

AUTOMATED RED-LIGHT RUNNING ENFORCEMENT ENGINEERING AUDIT

Sacramento County Sheriff's Department
Sacramento County
City of Sacramento

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1.0 INTRODUCTION

Iteris performed an engineering audit of the City and County of Sacramento's red light running (RLR) photo enforcement program the week of April 23, 2012. System data was collected and evaluated for accuracy. In order to maintain the integrity of the program in the future, specific recommendations were noted during field investigation and included in this report.

1.1 BACKGROUND

In order to provide 24-hour enforcement of red light running violations, cameras were installed at locations within the City and County to provide automated red light running enforcement. At the time this audit was conducted, there were 22 intersections with a total of 25 approaches equipped for red light running enforcement and one location under construction within the City and the County of Sacramento. The cameras are part of the Red Light Photo Enforcement Program, a partnership between the Sacramento County Sheriff's Department, California Highway Patrol (CHP), County of Sacramento, and City of Sacramento. Table 1, below, provides a list of the intersections and their owning agency.

TABLE 1: EXISTING RED LIGHT PHOTO ENFORCEMENT LOCATIONS

NO	OWNING AGENCY	INTERSECTION NAME	DIRECTION OF ENFORCEMENT
1	County	Watt Avenue at Fair Oaks Boulevard	<ul style="list-style-type: none"> NB Watt Ave WB Fair Oaks Blvd
2	County	Watt Avenue at Arden Way	<ul style="list-style-type: none"> EB Arden Way
3	County	Howe Avenue at Hurley Way	<ul style="list-style-type: none"> NB Howe Ave
4	County	Martin Luther King Boulevard at 47 th Avenue	<ul style="list-style-type: none"> WB 47th St*
5	County	Madison Avenue at Sunrise Boulevard	<ul style="list-style-type: none"> EB Madison Ave
6	County	Madison Avenue at Date Avenue	<ul style="list-style-type: none"> WB Madison Ave
7	County	Florin Road at East Avenue	<ul style="list-style-type: none"> EB Florin Rd
8	County	Florin Road at Franklin Boulevard	<ul style="list-style-type: none"> WB Florin Rd
9	County	Manzanita Avenue at Cypress Avenue	<ul style="list-style-type: none"> SB Manzanita Ave[^]
10	County	El Camino Avenue at Eastern Avenue	<ul style="list-style-type: none"> EB El Camino Ave[^]
11	County	Florin Road at Lindale Drive	<ul style="list-style-type: none"> EB Florin Rd
12	County	Elkhorn Boulevard at Don Julio Drive	<ul style="list-style-type: none"> EB Elkhorn Blvd
13	County	Hwy 99 NB Off-Ramp at Calvine Road	<ul style="list-style-type: none"> EB Calvine Rd

NO	OWNING AGENCY	INTERSECTION NAME	DIRECTION OF ENFORCEMENT
14	City	Mack Road at Center Parkway	• EB Mack Rd
15	City	Mack Road at Valley High Drive / La Mancha Way	• WB Mack Rd
16	City	21 st Street at Broadway	• WB Broadway
17	City	Alhambra Street at J Street	• EB J St
18	City	El Camino Avenue at Evergreen Street	• EB El Camino Ave
19	City	Howe Avenue at Fair Oaks Boulevard	• EB Fair Oaks Blvd • SB Howe Ave*
20	City	Folsom Boulevard at Power Inn Road / Howe Avenue	• SB Howe Ave*
21	City	5 th Street at I Street	• WB I St
22	City	Arden Way at Challenge Way	• EB Arden Way
23	City	16 th Street at W Street	• NB 16 th St (under construction)

* Right-turn lane not equipped for red light running enforcement

^ Left-turn lane not equipped for red light running enforcement

Intersections and the approaches listed in the table above and shown in Figure 1, below, are those currently being enforced by the Sheriff's department, including a future location under construction during the field visit. No field measurements or observations were recorded at intersection approaches with camera housings not currently in use.

The City of Sacramento began its program in 1999, and the County's was started in 2001. In July 2003, the Sheriff's Department began managing the program for both the City and County. Currently, under the sheriff department's supervision, three local CHP officers alternate working at the Sheriff's department to operate and control the program.

