1. INTRODUCTION

The Alameda County Transportation Commission (Alameda CTC), a Joint Powers Authority, is a newly formed countywide transportation agency, resulting from the July 2010 merger of the Alameda County Congestion Management Agency (ACCMA) and the Alameda County Transportation Improvement Authority (ACTIA). For more than two decades, ACTIA and the ACCMA collectively spearheaded transportation programs and projects in Alameda County. In assuming the duties of the ACCMA, the Alameda CTC is the Congestion Management Agency for Alameda County and will continue to perform congestion management activities.

The Congestion Management Program statute, requires designation of a system ('CMP network') of highways and roadways including all freeways, state highways and principal arterials. The statue also requires that a level of service standard be established to measure congestion on the CMP network, and the network be monitored at least biennially. Alameda CTC, as the designated CMA for Alameda County, has established the Alameda County CMP network and adopted Level of Service (LOS) standards. Alameda CTC monitors the network biennially in even numbered years.

The objectives of this monitoring effort are:

- to determine the average travel speeds and existing LOS throughout Alameda County
- to identify those roadway segments in the County that are operating at LOS F
- to identify long-term trends in traffic congestion on the CMP network

THE CMP NETWORK

The Alameda County CMP network was initially adopted in 1991 and consisted of approximately 232 miles of roadways. Of this total, 134 miles are freeways, 71 miles are conventional state highways, and 27 miles are City/County arterials. Additionally, in 1992, 22 major freeway-to-freeway and freeway-to-state route connectors were added to the network. The same network with the exception of three minor changes was used for monitoring purposes until the 2010 monitoring cycle.

Since the adoption of the CMP network in 1991, land use and traffic patterns across the county have changed significantly. However, the CMP network was not expanded to be reflective of these changes, with the exceptions of a two-mile segment of Hegenberger Road in Oakland and changes due to the realignment of SR 84 in East County. Therefore, in view of the need for measuring performance of the larger road network where the majority of the travel occurs in the county, the Commission, as part of the 2011 CMP Update, expanded the CMP network by adding approximately 90 miles of additional principal arterials and major collectors across the county using a set of adopted qualitative criteria. With this expansion of the CMP network, a two-tier CMP roadway system was created with Tier 1 being the existing CMP network and Tier 2 being the newly added 90 miles of roadways.

The full list of routes for Tiers 1 and 2, summarized by jurisdiction, is shown in Tables 1 and 2 respectively. The entire CMP network (Tiers 1 and 2) is shown in Figure 1. Of the fifteen jurisdictions, Piedmont is the only city in Alameda County that does not have any roadways that are part of the CMP network. Starting in the 2012 LOS Monitoring cycle, travel-time data was collected for both Tiers 1 and 2 roadways.

Table 1: Tier 1—Alameda County CMP Designated Roadway Network[1] Routes and Estimated Mileage by Jurisdiction

