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MEMORANDUM

Date: January 17, 2017 Project #: 20998

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From: Brian L. Ray
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Project: Coast Village Road/Olive Mill Road/US 101 Interchange

Subject: Intersection Control Evaluation (ICE) Analysis Methodology and Findings

This memorandum summarizes traffic analysis work performed by Kittelson & Associates, Inc. (KAI) for the Coast Village Road/Olive Mill Road/US Highway 101/North Jameson Lane interchange (US 101/Olive Mill Road Interchange); specifically, for the five-leg all-way stop-controlled northbound ramp terminal intersection (Ramp Terminal Intersection).

The analysis described herein was originally performed during an intersection control evaluation (ICE) to determine the most appropriate traffic control strategy to meet expected future demands.

This memorandum is organized into the following sections:

- Limitations of Highway Capacity Manual Methods
- Forecast Traffic Volumes and Adjustments
- Analysis Method for All-Way Stop Control
- Existing and Future Performance Under All-Way Stop Control

LIMITATIONS OF HIGHWAY CAPACITY MANUAL METHODS

The Ramp Terminal Intersection has a relatively unconventional form compared to typical diamond interchanges. The northbound off-ramp and southbound on-ramp connect to Olive Mill Road on the north side of US 101, effectively providing continuity to and from Coast Village Road. North Jameson Lane also connects to the Ramp Terminal Intersection immediately north of the northbound off-ramp terminal intersection. Currently, each of the five intersection approaches are stop controlled.

An all-way stop-controlled (AWSC) intersection with five approaches is atypical, and poses a challenge for quantifying intersection traffic performance. Typically, such performance is measured by the amount of delay experienced by users of individual vehicles. This amount of delay can be determined using methodologies in the Highway Capacity Manual (HCM). However, HCM methodologies do not apply to all-way stop-controlled intersections with more than four approaches. Therefore, KAI was

unable to apply the HCM-based static analysis to the five-leg all-way stop-controlled configuration of the Ramp Terminal Intersection of the US 101/Olive Mill Road Interchange. To overcome the limitations of HCM methods and analyze a five-leg AWSC intersection, KAI applied a dynamic analysis approach and used simulation modeling (VISSIM software) to estimate delays and queue lengths. We then converted these delay values to applicable level-of-service (LOS) measures based on the HCM fifth-edition (HCM2010) LOS criteria for unsignalized intersections. Our analysis approach is described in more detail in the Analysis Method for All-Way Stop Control section of this memorandum.

FORECAST TRAFFIC VOLUMES AND ADJUSTMENTS

Traffic Data

Baseline Conditions

Traffic counts were collected in April 2014 during the 7 AM to 9 AM and 4 PM to 6 PM peak periods. KAI identified AM/PM peak-hour volumes from this four-hour count. These peak-hour volumes are depicted in **Figure 1.**

Design-Year Conditions

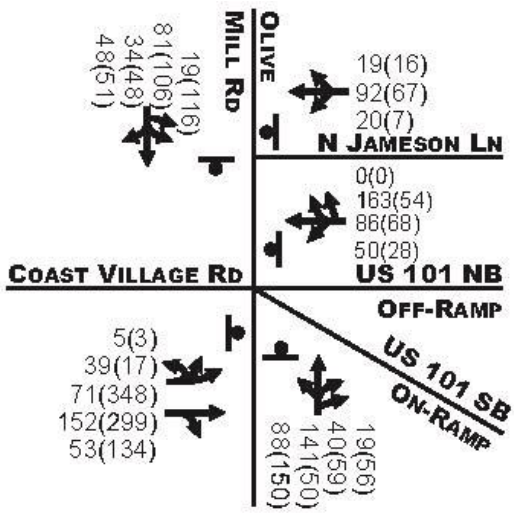
The design-year volume set was based on traffic projections developed for the *SC101 HOV PA-ED Traffic Study* (December 2011) and generated using the Santa Barbara County Association of Governments (SBCAG) travel demand model. The AM/PM peak-hour models were used to forecast 2040 year volumes appropriate for peak-hour operational analysis.

To obtain intersection turn movement forecasts, KAI applied a refinement process called the Furness Method. This post-processing adjustment was necessary given that travel models are calibrated to produce more accurate results for road segments than for individual turn movements. Using the Furness Method, KAI iteratively adjusted the 2014 turning movement counts until the directional sum of the movements balanced to the adjusted future link volumes. This factoring process produced forecast turn distributions that resembled the count distribution, and turn movement proportions that changed in response to different growth rates on different legs as produced by the AM/PM peak-hour travel demand model. KAI made additional spot adjustments so that no future volume for a given turn movement was less than the 2014 traffic count.