The Sheriff's Department has an agreement with Redflex Traffic Systems (Redflex) to install and maintain the red light running (RLR) cameras. Staff from the Sheriff's department also visits the Redflex facilities in Arizona annually to ensure that the facilities, staff, and equipment continue to meet their standards. Under this agreement, Redflex is paid a fixed amount for installations and a monthly flat fee for maintenance. As prohibited by California Vehicle Code (CVC) section 21455.5, Redflex does not receive a percentage of the revenue collected, nor do they receive compensation based on the number of citations issued.

Installation locations for the program are based on the following:

- The number of collisions due to red light running
- Total vehicular volume
- Video survey
- Police and community input

Camera conditions, settings, as well as general intersection conditions and signage are observed and logged daily (with the exception of weekends and holidays) by a certified field technician. Field technicians are employed by Redflex. Once a week, the field technicians are accompanied by a CHP officer to provide an unbiased review of the settings. The officer records the settings and conditions on a separate log sheet. If there are issues observed during these inspections, they are also noted on the log sheets until they are resolved.



The maintenance logs conducted by Redflex and the CHP officer is filed in a locked filing cabinet only accessible by CHP officers. In addition to the field observations, Redflex also receives daily video feeds from each approach, which can be sent directly to the Sheriff's department should there be any visual issues observed.

Previous engineering audits were performed by Iteris, Inc as Meyer, Mohaddes Associates on the City's RLR system in October 2001, February 2002, and January 2003. An engineering audit of both the City and County's RLR systems were performed on October 2004 and January 2006. No engineering flaws were found in the operation of the system during any of the past audits.

1.2 ENABLING LEGISLATION

Automated enforcement systems are permitted by the California Vehicle Code (CVC) section 21455.5. An additional CVC section (21455.7) became effective on January 1, 2002, requiring intersections with automated RLR cameras to meet or exceed the California Department of Transportation's (Caltrans) standards for yellow change intervals. The policies of the City and County of Sacramento are that at intersections equipped with automated RLR cameras, all approaches shall exceed the Caltrans guidelines.

As of January 13, 2012 Caltrans has adopted the California Manual on Uniform Traffic Control Devices (California MUTCD) 2012 edition, Figure 2, to provide for uniform standards and specifications for all official traffic control devices in California.

FIGURE 2: CALIFORNIA MUTCD 2012



The minimum yellow change intervals for through movements would be determined by the posted speed limit, or the prima facie speed limit established by the California Vehicle Code. Furthermore, the minimum yellow light change interval for protected left-turn or right-turn phases was set to 3.0 seconds.

