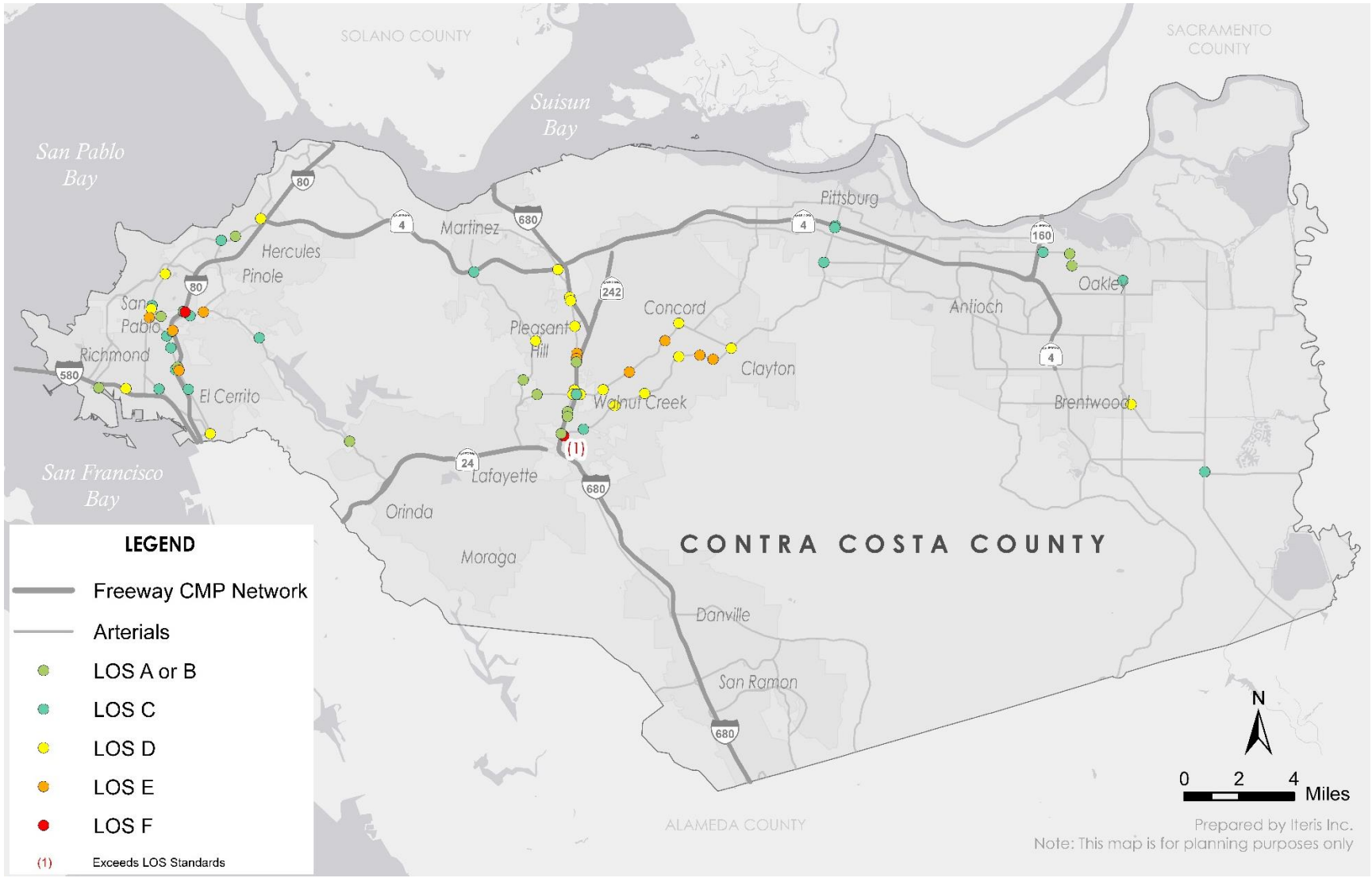

Figure 3-2: 2015 Intersection LOS Results during AM Peak Period

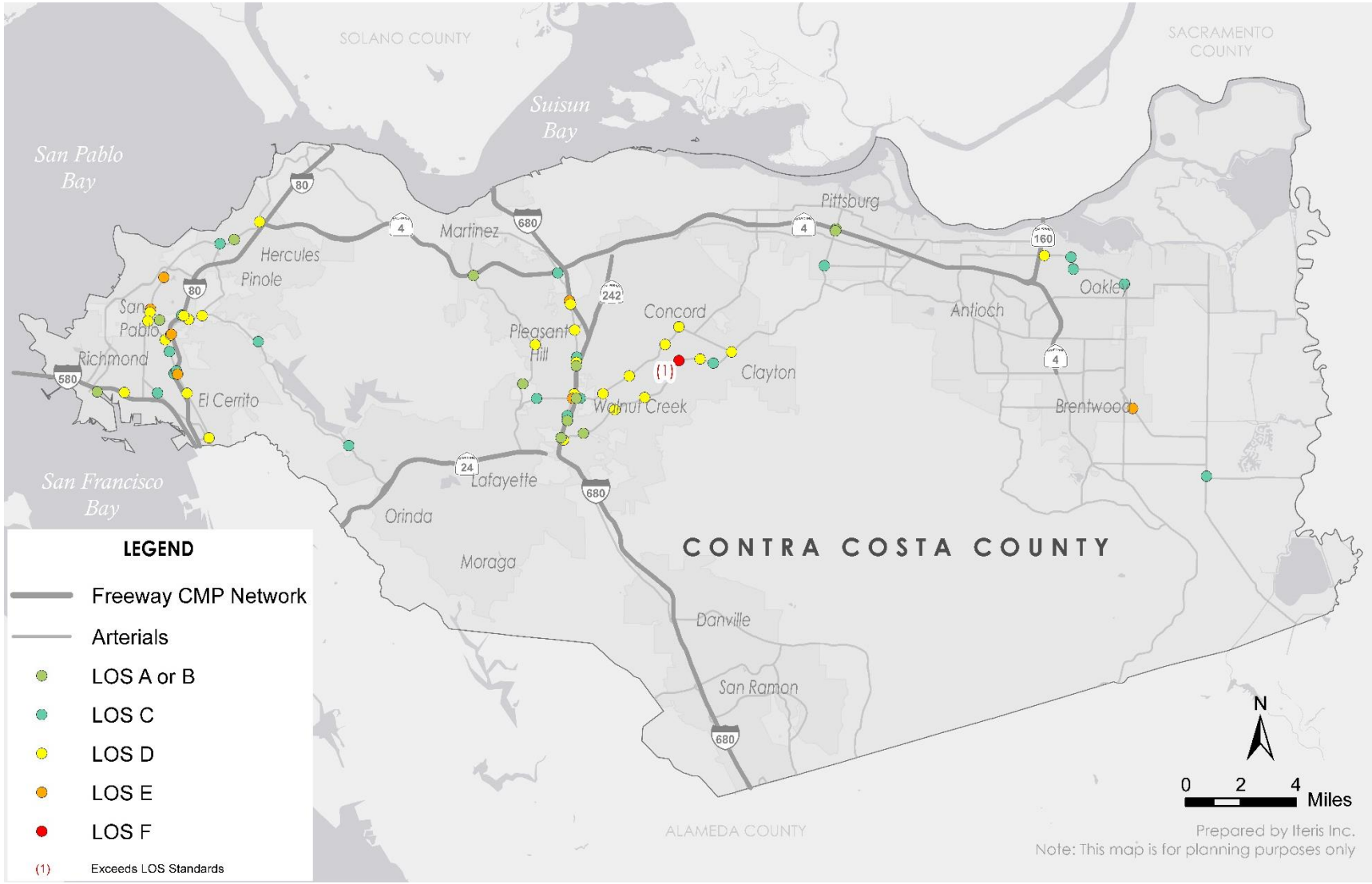

Figure 3-3: 2015 Intersection LOS Results during PM Peak Period

3.2 Freeway Level of Service

Freeway LOS was monitored for a total of 23 CMP segments in both directions. This monitoring includes two new segments compared to 2013 monitoring. The new segments are SR-4 between SR-160 and Sand Creek Road, and SR-160 between SR-4 and the north County Line. Table 3-3 summarizes the overall freeway LOS results.

Table 3-3: Summary of 2015 Freeway LOS Results

	Total Segments	Achieving LOS Standard	Not Achieving LOS Standard
AM Peak Hour	23	22	1
PM Peak Hour	23	21	2

Of the 23 segments monitored during 2015, 22 segments meet the LOS standards in the AM peak and 21 segments meet the standards in the PM peak. The three segments that do not meet the LOS standard are noted below:

- Westbound SR-24 between Oak Hill Road and I-680 in the AM peak (new to 2015)
- Northbound I-680 between El Cerro Boulevard and Bollinger Canyon Road in the PM peak (new to 2015)
- Eastbound SR-4 between I-680 and SR-242 in the PM peak (same as 2013)

Figure 3-4 summarizes the results by centerline miles operating at each LOS. Of the total freeway CMP network, 83 miles (43%) operated at LOS A in the AM and 81 miles (42%) operated at LOS A in the PM peak period. On the other hand, 42 miles (22%) operated at LOS F in the AM and 41 miles (21%) operated at LOS F in the PM peak period.

By corridor, I-580 experienced the lowest average bi-direction speed in the AM peak hour at 36 mph, and the highest average speed in the PM peak hour at 60 mph (Figure 3-5). The average speeds for the remaining freeway corridors ranged between 46 mph to 56 mph in the AM and PM peak hours.

Table 3-4, Figure 3-6 and Figure 3-7 present the LOS calculated for each freeway CMP segment. Additional tables comparing the results with 2013 monitoring are included in Appendix E.

