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Farhad Mansourian, RCE

Director

December 2, 2010

California Traffic Control Devices Committee Attn: Devinder Singh, CTCDC Executive Secretary Department of Transportation, Division of Traffic Operations MS 36 P.O. Box 942874, Sacramento, CA 94274-0001

Experimentation Final Report Flashing Yellow Arrow for Permissive Right Turn Movement Intersection of Sir Francis Drake Blvd and Wolfe Grade Kentfield, Marin County, CA

Dear Mr. Singh:

RE:

This is the final report for the experimentation of the flashing yellow arrow (FYA) for permissible right turn movement. In our progress report of December 15, 2009, we indicated a significant reduction in the one year collision after installation of the FYA. This final report confirms a significant intersection collision reduction and provides our final observation and conclusions.

PURPOSE

The primary objective of this experiment was to provide a traffic signal control for a permissive right turning lane without impacting the traffic flow rate as well as improving the safety of pedestrians crossing, especially school children. The ability of the FYA indication to improve safety was evaluated with respect to crash experience. Findings of the crash analysis were compared to other variables or modifications such as signal phasing, vehicle queue, and traffic lane configuration approaching the intersection.

BACKGROUND

Accommodating pedestrians and providing a free right turn movement at a signalized intersection provides a challenge to traffic engineers. Most drivers complete the free right turn movement without regard to pedestrian's right of way. As a result of this conflict of movements, successfully accommodating pedestrians and opposing right turning through movement vehicles is critical to the safe and efficient operation of signalized intersections.

The subject intersection (See Figure 1) was operating with a permissible Right-Turnon-Red (RTOR) movement for both the westbound right turning traffic and the southbound right turning traffic. The RTOR was introduced in the 1970s as a fuelsaving measure and has sometimes had detrimental effects on pedestrians. While the law requires motorists to come to a full stop and yield to cross-street traffic and pedestrians prior to turning right on red, many motorists in this case did not fully comply with the regulations.

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Westbound right turning motorists were observed watching for traffic approaching on their left (eastbound motorist making left turn) while not being alert to pedestrians' presence on the crosswalk. In addition, motorists were pulling up into the crosswalk to wait for a gap in traffic, blocking pedestrian crossing movements. In some instances, motorists simply did not come to a full stop.

Traffic engineers had used different types of warning and or regulatory signage to accommodate the free right turn traffic movements at signalized intersections. A previous attempt to prohibit the free right turn on red created a traffic backup on SFDB and was also ignored. To increase the operational efficiency on transportation corridors such as Sir Francis Drake Boulevard, County of Marin traffic engineers decided to employ the flashing yellow arrow (FYA).



Figure 1

DRIVER BEHAVIOR

One of the most effective means to measure the FYA was by conducting a field observation of driver behavior, and drivers' understanding of the FYA. The field observations of driver's behavior, making a right-turn vs. conflicting with pedestrians in the crosswalk pedestrians or the opposing left turning vehicles was also observed. The flashing yellow arrow had a high level of driver comprehension. Drivers were observed and have shown a good observation of the FYA regulation.

COLLISION ANALYSIS

Data essential for evaluation included 'before' and 'after' collision data and supporting information about the intersection such as traffic volume (ideally turning movement counts), signal timing and the geometry. A minimum of three years of crash data were obtained for the time period prior to implementation of the FYA indication. Crash data available 'after' implementation were obtained from the date of installation to the most recent date for which

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data were available (See Table 1). When available, actual crash reports were acquired to obtain all information known about the reported crashes. Data related to signal timing of the intersection and pertinent operational data 'before' and 'after' the FYA installation were reviewed. Impact of changes in signal timing parameters for the overall timing and phasing was evaluated

The collision types were summarized in the experiment using the following classifications:

Side-Swipe: Collisions that included side-to-side impact between two vehicles. This type of accident usually occurred between the westbound left turning vehicles and the permissive right turn vehicles.