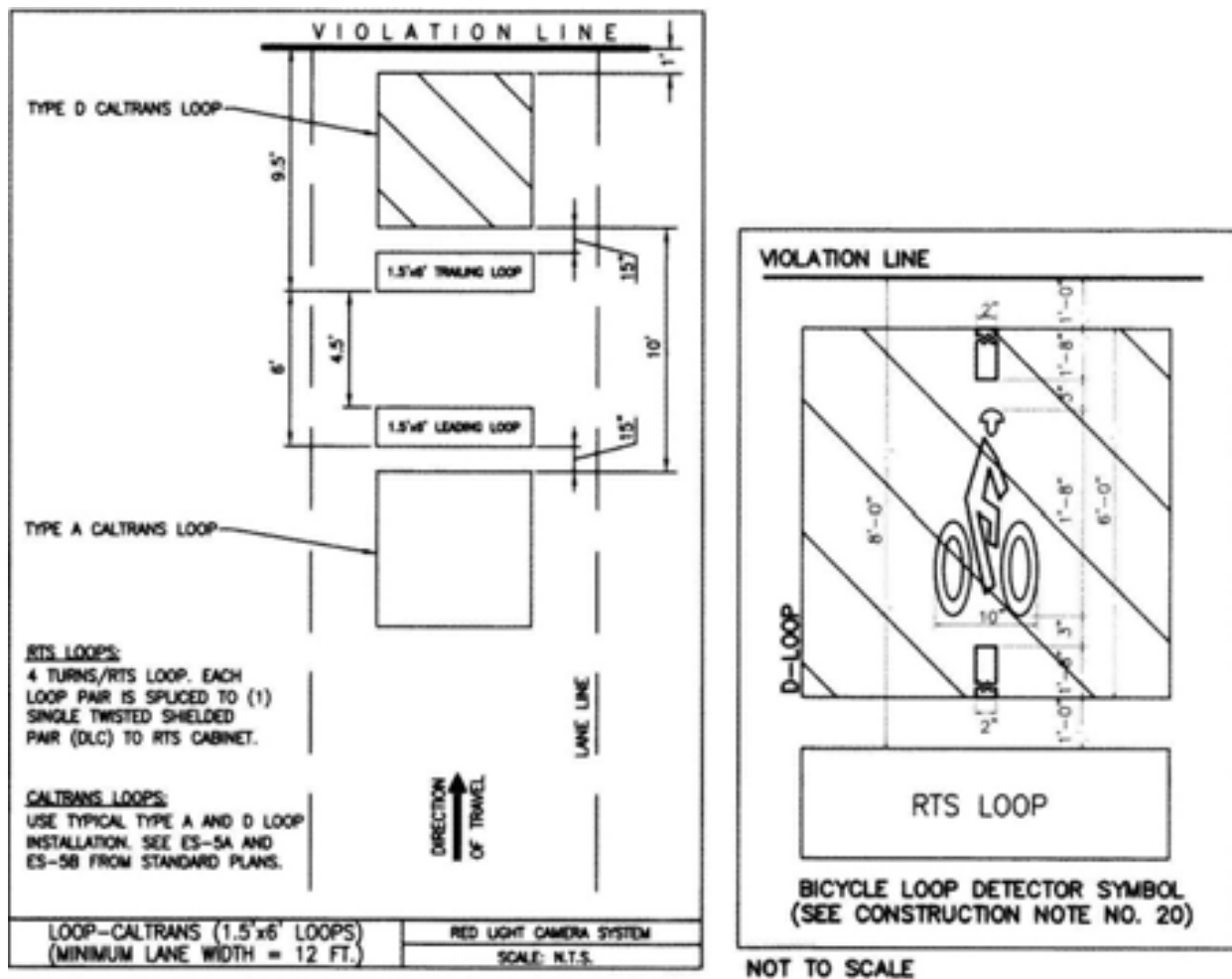
2.0 DATA COLLECTION AND VERIFICATION

Field visits were conducted at the 23 RLR camera locations to observe and verify camera settings, loops, signage, and yellow change intervals.

2.1 LOOP LOCATIONS

Per the as-built plans provided and the field visit with Redflex staff, it was noted that the standard loop placement is typically six feet from the limit line; however, at locations with existing loop, some loops are placed approximately 7.5-feet (as shown in Figure 3, below) from the limit line to ensure that the existing loops remain in place. Loop cuts are variable in width and loop sealant masks the exact edge of the loop. On some occasions, loops might be overlaid, obscuring the exact loop boundaries. With regard to loop measurements, verification consisted of reviewing the loop areas for evidence of new or moved loops.

FIGURE 3: LOOP SPECIFICATION AT ROUTE 99 AND CALVINE ROAD



2.2 WARNING SIGNS

As part of the CVC section 21455.5 requirements, the use of automated enforcement systems is allowed if the system is identified by:

“ ... signs that clearly indicate the system's presence and are visible to traffic approaching from all directions, or posts signs at all major entrances to the city, including, at a minimum, freeways, bridges, and state highway routes.”

There are two primary types of signs used in conjunction with the automated enforcement programs in the City and the County of Sacramento. The designs of these signs are determined by the California Special Regulatory Sign Specifications SR56 and SR58.

Each RLR camera location was observed to see whether or not these signs were clearly visible, legible, understandable, and met the requirements outlined in CVC section 21455.5. The notes taken at each RLR camera location is available as part of **Appendix A**. The presence and condition of the signs were also noted, as was the approximate distance from the sign location to the limit line.

Figure 4 and Figure 5, taken at RLR camera locations, illustrate the appearance of typical signs. The sign in Figure 4 (SR58) has a red background with white letters. The sign in Figure 5 (SR56) has a white background with black letters and a multicolor traffic signal logo.

FIGURE 4: SR-58 SIGN



FIGURE 5: SR-56 SIGN



2.3 YELLOW CLEARANCE INTERVALS

As mandated in CVC section 21455.7, subdivision (a), "...the minimum yellow light change interval shall be established in accordance with the Traffic Manual of the Department of Transportation.", and "A yellow light change interval may exceed the minimum interval established pursuant to subdivision (a)". If connected to the City or County central system, the yellow time was uploaded directly from the controllers; otherwise, field verification was conducted to determine the actual yellow change interval for each movement. The yellow time taken for each location is available as part of **Appendix A**.