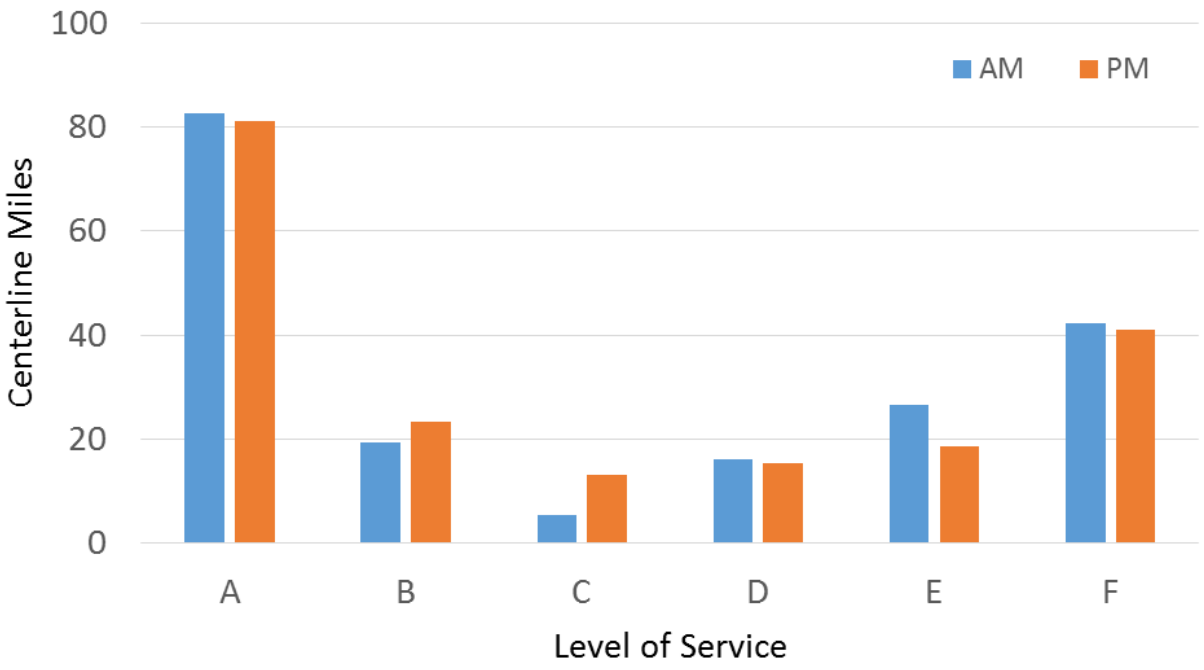

Figure 3-4: Centerline Miles of the CMP Network Performing at each LOS

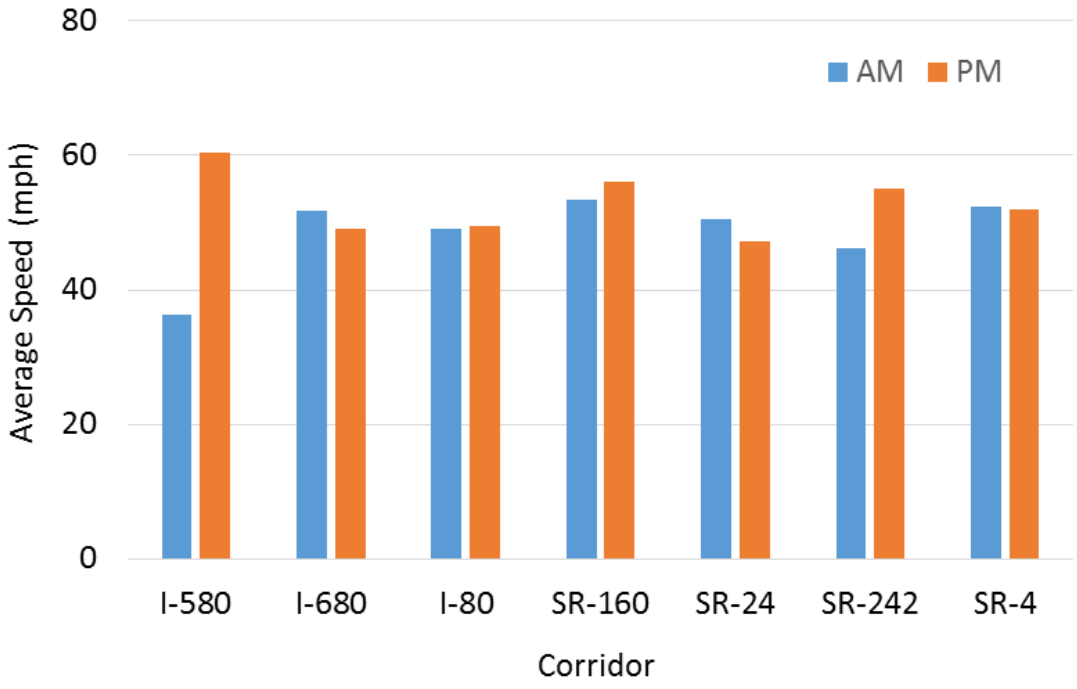

Figure 3-5: Average Bi-directional Speed by Corridor in the CMP Network

Table 3-4: 2015 CMP Freeway Segments LOS Results

Segment Information				AM Peak		PM Peak		LOS
ID	Route	Limits	Dir.	Speed	LOS	Speed	LOS	Standard
F80-1	I-80	Carquinez Bridge to Cummings Skyway	EB	63.3	A	61.6	A	F
F80-1	I-80	Carquinez Bridge to Cummings Skyway	WB	64.4	A	65	A	E
F80-2	I-80	Cummings Skyway to State Route 4	EB	65.4	A	66.7	A	F
F80-2	I-80	Cummings Skyway to State Route 4	WB	61.4	A	67.5	A	E
F80-3	I-80	State Route 4 to San Pablo Dam Road	EB	63.6	A	28	F	F
F80-3	I-80	State Route 4 to San Pablo Dam Road	WB	24.8	F	63	A	F
F80-4	I-80	San Pablo Dam Road to Cutting Blvd.	EB	62.6	A	25	F	F
F80-4	I-80	San Pablo Dam Road to Cutting Blvd.	WB	25.8	F	49.9	D	F
F80-5	I-80	Cutting Blvd. to Alameda County	EB	63.7	A	23	F	F
F80-5	I-80	Cutting Blvd. to Alameda County	WB	18.6	F	64.7	A	F
F580-1	I-580	Richmond Bridge to Alameda County Line	EB	41.5	E	58.7	B	E
F580-1	I-580	Richmond Bridge to Alameda County Line	WB	31.1	E	62.2	A	E
F680-1	I-680	Benicia Bridge to State Route 4	NB	60.7	A	58.4	B	F
F680-1	I-680	Benicia Bridge to State Route 4	SB	53.9	D	66.3	A	F
F680-2	I-680	State Route 4 to State Route 242	NB	65.9	A	59.2	B	E
F680-2	I-680	State Route 4 to State Route 242	SB	44.1	E	65.7	A	F
F680-3	I-680	State Route 242 to El Cerro Blvd.	NB	59.1	B	26	F	F
F680-3	I-680	State Route 242 to El Cerro Blvd.	SB	27	F	52.2	D	F
F680-4	I-680	El Cerro Blvd. to Bollinger Canyon Road	NB	48.3	D	29.3	F	E
F680-4	I-680	El Cerro Blvd. to Bollinger Canyon Road	SB	66	A	60.5	A	F