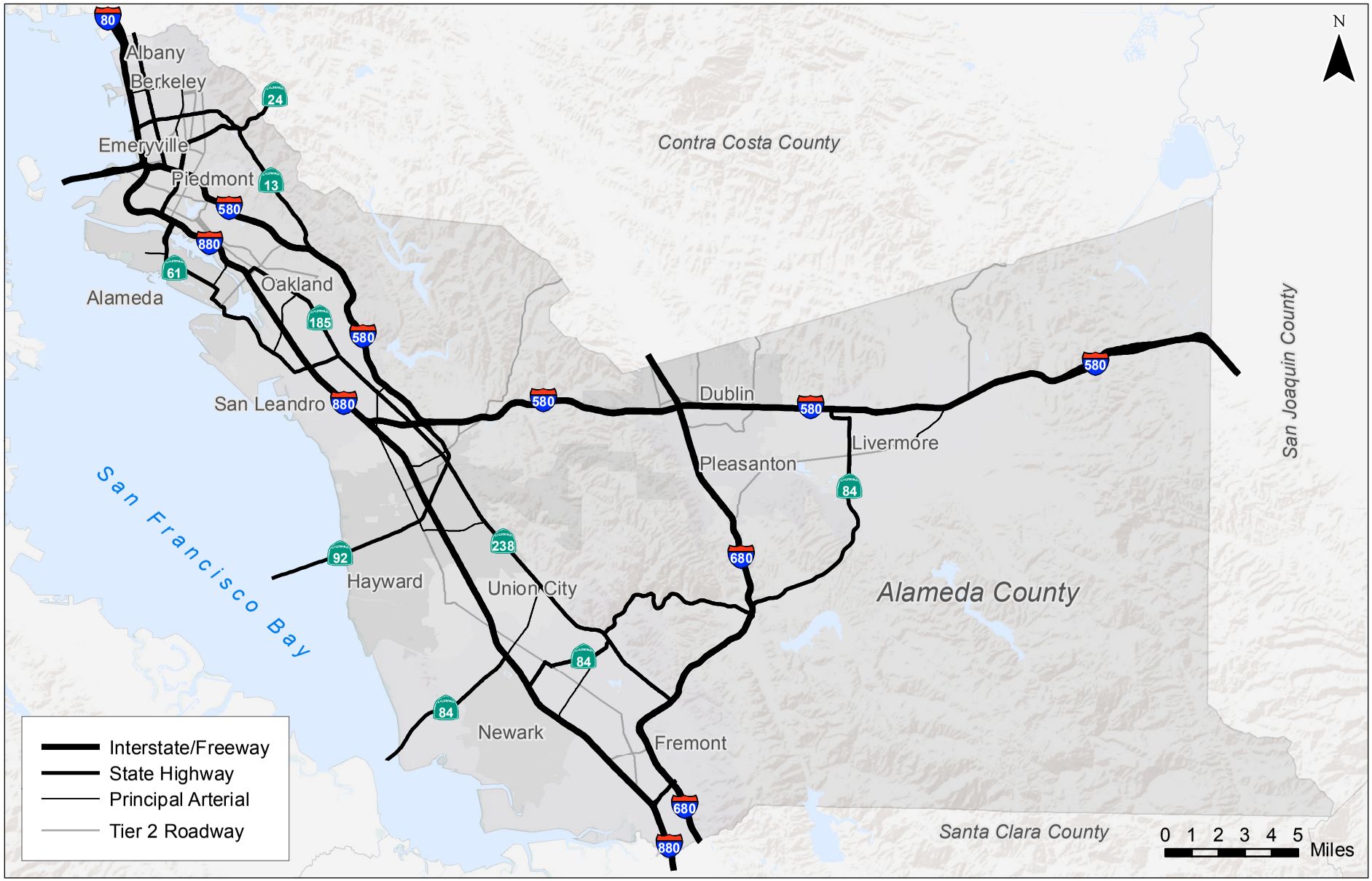
Jurisdiction	Freeway	Miles	Other State Highways	Miles	Other Arterials	Miles
Albany	I-80 I-580	0.61 0.92	SR 123 (San Pablo Ave.)	1.22	None	—
Berkeley	I-80	3.14	SR 123 (San Pablo Ave.) SR 13 (Ashby/Tunnel Rd.)	2.36 3.87	University Ave. Shattuck Ave. MLK Jr. Blvd. Adeline	2.04 1.84
Emeryville	I-80	1.31	SR 123 (San Pablo Ave.)	0.68	None	—
Oakland	I-80 I-880 I-980 I-580 SR 24 SR 13	4.09 7.66 2.30 11.28 4.50 5.43	SR 123 (San Pablo Ave.) SR 13 (Tunnel Rd.) SR 61/260 (Tubes) SR 61 (Doolittle Dr.) SR 77 (42nd Ave.) SR 185 (E 14th St.)	1.19 0.10 0.66 2.39 0.31 3.98	MLK Jr. Blvd. Hegenberger Rd. 29th Ave./23rd Ave. -(See Park St-Alameda)	0.89 2.52 0.85
Piedmont	None	—	None	—	None	—
Alameda	None	—	SR 61 (Doolittle Dr., Otis, Webster St) SR 61/260 (Tubes)	4.47 0.65	Atlantic Ave. Park St.	0.80 0.55
San Leandro	I-880 I-580	3.78 2.95	SR 61 (Doolittle Dr.) SR 61/112 (Davis St.) SR 185 (E 14th St.)	0.70 1.78 3.16	150th Ave. Hesperian Blvd.	0.49 0.97
Hayward	I-880 SR 92	4.23 6.36	SR 185 (Mission Blvd.) SR 238 (Mission Blvd.) SR 238 (Foothill Blvd.) SR 92 (Jackson St.)	0.85 3.29 1.50 1.58	A St. Hesperian Blvd. Tennyson Rd.	1.61 2.60 2.32
Union City	I-880	1.70	SR 238 (Mission Blvd.)	2.57	Decoto Rd.	1.76
Fremont	I-680 I-880 SR 84	6.20 11.96 3.17	SR 238 (Mission Blvd.) SR 262 (Mission Blvd.) SR 84 (Thornton, Fremont, Mowry Ave.)	5.03 1.22 10.99	Decoto Rd. Mowry Ave.	1.15 2.96
Newark	SR 84	1.99	None	—	None	—
Pleasanton	I-580 I-680	4.65 5.26	None	—	None	—
Livermore	I-580	4.61	SR 84	5.29	1st Street	1.66
Dublin	I-680	1.84	None	—	None	—
Unincorporated Areas	I-680 I-580 I-238 I-880	7.91 22.50 1.99 1.93	SR 84 (Vallecitos Rd.) SR 185 (Mission Blvd & E 14th) SR 238 (Foothill Blvd.)	7.97 2.47 0.79	Hesperian Blvd.	1.99
Totals		**134 mi**		**71 mi**		**27 mi**