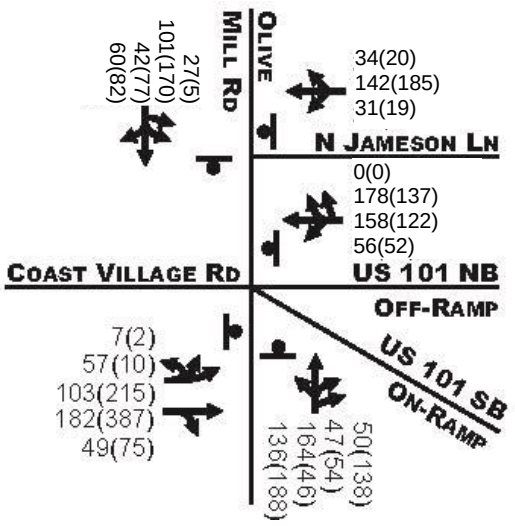
Given that the US 101/Olive Mill Interchange is affected by operations at adjacent US 101 interchanges, KAI accounted for planned modifications to the Cabrillo-Hot Springs interchange in our analysis. KAI (as Dowling and Associates, Inc.) prepared the *Cabrillo Boulevard I/C Modified Configurations Analysis* (July 19, 2011) included as part of the *Cabrillo/Hot Springs Interchange Configuration Analysis Technical Memorandums* (December 11, 2011). Based on these technical studies, the "Modified F" configuration was advanced as the preferred configuration for the Cabrillo-Hot Springs interchange. This configuration is assumed as part of the US 101/Olive Mill Interchange analysis. Adjusted 2040 traffic volumes are also depicted in Figure 1.

Figure 1. 2014 Traffic Counts and 2040 Forecast Traffic Counts

2014 Traffic Counts



2040 Forecast Traffic Counts



LEGEND: XX (YY) – AM (PM) Peak Hour

ANALYSIS METHOD FOR ALL-WAY STOP CONTROL

KAI conducted site visits and used aerial imagery to document the physical, geometric and operational characteristics of each study area intersection and roadway approach segment. Site visits included observation of queue lengths and back-of-queue distances at each approach.

KAI input the existing traffic volumes and the adjusted 2040 turn movement forecasts into VISSIM to determine the amount of delay, and to predict future queue lengths.

Given the limitations of HCM2010 methods for addressing the five-leg all-way stop form of the current Ramp Terminal Intersection, KAI conducted simulation analysis using VISSIM to better determine queues and delays. We developed and calibrated the model to existing conditions using field-measured queue-length delays to obtain an accurate representation of the intersection. VISSIM simulation runs were based on a minimum 15-minute seeding time and 60-minute analysis time (divided into four 15-minute intervals), and reflect an average of 10 multiple runs. We validated VISSIM simulation analyses for existing traffic volumes and queues using the criteria recommended by the *FHWA Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software* (FHWA, July 2004).

KAI compared the simulated delays from VISSIM to the HCM2010 criteria to determine intersection LOS. We used the worst movement delay as an indicator for the operational performance. LOS is a qualitative measure of driver satisfaction and is quantitatively expressed by the level of delay and congestion experienced by motorists using an intersection. LOS is designated by the letters A through F, with A being the best condition and F being the worst (high delay and congestion).

EXISTING AND FUTURE PERFORMANCE UNDER ALL-WAY STOP CONTROL

Based on the methodology described herein, KAI analyzed the traffic volumes collected in April 2014 and projected for year 2040. The results of this analysis are presented in **Table 1** and **Table 2**.

Table 1. Year 2014 Operations

Approach	Movement*	Delay and LOS (seconds/vehicle)		Max Queue (feet)[2]		Storage (feet)[2]	Adequate Storage (Yes/No)
		AM	PM	AM	PM		
Northbound – Olive Mill Road	L/T/R	29.1 (D)	31.0 (D)	200	250	275	Yes
Westbound – US 101 NB Off-Ramp	L/T/R	**57.0 (F)**	32.0 (D)	325	125	750	Yes
Westbound – Jameson Lane	L/T/R	21.6 (C)	14.0 (B)	100	75	710	Yes
Southbound – Olive Mill Road	L/T/R	18.6 (C)	27.9 (D)	150	225	720	Yes
Eastbound – Coast Village Road	Left	17.6 (C)	**58.8 (F)**	100	**1325**	410	**No**
	T/R	19.6 (C)	34.8 (D)	150	**1600**	150	**No**

*Key: L=left turn, T=through, R=right turn. Table cell shading indicates failing LOS (F) and queue lengths that exceed available storage.

Table 2. Year 2040 Operations (Freeway Build Condition)

Approach	Movement	Delay and LOS (seconds/vehicle)		Max Queue (feet)		Storage (feet)[2]	Adequate Storage (Yes/No)
		AM	PM	AM	PM		
Northbound – Olive Mill Road	L/T/R	**101.7 (F)**	**97.3 (F)**	**985.7**	**1,054.1**	275	**No**
Westbound – US 101 NB Off-Ramp	L/T/R	**195.6 (F)**	**228.0 (F)**	**1,672.4**	**1,616.2**	750	**No**
Westbound – North Jameson Lane	L/T/R	36.8 (E)	19.2 (C)	148.9	131.5	710	Yes
Southbound – Olive Mill Road	L/T/R	23.2 (C)	30.9 (D)	160.4	235.6	720	Yes
Eastbound – Coast Village Road	Left	22.0 (C)	**69.9 (F)**	112.3	365.9	410	Yes
	T/R	28.0 (D)	**95.7 (F)**	**206.9**	**1,603**	150	**No**

* Key: L=left turn, T=through, R=right turn. Table cell shading indicates failing LOS (F) and queue lengths that exceed available storage.

As shown in Table 2, by 2040 several movements will operate at a level of service of F during both the AM and PM peak hours. Additionally, queues may exceed 1,600 feet long for the westbound movement (northbound US 101 off-ramp). A queue of this length will exceed the available storage of approximately 750 feet, indicating that the queue could spill back onto the freeway mainlines.