F680-5	I-680	Bollinger Canyon Rd. to Alameda County Line	NB	56.7	C	66.8	A	E
F680-5	I-680	Bollinger Canyon Rd. to Alameda County Line	SB	66.8	A	56.9	C	E
F4-1	SR-4	I-80 to Cummings Skyway	EB	57.2	B	59.5	B	F
F4-1	SR-4	I-80 to Cummings Skyway	WB	61.6	A	61.8	A	F

Segment Information				AM Peak		PM Peak		LOS
ID	Route	Limits	Dir.	Speed	LOS	Speed	LOS	Standard
F4-2	SR-4	Cummings Skyway to I-680	EB	61.7	A	36.9	E	E
F4-2	SR-4	Cummings Skyway to I-680	WB	63.8	A	63.3	A	E
F4-3	SR-4	I-680 to State Route 242	EB	60.7	A	16.3	F	E
F4-3	SR-4	I-680 to State Route 242	WB	40.4	E	55.3	C	E
F4-4	SR-4	State Route 242 to Bailey Road	EB	65.1	A	40.9	E	F
F4-4	SR-4	State Route 242 to Bailey Road	WB	27.4	F	65.2	A	F
F4-5	SR-4	Bailey Road to Loveridge Road	EB	66.5	A	56.6	C	F
F4-5	SR-4	Bailey Road to Loveridge Road	WB	21.4	F	66.8	A	F
F4-6 [1]	SR-4	Loveridge Road to State Route 160	EB	60.7	A	22.7	F	F
F4-6 [1]	SR-4	Loveridge Road to State Route 160	WB	29.5	F	63.1	A	F
F4-7	SR-4	State Route 160 to Sand Creek Road	EB	57.9	B	56.9	C	F
F4-7	SR-4	State Route 160 to Sand Creek Road	WB	51.2	D	58.9	B	F
F24-1	SR-24	Alameda County Line to Camino Pablo	EB	61.3	A	30.2	E	E
F24-1	SR-24	Alameda County Line to Camino Pablo	WB	36.7	E	61.4	A	E
F24-2	SR-24	Camino Pablo to Oak Hill Road	EB	66.8	A	28.8	F	F
F24-2	SR-24	Camino Pablo to Oak Hill Road	WB	39	E	66.8	A	F
F24-3	SR-24	Oak Hill Road to I-680	EB	66.6	A	29.4	F	F
F24-3	SR-24	Oak Hill Road to I-680	WB	29.5	F	64.9	A	E
F160-1	SR-160	SR-4 to County Line	EB	52.3	D	52.3	D	F
F160-1	SR-160	SR-4 to County Line	WB	54.5	C	60.2	A	F
F242-1	SR-242	I-680 to State Route 4	NB	63.9	A	44.8	E	E
F242-1	SR-242	I-680 to State Route 4	SB	28.4	F	65.5	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.