[1] As adopted in October 24, 1991 (except for the re-aligned SR 84 and 1st Street in Livermore, which were changed in 2004 and 2006 studies, respectively; and Hegenberger Road between I-880 and Doolittle Drive in Oakland, which was added in the 2008 study).

Table 2: Tier 2—Alameda County CMP Designated Network** Routes and Estimated Mileage by Jurisdiction

Jurisdiction	Distance (miles)	Route
Alameda County	0.9	A Street*
	7.0	Crow Canyon Road
	2.7	Sunol Blvd.–1st Street–Stanley Blvd.*
	1.0	Grove Way
Alameda	1.2	High Street
Berkeley	0.7	Bancroft
	1.4	College Avenue*
	0.5	Shattuck Avenue*
	1.4	Telegraph Avenue*
	0.8	Powell Street–Stanford Avenue
Dublin	1.9	Dougherty Road
	3.6	Dublin Blvd.
	1.7	San Ramon Road
	2.8	Tassajara Road
Emeryville	1.5	40th Street–Shellmound Avenue
	0.6	Powell Street–Stanford Avenue
Fremont	1.6	Automall Parkway
	8.8	Fremont Boulevard
Hayward	0.3	A Street*
	1.6	Hesperian Boulevard–Union City Blvd.*
	2.2	Winton Avenue–D Street
Livermore	4.2	E. Stanley Blvd–Railroad Avenue–1st Street
	5.7	Vasco Road
Oakland	2.4	12th Street–Lakeshore Avenue
	0.8	51st Street
	3.1	Broadway
	1.0	College Avenue*
	1.0	E. 15th Street
	5.3	Foothill Boulevard
	2.3	High Street
	2.9	International Boulevard
	0.8	Powell Street–Stanford Avenue
	1.0	Shattuck Avenue*
	0.8	Telegraph Avenue*
	3.1	W. Grand Avenue to Grand Avenue
	1.1	73rd Avenue
Pleasanton	1.2	Santa Rita Road
	2.5	Stoneridge Drive
	2.9	Sunol Blvd.–1st Street–Stanley Blvd.*
Union City	2.2	Alvarado Blvd.
	1.3	Hesperian Boulevard–Union City Blvd.*
TOTAL	**89.8**	

* Denotes that roadway traverses more than one jurisdiction.
**As adopted by Alameda CTC in December 2011.