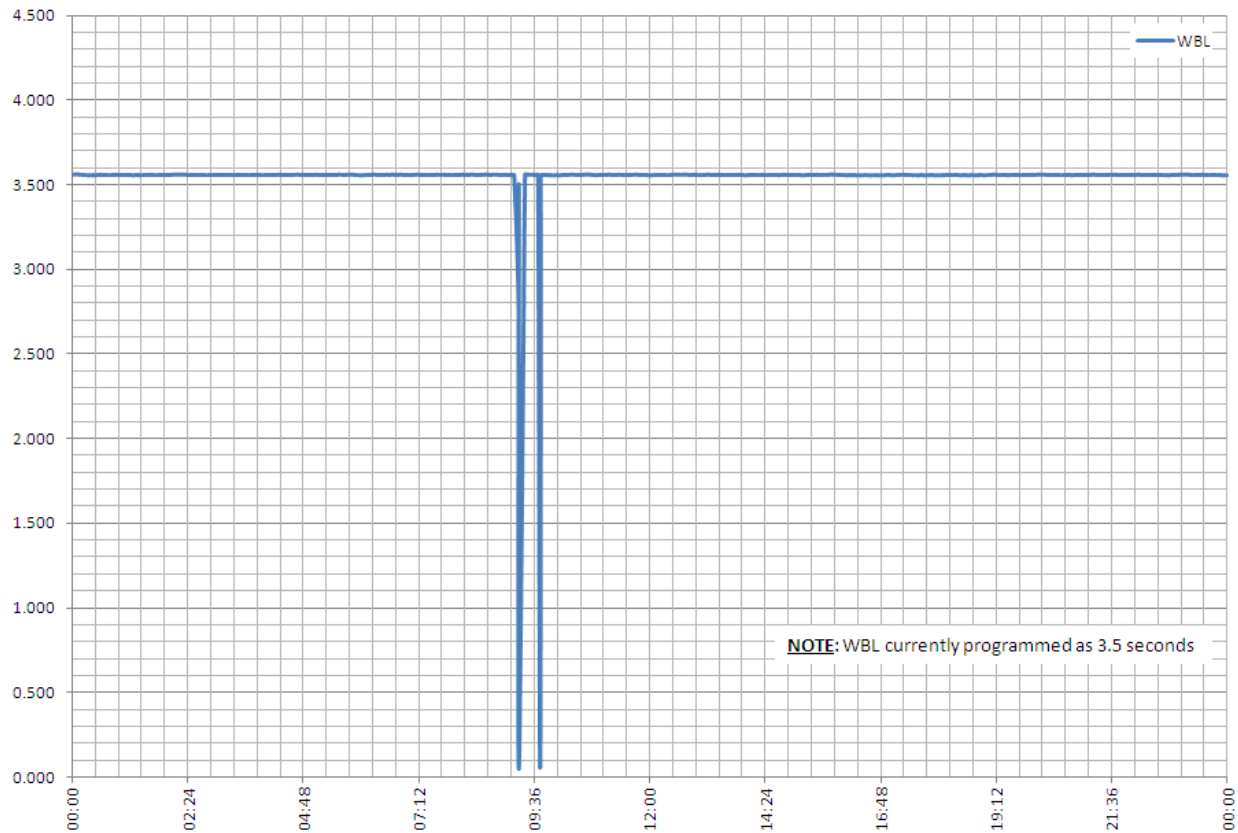
Because the Redflex equipment collects the yellow (amber) time from the controller output rather than from the programmed time in the controller, the City of Sacramento had requested a review of the yellow interval to determine if there are any discrepancies between what is programmed and what is being outputted, as

well as any deviation per output. Redflex provided output data collected throughout a 24-hour period (July 11, 2012). A summary of the Redflex amber output (minimum, average, and maximum) compared to the programmed yellow time (collected on April 24, 2012) is available below in Table 2.