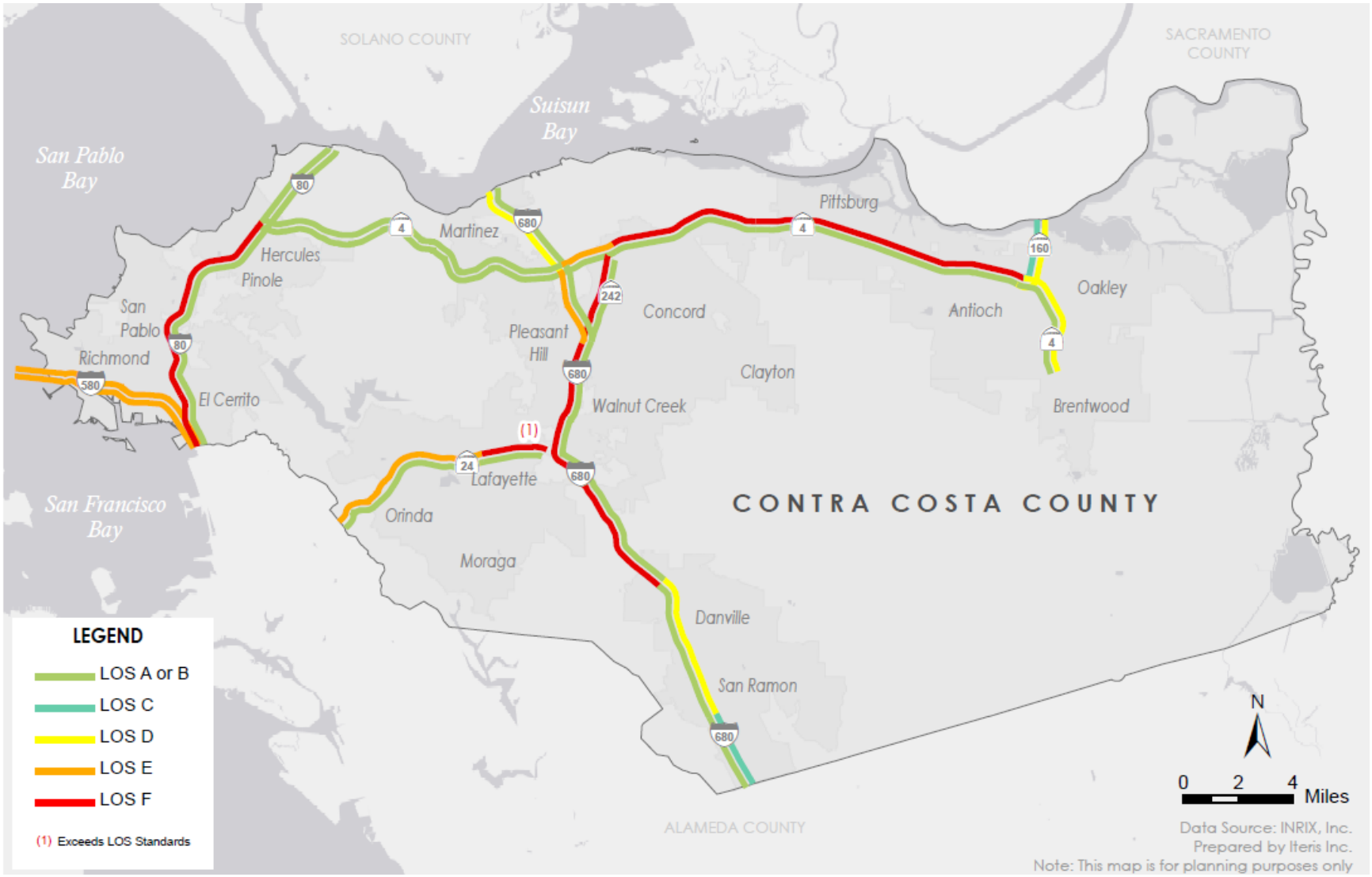

Figure 3-6: 2015 Freeway LOS Results during AM Peak Period

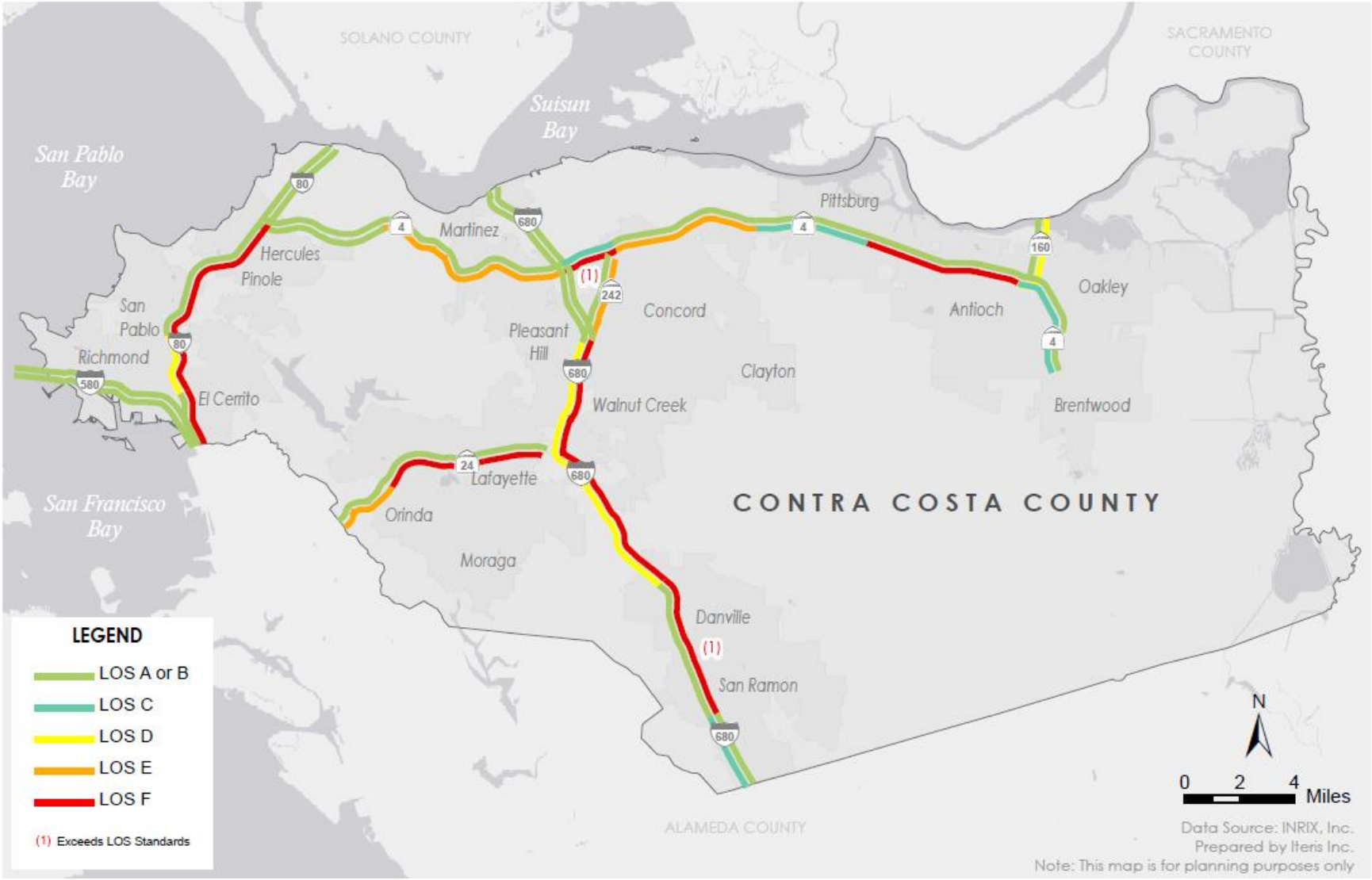

Figure 3-7: 2015 Freeway LOS Results during PM Peak Period

4 Conclusions and Recommendations

This section provides additional trends including comparisons to 2013 results and recommendations for future monitoring.

4.1 Trend Analysis

Traffic volumes generally increased between the 2013 and 2015 LOS monitoring. This increase in traffic is reflected in a general worsening of LOS in the 2015 monitoring for intersections and freeways as presented below.

4.1.1 Intersection LOS Trends