ALAMEDA County Transportation Commission

Alameda County CMP System

Figure 1

H:\projfile\171447\0\2012 LOS\01_Alameda County CMP System.mxd - jsommerville - 4:55 PM 7/12/2012

KITTELSON & ASSOCIATES, INC.
TRANSPORTATION ENGINEERING/PLANNING

Coordinate System: NAD 1983 StatePlane California III FIPS 0403 Feet

LEVEL OF SERVICE STANDARDS AND CMP CONFORMITY

LOS definitions generally describe traffic conditions in terms of speed and travel time, volume and capacity, freedom to maneuver, traffic interruptions, comfort and convenience and safety. LOS is represented by letter designations, ranging from A to F, with LOS A representing the best operating conditions and LOS F the worst. The level of service standard for CMP monitoring purposes is LOS E.

- Levels of Service A, B and C indicate conditions where traffic can move relatively freely.
- Level of Service D describes conditions where delay is more noticeable.
- Level of Service E describes conditions where traffic volumes are at or close to capacity, resulting in significant delays and unstable traffic flow.
- Level of Service F characterizes conditions where traffic demand exceeds the available capacity, with very slow speeds (stop-and-go), long delays (over one minute at intersections), and average speeds of less than half of the uncongested or free flow speed.

Each year, member agencies must demonstrate that all CMP roadway systems within their jurisdictions are operating at or above the CMP traffic LOS standard. A member agency's state gas tax subventions may be withheld if the member agency does not maintain the traffic LOS standard or have an approved deficiency plan for roadways that fall below the LOS standard. The deficiency plan should identify:

- the cause of the deficiency;
- measures to improve the performance of the roadway; and
- a funding plan for the proposed improvements.

An exception to this requirement is made for roadways that operated at LOS F in the 1991 "baseline" conditions. These roadways were "grandfathered" in at LOS F.

Monitoring for Conformance and Information

Until 2010, travel-time data was collected during the p.m. (4:00 to 6:00) and a.m. (7:00 to 9:00) peak periods on the Tier 1 network. Beginning in 2012, data had also been collected on the freeways during weekend peak period (1:00 to 3:00 p.m.) and on the Tier 2 network during both a.m. and p.m. peak periods. For CMP Conformity (identifying whether a CMP segment meets the LOS standard, and if not, whether a deficiency plan is required to be prepared) purpose, only data collected on the Tier 1 network during p.m. peak period is used. All other data collected on the Tier 1 (a.m. and weekend peak periods) and on Tier 2 (a.m. and p.m.) networks including any additional data are used for informational purposes only.

In addition to the travel-time data collection on the CMP network, travel-time surveys are also conducted for auto, transit, bicycle and HOV lane trips between selected Origin-Destination (O-D) pairs. These O-D pairs have been selected as either major employment centers or residential areas to simulate typical commute trips on the County's major corridors and to evaluate the comparative performance of various transportation modes between these pairs. Travel times on the three Bay bridge crossings (i.e., Bay Bridge, San Mateo Bridge and Dumbarton Bridge) that connect Alameda County to San Francisco and San Mateo Counties have also been reported since 2002.

Table 3 shows data collection time periods and the purpose for which the data is used.

Table 3: CMP Network Monitoring Periods and Purpose of Monitoring

		Monitoring Purpose: Conformity	Monitoring Purpose: Informational
Tier 1	Freeways p.m.	X	
	Arterials p.m.	X	
	Ramps and Special Segments p.m.	X	
	Freeways–Weekend 1-3 p.m.		X
	Freeways a.m.		X
	Arterials a.m.		X
	Ramps and Special Segments a.m.		X
Tier 2	Arterials p.m.		X
	Freeways a.m.		X

STUDY METHODOLOGY

The Alameda County CMP established that measurement of LOS be based on average travel speed, consistent with the method described in the *Manual of Traffic Engineering Studies*[2]. The study methodology involves: establishing roadway segment boundaries; collecting travel-time data; computing travel speeds; and comparing average speeds with LOS speed ranges as specified in the 1985 Highway Capacity Manual[3]. For this study, the "floating car" method was used to record travel times through the Global Positioning System (GPS) between roadway segments.

