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October 15, 2015

To: Urban Design Committee, City of Richmond

RE: *Adaptive Left Turns for GRTC Bus Rapid Transit Project*

UDC/PC Comment 22: That the BRT planning team investigate using adaptive technology for left-turn movements in the project corridor.

Applicant Response: An adaptive left-turn phase is a protected/permissive left-turn phase operated via a Flashing Yellow Arrow (FYA) signal indication. Although FYA has been successfully implemented at traffic signals throughout the United States, the Commonwealth of Virginia, and the Richmond Metropolitan Area, its proposed implementation in a corridor with BRT operations is different from a typical FYA implementation. In particular, FYA would conflict with the transit vehicle in a dedicated lane traveling in the same direction as the left-turning vehicle. A left-turning vehicle would be required to yield not only to opposing through traffic, but also to the transit vehicle traveling in the same direction and approaching from behind the left-turn driver's field of view. This creates a condition that is not consistent with driver expectations since the driver must identify vehicles traveling in both directions before the left turn can be safely made.

An adaptive left-turn phase with protected/permissive operation is not a standard installation for median-running transit guideways. The current available transit and traffic technology has not reached a point where adaptive left-turn phasing can be safely implemented concurrent with median running BRT operations. FYA signal indications can be installed as part of the BRT Project; however they should not operate at the same time BRT buses are operating along the corridor. Permissive operations would only be permitted outside of the hours of BRT operation.

SUPPORTING DOCUMENTATION

Adaptive left-turn technology allows vehicles to turn left on a FYA signal indication at all times except when a BRT bus is approaching the intersection. This operation improves intersection capacity by allowing for an increase in left-turn movements during the permissive signal phase. When a BRT bus approaches the intersection, the flashing yellow arrow would change to a red arrow thereby providing the BRT priority through the intersection without conflict with left-turn movements. The challenge of implementing this technology is determining how to detect the presence and exact location of the BRT bus and how to install this detection to provide sufficient warning time to the signal controller to terminate the FYA signal indication.

Proposed left-turn movements in the median-running segment of the BRT corridor are designed to occur at signalized intersections with protected-only left-turn phasing per guidelines documented in the American Public Transportation Association (APTA) Recommended Practice for *Designing Bus Rapid Transit Running Ways, Section 4.1.3*. Protected-only left-turn phasing requires a green arrow to be present for vehicles to turn left. This signal phasing reduces the risk for crashes at the intersection. The potential for severe right angle crashes due to the impact of left-turning vehicles with

vehicles in the opposite direction, including passenger cars and BRT buses, as well as BRT buses in the same direction increases significantly with permissive left-turn phasing.

Adaptive left-turn phasing was recently evaluated on other BRT systems including Vanness BRT in San Francisco and Ashland BRT in Chicago. The conclusions from those evaluations was that the only safe approach for handling permissive left-turn movements on facilities with dedicated transit lanes was to use curb-running transit guideways.

Flashing yellow arrow signal indications could be implemented for left-turns adjacent to median running transit guideways with 100% reliable and appropriately located transit detection. This would require a physical, hard-wired connection between the traffic signal cabinets and the BRT bus detection. “Check-In” and “Check-Out” detectors embedded in the pavement on all transit approaches to each intersection in the median running BRT lanes would be needed. In addition, the FYA and the BRT phases in the same direction must be hard-wired so that the two phases are not allowed to operate concurrently. This technology is employed for railroad/LRT preemption when a train or LRT vehicle approaches a signalized intersection. However with a train scenario, it is easier to physically locate the detectors within the tracks and preemption is an acceptable signal operational mode.

Other potential detection technology options for adaptive left-turn operation include video detection, inductive loop systems, bus transponders, GPS systems to track buses in real-time, and connected vehicle systems. However, none of these technology options can provide guaranteed detection of the transit vehicle to avoid the conflict between the transit vehicle and the permissive left-turn movement if operated simultaneously.

The potential detection technology solutions all have risks of failure since they are not hard-wired. Therefore these detection options increase the potential for crashes between permissive left-turning vehicles and head-on vehicles, head-on BRT vehicles, and BRT vehicles approaching from behind if FYA and BRT operations occur simultaneously. Aside from hard-wiring the BRT detection to the traffic signal cabinet, as previously described for railroad/LRT preemption, there is no known technology that that will enable adaptive left turns without the potential for detection failure.

Should the hard-wire connection option be considered, additional VISSIM modeling should be conducted to determine the impact of permissive left-turns on BRT travel times with and without the implementation of adaptive left-turn phasing technology. BRT travel times using adaptive left-turn phasing technology need to be compared to the travel time savings computed during both the project approval and Environmental Assessment processes to remain complaint with approved travel time savings which were a factor in the TIGER Grant award. BRT travel times are expected to increase since the BRT vehicles will likely be stopped at many of the traffic signals in the median running segment of the corridor during the AM and PM peak hours to accommodate FYA operations.