Figure 4-1 presents a comparison of the intersection LOS between 2013 and 2015 monitoring. As shown in this Figure, the number of intersections operating at LOS E or LOS F increased by 15% in the AM peak and 8% in the PM peak between 2013 and 2015.

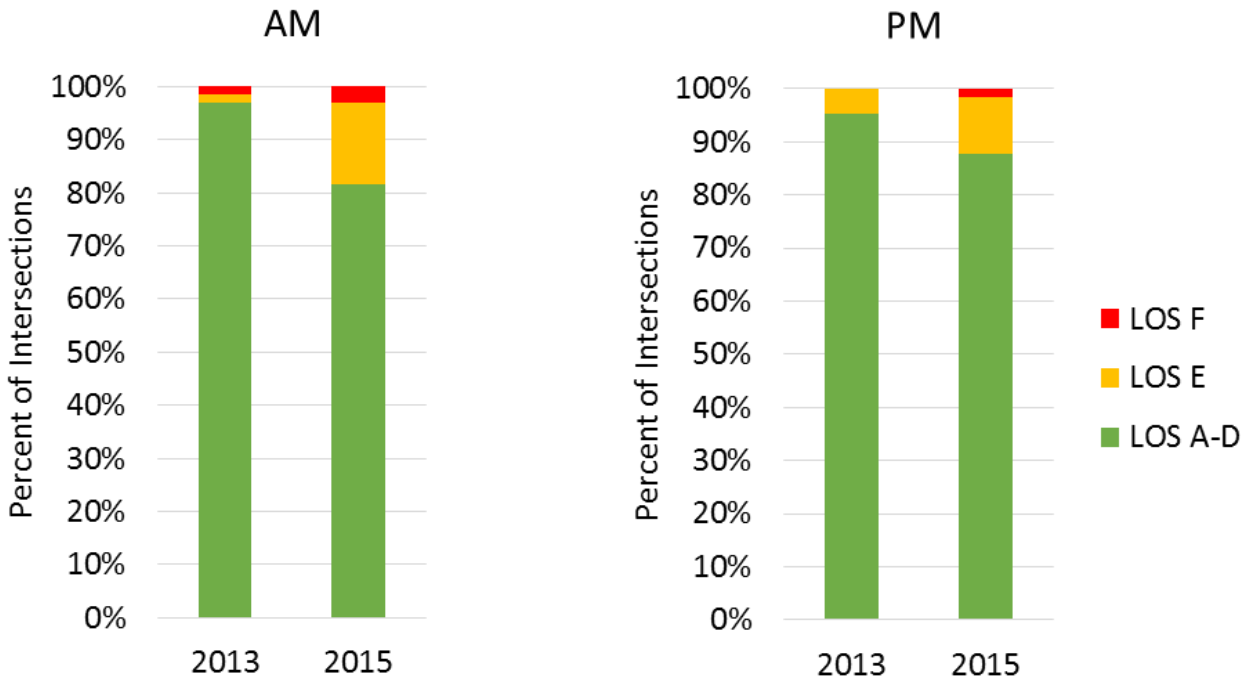

Figure 4-1: Intersection LOS Comparison between 2013 and 2015 LOS Monitoring

Figure 4-2 provides the change in LOS scores from 2013 to 2015, where a negative score indicates a worsening of LOS and a positive score indicates an improvement in LOS. For example, a value of -3 would indicate that an intersection worsened from LOS A (for example)

in 2013 to LOS D (for example) in 2015; a value of 2 would indicate that an intersection improved from LOS D (for example) in 2013 to LOS B (for example) in 2015.