CMP Roadway Segments

Tiers 1 and 2 roadways were divided into approximately 372 segments for Tier 1 and 196 segments for Tier 2 for this study, using the methodology described below for the different roadway classifications. The number of segments increased from 296 in 2006 to 372 in 2008 for Tier 1 roadways due to the segmentation of longer CMP network segments into shorter segments.

Freeways—Tier 1

The 134 miles freeways on the CMP network consist of 150 segments for monitoring purposes. When CMP roadway segments were developed in 1991, major interchanges were used as segment boundaries for freeways. Along more heavily traveled sections, segments generally span from one to three interchanges. Where traffic volumes entering and exiting the freeway were minor, three or more sections were combined into longer segments. This was the case, for instance, in the eastern section of the I-580 corridor. However, over the last two decades the land use and traffic patterns have changed in places such as East County as a result of housing and job growth, creating the need to split longer CMP segments into shorter segments. This exercise was carried out as a trial in the 2006 LOS Monitoring Study. It was subsequently refined and adopted in the 2007 CMP. As of the 2008 monitoring cycle, the LOS Monitoring Study uses the shorter segments.

Arterials—Tier 1

Tier 1 Arterials include 232 segments covering 98 miles. For arterials, break points between segments generally occur at:

- jurisdiction boundaries
- points where the number of travel lanes change
- major arterial street crossings; and at points where land use, speed limit, or channelization schemes change significantly

Segment boundaries for arterial roadways are identical for both directions and the distances are generally the same or sufficiently similar so as to be considered equal. Nevertheless, the distances for each direction of the same segment may differ slightly in cases of very wide intersections or when the street crossings are staggered.

Additionally, classification of arterials was developed for determining level of service. For this purpose, each section between two adjacent signals was first reviewed to determine its arterial class as Class I, II, or III. Arterial class is based on access control, land use intensity, free flow speed and other factors as defined in the 1985 Highway

[2] Paul C. Box and Joseph C. Oppenlander, *Manual of Traffic Engineering Studies,* 4th ed. (Arlington VA.: Institute of Transportation Engineers, 1976).

[3] As part of the 2013 CMP Update, the 2010 Highway Capacity Manual standards will be considered to be used for LOS Monitoring purposes.

Capacity Manual (Chapter 11, pp. 11-1 to 11-4)[4].

In 2006, similar to the split of freeway CMP network segments into shorter segments, a few arterial roadway segments were also split. These shorter arterial segments were used starting in the 2008 LOS Monitoring Study.

Arterials—Tier 2

The segmentation of Tier 2 Arterials was developed similar to Tier 1 Arterials.

To develop the arterial classification for the Tier 2 Arterials, free flow speed data is required. It is anticipated to be collected during or prior to the 2014 LOS Monitoring cycle. The 2010 Highway Capacity Manual will also be used for developing the classification of Tier 2 Arterials. Therefore, only the speed data that is reported for Tier 2 Arterials is included in the 2012 LOS Monitoring Study report.

Ramps and Special Segments—Tier 1

Separate travel time/speed runs are conducted for the ramps at freeway-to-freeway interchanges, since these connections can frequently have very different characteristics than the freeways themselves. There are 22 freeway-to-freeway ramps and special connectors that have been studied since 1992:

1. I-80 to I-580 connections (Oakland-Emeryville area)
2. I-580 to SR 24 connections (Oakland)
3. SR 13 to SR 24 connections (in the vicinity of the Caldecott Tunnel, Oakland)
4. I-880 to I-238 connections (San Leandro)
5. I-238 to I-580 connections (Hayward)
6. I-580 to I-680 connections (Pleasanton)
7. I-880 to SR 260 connections (at the Alameda tubes, Oakland)

[4] Highway Capacity Manual, Special Report 209, a publication of the Transportation Research Board, Washington D.C., 1985.