TABLE 2: YELLOW OUTPUT COMPARISON

Intersection	Controller Type	Dir	Phase	Yellow (4/24)	Yellow Output from Redflex (7/11)			
					MIN	AVG	MAX	STDV
Mack Road @ Center Parkway	Intelight 2070 D4	EBL	5	3.5	3.546	3.556	3.559	0.0011
		EBT	2	4.7	4.752	4.756	4.761	0.0014
Mack Road @ Valley High Drive / La Mancha Way	Intelight 2070 D4	WBL	5	3.5	0.056	3.538	3.560	0.2468
		WBT	2	4.7	0.056	4.734	4.762	0.0560
21st Street @ Broadway	McCain 170E (222P)	WBL	5	3.6	3.737	3.755	3.777	0.0064
		WBT	2	3.6	3.711	3.732	3.766	0.0201
El Camino Avenue @ Evergreen Street	Traconex TMP-390	EBL	1	3.9	3.953	3.956	3.959	0.0012
		EBT	5	3.9	3.953	3.956	3.960	0.0012
Howe Avenue @ Fair Oaks Boulevard	Econolite ASC/2	EBL	1	3.5	3.553	3.559	3.571	0.0049
		EBT	6	4.7	4.752	4.758	4.771	0.0039
		SBL	7	3.5	3.553	3.558	3.572	0.0042
		SBT	4	4.3	4.353	4.357	4.370	0.0036
Folsom Boulevard @ Power Inn Road / Howe Avenue	Econolite ASC/2	SBL	3	3.5	3.455	3.516	3.626	0.0227
		SBT	8	4.3	4.262	4.321	4.210	0.0043
5th Street @ I Street	Traconex TMP-390M	WB	4	3.5	3.499	3.526	3.543	0.0016
Arden Way @ Challenge Way	Econolite ASC/2	EBL	2	3.5	3.447	3.501	3.527	0.0232
		EBT	6	4.7	4.701	4.714	4.731	0.0045

As shown in the table above, most controller outputs, regardless of controller type, were measured to be longer than or equal to the programmed yellow time. Some intersections (Folsom @ Howe and Arden @ Challenge) had a lower output than the programmed time but was still within the City's 0.05-second threshold. The intersection of Mack Road at Valley High Drive / La Mancha Way; however, was shown to have a minimum amber output of less than one (1) second. In order to get a better understanding of when and how frequent this occurred, graphical plots of all outputs collected throughout the 24-hour period was generated, as shown in Figure 6 (next page). The plot indicates a constant amber time higher than the programmed 3.5 seconds for the left-turn movement with the exception of drastically lower outputs near 9:30AM. Further analysis also indicated that only six (6) out of 815 outputs for the 24-hour period were lower than 3.5 seconds for the left-turn phase and only five (5) out of 789 outputs were lower than 4.7 seconds for the thru phase. This may have been an isolated incident; however, it is important that the City of Sacramento monitor the intersection during this time period to determine that the intersection operates as programmed.

FIGURE 6: MACK ROAD AT VILLAGE HIGH DRIVE – WBL AMBER OUTPUT

Summary graphical plots, output per time of day and frequency of output value for each movement with RLF camera, are available as part of **Appendix B**.

2.4 ADDITIONAL FIELD OBSERVATIONS

Other factors were observed in the field to determine whether or not there may be other conditions which might cause a driver to inadvertently enter the intersection on a red phase. Although specific measurements were not made, the following conditions were also checked in the field:

- Sight distance
- Traffic volumes
- Traffic speeds and regulatory signs
- Traffic signal display conditions – visibility, number of heads, placement
- Quality of pavement markings, especially stop lines
- Geometric features – horizontal and vertical curves, lane widths, etc.
- Pavement conditions and surface treatment

3.0 ANALYSIS

This section summarizes all the analysis conducted to ensure that the existing red light running enforcement program and equipment meets and exceeds the California standards.

3.1 SYSTEM OPERATION

When the system is triggered, digital photographs for the appropriate approach are taken at the RLR camera location. Four still images along with a 12-second of video is collected for each red light running incident. Once processed in the Redflex's Arizona office, digital copies are uploaded onto the Redflex website accessible by the sheriff's department staff. The CHP officers review the videos and make the final decision whether a ticket should be issued and to whom, which is printed and sent directly from the sheriff's department facilities.

The speed threshold for red light running is currently set to 15 miles per hour for all movements (left, thru, and right). If a vehicle is detected to be running at a speed higher than 15 mph once the yellow change interval is complete, the cameras will trigger and a camera from the rear of the vehicle will record the incident.