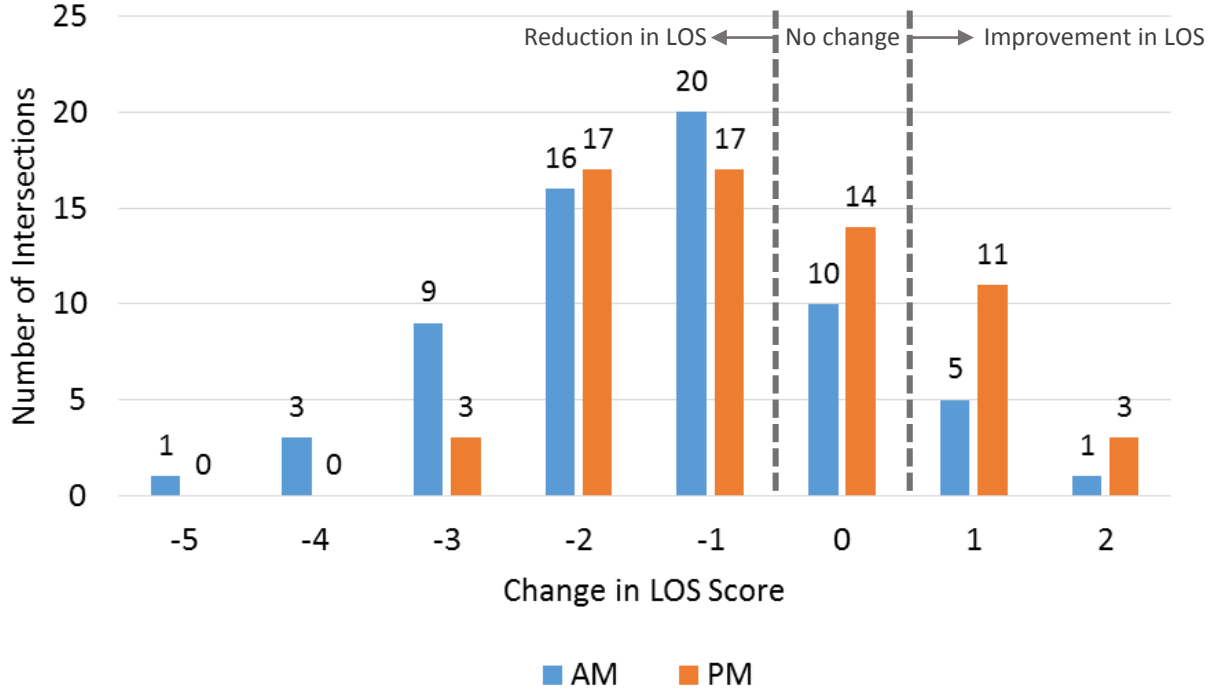

Figure 4-2: Change in LOS Score from 2013 to 2015

For both AM and PM, most intersections worsened by one or two LOS scores. In the AM, some intersections got worse by more than three LOS scores. For example, the intersection of El Portal Drive and Eastbound I-80 Ramps worsened from LOS A to LOS F (-5), which is a change that will be investigated by CCTA in consultation with Caltrans (see Section 3.1). The results also indicate that more intersections improved or stayed the same in the PM peak than in the AM peak.

While comparing these results between 2013 and 2015, it should be noted that some of these differences may also be attributed to the change in LOS methodology between the two years. In 2013, a volume-to-capacity methodology was used, while in 2015 a delay-based methodology was used. In general, the former methodology used in 2013 produces better LOS results for a given intersection and traffic condition compared to the 2015 methodology.

4.1.2 Freeway LOS Trends

Figure 4-3 presents a comparison of the freeway LOS between 2013 and 2015 monitoring. Similar to the intersections, freeways also indicate a general worsening of LOS in the 2015 monitoring. On an average, the number of intersections operating at LOS F increased by 14% in 2015 when compared to 2013 monitoring.

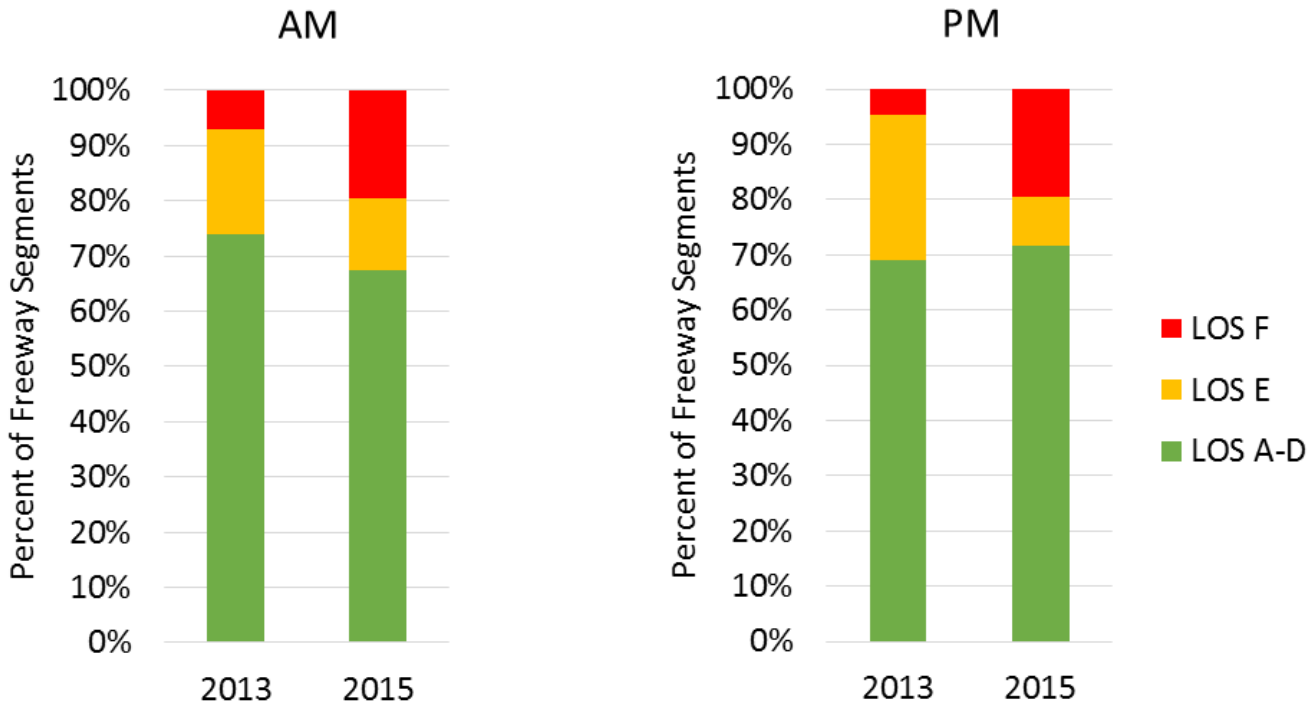

Figure 4-3: Freeway Segment LOS Comparison between 2013 and 2015 LOS Monitoring

Figure 4-4 presents similar comparisons in speeds (in both directions combined) between 2013 and 2015. Out of the 6 freeway corridors reviewed, the majority of corridors had average speeds up to 5 mph less than 2013 results. The two exceptions include I-580 in the AM peak and SR-24 in the PM peak. I-580 showed a significant reduction in speed in the AM peak, especially in the westbound direction. However, SR-242 showed a slight increase in speed during the PM peak, resulting from improved speed in the southbound direction.