LEVEL OF SERVICE SPEED STANDARDS

Freeways and Arterials

This study uses the LOS speed standards shown in Table 4 for arterials and freeways based on the 1985 Highway Capacity Manual[5].

Non-Standard Roadways

The standards for other more unique types of roadway segments are described below.

Table 4: Relationship Between Average Travel Speed and Level of Service

Freeway Levels of Service[6]

LOS	Density (pc/mi/ln)[7]	Speed (mph)	Volume/ Capacity Ratio	Maximum Service Flow (pcphpl)[8]
A	≤ 12	≥ 60	0.35	700
B	≤ 20	≥ 55	0.58	1,000
C	≤ 30	≥ 49	0.75	1,500
D	≤ 42	≥ 41	0.90	1,800
E	≤ 67	≥ 30	1.00	2,000
F	> 67	< 30	—[9]	—

Range for LOS F for Freeway Sections[10]
F30—Average Travel Speed <30
F20—Average Travel Speed <20
F10—Average Travel Speed <10

Arterial Levels of Service[11]

Arterial Class	I	II	III
Range of Free Flow Speeds (mph)	45 to 35	35 to 30	35 to 25
Typical Free Flow Speed (mph)	40	33	27

LOS	Average Travel Speed (mph)		
A	≥ 35	≥ 30	≥ 25
B	≥ 28	≥ 24	≥ 19
C	≥ 22	≥ 18	≥ 13
D	≥ 17	≥ 14	≥ 9
E	≥ 13	≥ 10	≥ 7
F	< 13	< 10	< 7

[5] See footnote #3.
[6] Adapted from Table 4-1, Special Report 209, Highway Capacity Manual; 1985.
[7] Passenger cars per mile per lane.
[8] Maximum service flow under ideal conditions, expressed as passenger cars per hour per lane.
[9] Highly variable, unstable flow; V/C Ratio is not applicable.
[10] Approved by Alameda CTC on June 14, 2004 to show degrees of LOS F on congested roadways.
[11] Table 12-1, Special Report 209, Highway Capacity Manual, 1985. For Rural Roadways, refer to Table 8-1 in the Highway Capacity Manual.

Rural Roadways

Few of the CMP routes are rural roadways (mostly located in East County), which require a special analysis procedure. On these roadways, traffic and speed characteristics are fairly uniform. Variations in speed are a function of roadway curvature and the presence of slow trucks in the traffic stream. Based on suggested guidelines from the Highway Capacity Manual, LOS A is deemed to occur when vehicles are traveling at a free-flow speed for the given roadway conditions. LOS F is estimated to occur when speeds have dropped below 50 percent of the free flow speeds. Levels of Service B to E are calculated at even intervals between free flow speeds and LOS F speeds.

One such roadway is SR 84 between the southern city limit of Livermore and Mission Boulevard in Fremont. More rural roadways are expected to be identified in the Tier 2 Arterials located in East County when the Arterial classification is developed.

For the SR 84 rural roadway portion, initial free flow speeds were determined based on special studies conducted in the 1992 surveys during off-peak, low-volume conditions to document the free flow speed. Considering the change in land use pattern combined with the roadway improvements made since 1992, new free flow surveys were conducted during the 2010 monitoring cycle. These speeds have been used to determine the levels of service since 2010.

Freeway-to-Freeway and State Route-to-Freeway Ramps

The guidelines for establishing LOS for these ramp connections were similar to those used for rural highways. Special studies were previously conducted as a part of the 1992 studies, during off-peak low-volume conditions, to document free flow speeds.