Rear-End: Collision occurring primarily between the front of one vehicle and the rear of another. This type of collision occurred between the permissive right turning vehicles before crossing the north side crosswalk at Wolfe Grade. This usually involves a pedestrian in such a way that the leading vehicle stopping suddenly to avoid hitting the pedestrian in the crosswalk and the following vehicle could not stop in time and contacting/ colliding with the leading vehicle.

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	Sir Francis Drake Blvd and Wolfe Grade						
Before		After					
Installation/Collision Period 1/1/2001 – 9/30/2007		Installation/Collision Period 5/1/2008 – 3/30/2009					
	Date	Collision Type	Date	Collision Type			
	9/6/2001	Rear-end	5/10/2008	Rear-end			
6	5/27/2003	Rear-end	3/18/2009	Rear-end			
7	7/20/2003	Sideswipe					
	4/6/2005	Broadside					
	9/5/2007	Rear-end					

INSTALLATION & OPERATIONAL CONSIDERATIONS

The installation of the FYA indications has some challenges for the 170E controller running BITans 233. The installation required the writing of new command code, installation of additional logic boards, and the configuration of numerous jumpers within the controller cabinet. The newer controller needed a program for an FYA interval. The addition of external logic was necessary, because the conflict monitors routinely (once a week) indicated a conflict and needed to be reset.

CONCLUSION

The experiment implemented a FYA signal indication in an attempt to better communicate to the right-turning driver that they must yield to pedestrian traffic before proceeding. Before the FYA implementation, it was noted that drivers did not obey the pedestrian right-of-way and crashes between vehicles with fixed objects were noted. The result, as demonstrated by a reduction in collisions, indicated that the installation of the FYA to control the permissive right turning lane provided a safety improvement when added to signal phasing operations. Safety Experimentation Final Report December 2, 2010 4 of 4

is now improved at the intersection, and the average annual frequency of total crashes has been reduced.

The experimental project undertaken by the County of Marin showed that the FYA signals improve pedestrian's safety and moves traffic efficiently. The county encourages the California Traffic Device Committee to recommend the adoption of FYA signal to the California of Transportation as an official traffic control device.

Sincerely,

Amanuel Haile Assistant Engineer

Attachments:

CTCDC Status of experiment progress report form Photo of intersection

c: Farhad Mansourian

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CTCDC STATUS OF EXPERIMENT

Date: December 2, 2010

Item: <u>08-20</u>

Experiment:

Experimentation Final Report, Flashing Yellow Arrow for Permissive Right Turn Movement for the Intersection of Sir Francis Drake Blvd and Wolfe Grade Kentfield, Marin County, CA

Sponsor: Farhad Mansourian, County of Marin

Supporting Agency & Contact : Amanuel Haile, County of Marin

Next Appearance Before the CTCDC February 2, 2011

Milestones: Application for Experimentation: May 6, 2008 Progress Report I: December 15, 2009 Progress Report II: June 6, 2010 Final Report: December 2, 2010

Status: The experiment implemented a FYA signal indication in an attempt to better communicate to the right-turning driver that they must yield to pedestrian traffic before proceeding. Before the FYA implementation, it was noted that drivers did not obey the pedestrian right-of-way and crashes between vehicles with fixed objects were noted. The result, as demonstrated by a reduction in collisions, indicated that the installation of the FYA to control the permissive right turning lane provided a safety improvement when added to signal phasing operations. Safety is now improved at the intersection, and the average annual frequency of total crashes has been reduced. The experimental project undertaken by the County of Marin showed that the FYA signals improve pedestrian's safety and moves traffic efficiently. The county encourages the California Traffic Device Committee to recommend the adoption of FYA signal to the California of Transportation as an official traffic control device.

Applicant's Signature

Applicant's Name: Amanuel Haile, County of Marin

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<u>Sir Francis Drake Blvd and Wolfe Grade</u> <u>Collision Period</u>: 5/1/2008 to 3/30/2009 The 2 collisions that are considered for the experiment are located along Wolfe Grade with

05/10/08 Rear-End

03/18/09 Rear-End