While comparing these results between 2013 and 2015, it should be noted that some of these differences may also be attributed to the change in data source. In 2013 a combination of PeMS and floating car runs was used, while in 2015 commercial speed data provided from INRIX was used. Due to this change in data sources, this comparison may not fully reflect the actual

change in speeds between 2013 and 2015. For example, the reduction in average bi-directional speed along I-580 is approximately 23 mph or 40% compared to the 2013 monitoring speeds (Figure 4-4). However, when compared to the 2013 INRIX validation results, this reduction in speed is observed to be only 8 mph or 20%. Refer to Appendix C for an additional comparison of 2015 freeway INRIX speeds with 2013 freeway INRIX speeds from the Validation Study.

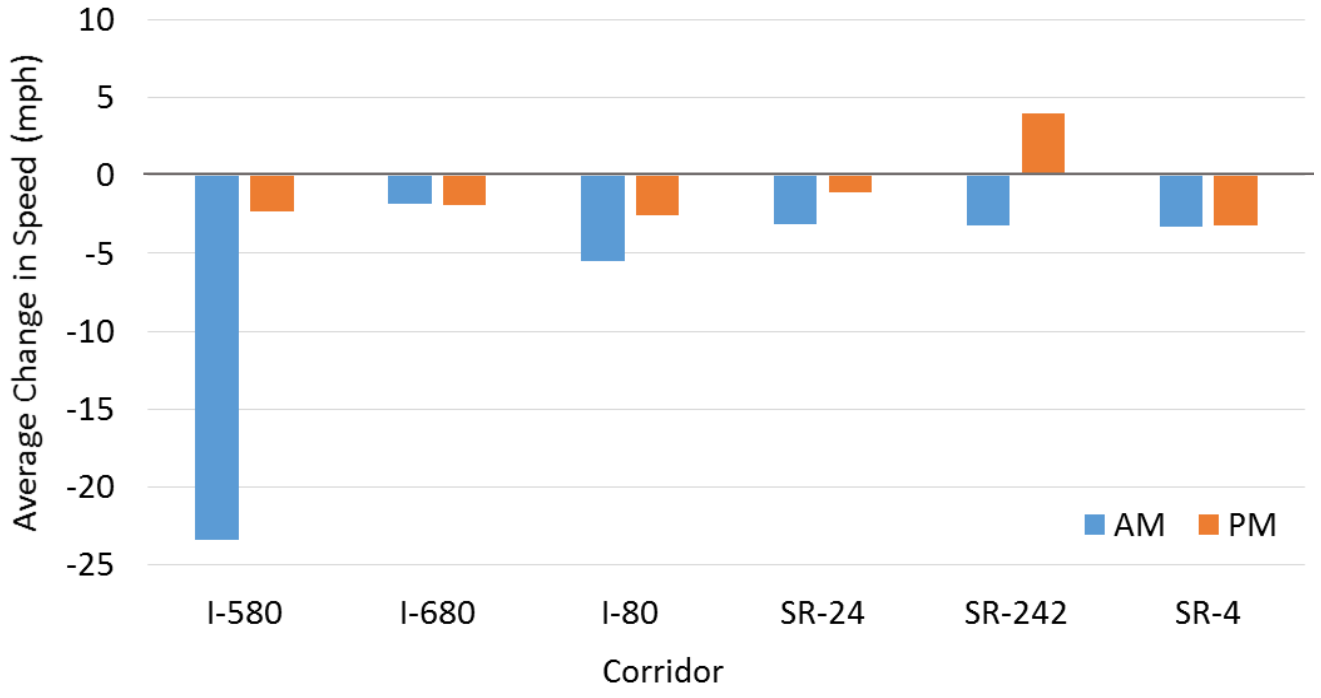

Figure 4-4: Change in Freeway Corridor Speed from 2013 Monitoring Results to 2015

It is expected that similar comparisons in the future would provide better insights, as CCTA continues to the use commercial speed data for 2017 LOS monitoring.

4.1.3 Employment Trends

Barring the differences in methodology and data sources, some of these noticeable changes in performance are influenced by employment growth in the Bay Area. Figure 4-5 shows that there has been a consistent increase in the employment levels since the 2013 monitoring. There is a growth of approximately 4% in the jobs from April 2013 to 2015. The source of the employment data presented in Figure 4-5 is Bureau of Labor Statistics for the Oakland-Hayward-Berkeley metropolitan area.

Figure 4-5 also presents a trend in freeway delay across Contra Costa County between 2013 and 2015. The freeway delay shown in this Figure is downloaded from PeMS[6] for a speed threshold of 35 mph. PeMS computes delay as the amount of extra time spent by all the vehicles over and above the time it takes to traverse a freeway at the threshold speed. This Figure shows a close correlation between the employment growth and the observed increase in the freeway delay.

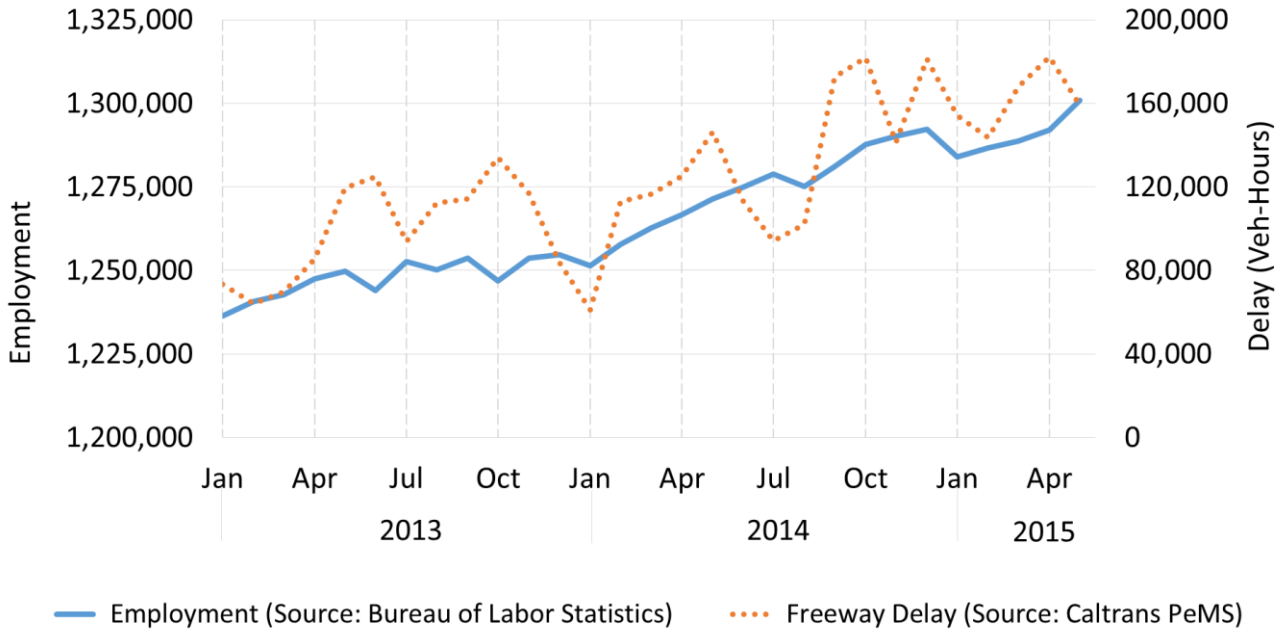

Figure 4-5: Trends in Employment and Freeway Delay between 2013 to 2015

The overall 2015 LOS performance trends presented in sections 4.1.1 and 4.1.2 resonate these employment and freeway delay trends. If the employment levels continue to rise, similar changes in performance results can be expected in the next monitoring cycle.