DATA COLLECTION

Travel-time data is typically collected for all segments on the CMP network during spring before the start of summer break from the schools to capture peak representative traffic conditions. Travel-time runs are made during the afternoon peak hours of 4:00 to 6:00 p.m. and the morning peak hours of 7:00 to 9:00 a.m. Consistent with the CMP guidelines, all runs are made on a Tuesday, Wednesday, or Thursday of a five-day work week. For 2012, data was collected from the second week of March 2012 through June 13, 2012.

The travel-time runs were spread evenly throughout the two-hour period. For each travel-time run, both the actual clock time and the location of the car were recorded using a GPS device. The travel times between checkpoints (i.e., segment limits) were then computed as the difference between the two corresponding clock times.

For the majority of the CMP system, at least six runs were made on each roadway segment. More than six runs were made on some Levels of Service E and F segments where heavy congestion has been previously reported or where a greater range of fluctuation in travel speed was found, or where questionable data was reported. On certain routes where free flow conditions of LOS C or better were experienced and where this data was consistent with previous reports, the studies were sometimes concluded after four runs were completed. The number of runs that were conducted on each route and the times and dates of the runs are available for review at the Alameda CTC.

Data Collection on the CMP Network and Other Surveys Since 1991

The study of p.m. peak period travel times has been conducted on the CMP network continuously since 1991. In 1994, the study was expanded to include a.m. peak period runs on selected arterials and freeways that were considered to be the most critical during the morning commute period. Starting in 2006, all of the CMP roadway segments are monitored in both a.m. and p.m. peak periods. In 2012, based on the directions from the Commission, travel-time data was also collected on the freeways during the weekend peak period between 1 p.m. and 3 p.m.

In addition, in 1996, the comparative travel times between auto and transit, and in one case bicycle, was also included for five selected origin-destination (O-D) pairs that reflect typical work trips in Alameda County. Over the years, additional O-D pairs were added, resulting in 10 home-work pairs being studied since 2006. In 2002, three pairs were added representing the three Bay Bridges Crossings that connect to Alameda County.

Construction Activities in 2012

Some CMP roadway segments were under construction during the 2012 study period, and the travel time/speed data on these routes could be considerably different than normal average traffic conditions. When the travel-time runs were conducted (March-June, 2012), the major projects under construction were:

- Bay Bridge
- I-880/5th Avenue Retrofit
- I-880/High Street Retrofit
- Caldecott Tunnel 4th Bore Project
- Oakland Airport Connector
- SR 238/ Foothill Boulevard Operational Improvements

At several locations, there may have been construction occurring along the edge of the roadway, but it was judged that the construction did not have a significant impact on the travel time results.

DATA ANALYSIS PROCEDURES

The travel speeds have been determined using measured times and distances between the checkpoints. The section-by-section and run-by-run travel time and speed data were checked for errors and abnormal results. Mathematically, the average travel time for a segment was computed as the sum of the average travel times of the individual sections comprising the segment. The average travel speed has been determined by dividing the average travel time for the segment into the segment length.

The LOS results represent the average travel speed during the two-hour peak periods on an average weekday. For many roadway segments, the range of measured speeds is very constant throughout the two-hour period. For others, speeds within this period can be quite different, especially when the peak congestion lasts for less than two hours.

For arterials, the travel-time results are closely related to (1) traffic signal timing and (2) the vehicle location in the traffic platoon during the study. In analyzing the data, if a travel-time run was made at the very beginning of the two-hour period, or toward the end of the period, and the data point was significantly different than other runs, this data point was discarded. Additional travel-time runs were then made during the time period when traffic congestion was more severe.

Some special conditions exist on freeway segments in the vicinity of major off-ramps. There may be different speeds in each lane of the freeway if the rightmost lanes are affected by congestion in the off-ramp. At some of the freeway-to-freeway interchanges on the CMP network, drivers may experience a different LOS in the rightmost lane or on the ramp connection than on the freeway itself. However, no separate travel time/speed runs were made for the rightmost lanes of the freeways approaching ramps.

This page intentionally left blank