Citations which are sent out provide the photographs as well the following data items recorded at the time the photographs were taken:

- Time and date
- Calculated speed
- Length of yellow just prior to photograph capture
- Duration of red at the time of the photograph capture

A website address is also available on the citation, which allows the party receiving the citation to view the photos and video. The link is password protected and is only available for viewing by the party who received the citation.

A photograph and video recording will only be taken if all of the following conditions are met:

- The movement has reached the end of its yellow change interval and the red clearance interval has begun
- The calculated speed of the vehicle is over a certain threshold (15 mph)
- The vehicle is moving in the indicated direction (whichever approach the RLR camera is set to enforce)

A loop system is in place at RLR camera locations to determine whether or not the conditions listed above were met. Regardless of how the photograph/video was triggered, as long as the evidence demonstrates that the vehicle was behind the stop line at the onset of red, and proceeded across the stop line during the red, a violation has occurred.

3.2 LOOP LOCATIONS

Loop locations were not measured during this audit; however, field observations revealed that loops installed for the movements equipped for red light running enforcement that were visible in the field matched the design plans provided by Redflex. Figure 7 is an example of new Redflex loops installed between the existing stop-bar loop detectors where as Figure 8 is an example of new Redflex loops installed at a location that did not have existing loop detection.

FIGURE 7: NEW RLR LOOPS WITH EXISTING LOOPS



FIGURE 8: NEW RLR LOOPS



3.3 YELLOW LIGHT CHANGE INTERVAL

The yellow light change interval provides drivers with sufficient time to stop before entering an intersection or to clear an intersection for an upcoming red phase. On January 1, 2002, California Vehicle Code 21455.7 became effective. It requires intersections with automated red-light cameras to have yellow change intervals that meet or exceed Caltrans guidelines.

As mentioned earlier, Caltrans adopted the latest California MUTCD in January 2012. The yellow change interval for through moving vehicles is defined in Table 3, below. Also included in Table 3, per guidelines provide, are the more conservative values being used by the City and County of Sacramento.

TABLE 3: MINIMUM YELLOW INTERVAL

Speed Limit*		Yellow interval (seconds)		
(mph)	(km/h)	CA MUTCD	CITY	COUNTY
25 or less	40	3.0	3.5	3.9
30	48	3.2	3.5	3.9
35	56	3.6	3.7	3.9
40	64	3.9	3.9	4.3
45	72	4.3	4.3	4.6
50	80	4.7	4.7	4.8

Speed Limit*		Yellow interval (seconds)		
(mph)	(km/h)	CA MUTCD	CITY	COUNTY
55	89	5.0	5.0	5.0
60	97	5.4	5.4	5.1
65	105	5.8	5.8	-

* The Speed Limit used:

CA MUTCD – posted or 85th percentile

City – 85th percentile speed, rounded up to the nearest 5 mph

County – 90th percentile speed, rounded to the nearest 5 mph

The California MUTCD also defined a minimum yellow light change interval of 3.0 seconds for protected left-turn or right-turn phases whereas the City and County are using a minimum value of 3.5 seconds. **Appendix C** summarizes the existing yellow change interval, as collected through uploading or field verification, versus the California MUTCD minimum and the agency minimum, as shown in Table 3.

The County provided speed survey data containing necessary 90th percentile speeds, rounded up to the nearest 5 mph, for each approach and the City provided speed data for segments along the study corridors containing the necessary 85th percentile speeds, rounded to the nearest 1 mph. If no speed data was available for certain segments, the posted approach speed limit was used to determine the appropriate minimum yellow interval. In order to be more conservative, the speed limit used for determining the yellow interval was the higher of the posted versus the 85th (for City) or 90th (for County) rounded up to the nearest 5 mph. Even though not all movements at each intersection were equipped with red light enforcement cameras, a review of all phases' yellow intervals was conducted. The inspections made during this engineering audit revealed that though most locations exceeded the minimum standard required yellow time, especially for the approached equipped for red light enforcement, a few locations do not currently meet the California MUTCD and/or the agency standard minimum value.

3.4 OTHER INTERSECTION FACTORS

Light emitting diode (LED) indications were observed at most of the RLR camera locations. The LED indications increase the visibility of the red, and because of the energy efficient characteristics of the LED indication, makes the replacement of the red indications less frequent.