4.2 Current and Future Improvements and Projects

In this monitoring, it was ensured that any days impacted by construction activities during the peak hours were excluded from the monitoring days. For major construction activities, even if the lane closures do not happen during the peak hours, they still have secondary impact on the traffic flows through the friction caused by narrower lanes, presence of concrete barriers at

[6] http://pems.dot.ca.gov/

close proximity or gawking. Such major and other minor construction projects active during 2015 monitoring along the CMP Network are listed in Table 4-1.

Table 4-1: Active Long-term Projects along the CMP Network during Spring 2015

Impacted Roads	Extents	Description of Work
SR-4	Somersville Road to SR-160 interchange	Roadway widening and BART extension
I-680 Northbound	Walnut Creek to San Ramon	Express lanes
I-80	San Francisco-Oakland Bay Bridge Toll Plaza to the Carquinez Bridge	Integrated Corridor Management (ICM)

SR-4 widening and I-680 express lane construction projects anticipate to ease congestion and increase mobility along SR-4 and I-680 corridors, respectively. I-80 ICM project proposes to make the most efficient use of the existing infrastructure within the I-80 corridor by implementing system management strategies to reduce congestion, reduce travel time, and improve safety.

In addition to these improvements, the following planned projects are anticipated prior to the next CMP monitoring:

- I-80/ San Pablo Dam Road Reconstruction
- I-680 / SR-4 Interchange Improvement
- SR-4 / Balfour Widening
- Hercules Intermodal Transit Center
- I-680 Southbound HOV Gap Closure Between North Main and Livorna
- SR-4/SR-160 Direct Connector Ramps

Improved performance resulting from some of these completed projects are expected to have a positive impact on the freeway operations in the next monitoring cycle.

5 Recommendations for Future Monitoring

Significant changes have been made to the LOS monitoring in 2015, both in terms of the data collection techniques and LOS calculation methodology. These include:

- The use of commercial speed data for calculating freeway LOS; and
- The use of HCM methodology and Synchro software for calculating intersection LOS.

While these changes are significant improvements to the CMP methodology in this monitoring cycle, additional enhancements may be considered for further improvements and to expand the scope of the LOS monitoring. Possible enhancements are recommended below.

5.1 Intersection Monitoring Recommendations

In 2015, intersections were monitored for the first time in Synchro using HCM methodology. While significant work was performed to review and update the intersection timings plans for approximately 30% of the monitoring intersections and to conduct the analysis in HCM 2010, the following additional updates can be performed for the next monitoring cycle:

- Update timings for all of the remaining intersections using the latest signal timing plans available from the member agencies (see Appendix F for a summary of signal timing updates);
- For intersections that were not analyzed in HCM 2010, investigate and update the intersection details in Synchro so that the intersection results can be consistently reported in HCM 2010.
- Review and consider the following updates to CCTA *technical procedures*:
    - Where the right turn on red (RTOR) volume is heavy, use the estimated value based on HCM 2000 procedures rather than the current default value of zero;
    - Where there is a right turn overlap with heavy volume, use estimated capacity increase based on HCM 2000 procedures; apply as a RTOR volume reduction; and
    - If the intersection cannot be analyzed in HCM 2010, use HCM 2000.

5.2 Freeway Segment Monitoring Recommendations

Based on the validation task conducted in spring 2015, INRIX speed data was used for monitoring the freeway LOS in 2015. This sub-section provides additional recommendations on using commercial speed data for future monitoring:

- ***Incorporate advanced metrics:*** Speed and LOS were used as the primary metrics for reporting and comparisons in this monitoring, as these were the metrics available from the previous monitoring methodology. Should CCTA and its constituents desire, travel time – including travel time reliability – may be explored for future monitoring.
- ***Monitor arterial roadways:*** Due to the availability of data from INIRX on arterials, CCTA and its constituents could consider monitoring major arterial roadways for future monitoring cycles. CCTA may consider replacing the intersection analysis with an analysis along the length of the arterial.
- ***Increase monitoring periods:*** The current monitoring only considered weekday AM/PM peak hour speeds. To leverage the advantages of big data, it is recommended that monitoring scope be expanded to include separate analysis on weekends and additional off-peak times during the monitoring months.

In addition to freeways, ramp connectors can also be considered for monitoring in the future cycles. Currently the coverage of commercial data along these ramp connectors is not adequate. However, INRIX and other commercial providers periodically expand their TMC network. Therefore it is recommended that CCTA review the availability of INRIX data along the ramp connectors in the future and include them in the monitoring network.

5.3 Additional Recommendations on using Big Data

With emerging technologies and availability of richer transportation data sources, CMP monitoring around the nation has been radically transforming. Agencies are now able to expand beyond the traditional LOS roadway monitoring and reporting. Following are additional recommendations that CCTA may consider for future monitoring to continue adopting advanced data sources and newer performance reporting approaches:

- ***New Data Sources*****:** Numerous data sources, such as origin-destination (OD), bicycle/pedestrian and volume data are becoming increasingly available through commercial providers with the advent of crowd sourcing techniques. This creates major opportunities for agencies such as CCTA to get better insights on their transportation network performance. For instance, an OD analysis can be undertaken on the county's most congested segments to understand where the major trips are originating from, thus better targeting solutions. Companies such as Airsage and StreetLight Data

provide crowd sourced OD data. For bicycle data there are providers such as Strava Metro that aggregate crowd sourced bicycle and pedestrian activity into commercial data products. The data can be filtered by commute or recreational purpose, and can be used to perform monitoring such as bicycle travel times, bicycle route choice, and success of new multimodal infrastructure.

- ***Enhanced Visualization:*** Text has served as the core communication for congestion monitoring, largely in the form of tables and static graphics in reports. However, the core communication medium for Big Data is not text, it is visualization. GIS based maps and interactive graphics can be incorporated into the CMP report or CCTA website to show the performance of the network in a manner that is more understandable to CCTA constituents and public.