In addition to the yellow interval, a review of the all red times for each phase was also conducted, which is available as part of **Appendix C**. Unlike the yellow interval, no actual calculations were conducted for the all red time. This review was conducted to ensure that movements with an all red clearance interval met the California MUTCD standard of ranging from 0.1 to 2.0 seconds. The City of Sacramento has an additional requirement for providing an all red interval, which is dependent on the approaching speed – all approaches with an approaching speed over 40 mph shall have an all red clearance interval. There was one location in the County of Sacramento, southbound approach of East Avenue and Florin Road, which has an all red value greater than 2.0 seconds (currently shown to be running 2.3 seconds). There were a few locations in the City of Sacramento that were programmed with an all red interval though the approaching speed was less than 40 mph. No recommendations to change these existing all-red values will be made, especially since the values are more conservative and provide for more all red time at the intersections.

Though the intersections experienced a high volume of traffic, especially those near the freeways, there were no additional factors, whether geometrical or operational, noted during the field observation that would affect a driver's ability to stop on red.

4.0 CONCLUSION

During the engineering audit, there were no equipment, signage, and/or geometric flaws found in the current operation of the automated red-light running program for either the County or City of Sacramento. There were some locations, however, which do not currently meet the latest California MUTCD and the County or City of Sacramento minimum yellow change interval.

4.1 SPECIFIC RECOMMENDATIONS

The first priority to ensure that all requirements are met is to update all yellow change intervals in the County and City of Sacramento to meet each agency's standards, which exceed the California MUTCD minimum requirements. This may require conducting new speed studies to ensure that the appropriate 10th, 85th, and/or 90th percentile speeds are used to calculate the yellow change interval.



Additional recommendations are presented below, in order to preserve the integrity of the existing program, and to ensure that citations are only given when the law has been clearly violated. Recommendations are given in no significant order.



- Yellow light change intervals should continue to be reviewed and/or updated based on the most current posted and prima facie speed limits. A review should be conducted every time a speed study is collected along a study corridor. It should be noted that for the speed limit of 60 mph, the County is currently recommending to use a value (5.1) that is less than the California MUTCD recommended minimum (5.4) yellow interval.
- Operation of the program should continue to be reviewed periodically by an independent party.
- The RLR camera mechanism should continue to be certified by a non-interested party periodically for timing accuracy.
- Both the City and the County should continue to obtain amber outputs from Redflex to ensure that the actual outputs equal or exceed the programmed yellow time.
- Trim trees that may partially obstruct the views of the cameras and/or red light running signs, as shown in the picture to the right.
- As noted at the group meeting, install a new SR-56 sign for the westbound approach at J Street and Alhambra Boulevard.





APPENDIX A: FIELD REVIEW SUMMARY


WATT AVENUE AT FAIR OAKS BOULEVARD


<p><i>Direction (approach equipped with RLR cameras):</i></p>	<p>Westbound on Fair Oaks Boulevard:</p> 							
	<p>Northbound on Watt Avenue:</p> 							
Agency:	County of Sacramento							
Date:	Monday, April 23, 2012							
Posted Speed Limit:	NB:	40 MPH	EB:	40 MPH	SB:	40 MPH	WB:	40 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 200-300 feet from the intersection.							
Programmed Yellow Time:	NBT:	5.1 sec	EBT:	4.8 sec	SBT:	5.0 sec	WBT:	4.6 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL:	3.5 sec
COMMENTS:	All movements (left, thru, and right) for both approaches are equipped with red light running equipment. The westbound approach currently has three left-turn lanes. Northbound was observed to have heavy northbound right-turn traffic during the PM peak.							


WATT AVENUE AT ARDEN WAY							
Direction (approach equipped with RLR cameras):	Eastbound on Arden Way: 						
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	40 MPH	SB:	40 MPH	WB: 40 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 200-400 feet from the intersection. For the eastbound approach, it was noted that the signs were slightly blocked by tree branches, which prevents motorist from viewing either sign clearly. A photo of the sign is shown to the right.						
Programmed Yellow Time:	NBT:	5.0 sec	EBT:	4.8 sec	SBT:	5.0 sec	WBT: 4.6 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	This intersection is striped (yellow) for school crossing and the speed limit through the intersection is 25 mph when children are present. All movements (left, thru, and right) for the eastbound approach is equipped with red light running equipment.						


HOWE AVENUE AT HURLEY WAY							
Direction (approach equipped with RLR cameras):	Northbound on Howe Avenue: 						
Agency:	County of Sacramento						
Date:	Tuesday, April 24, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	35 MPH	SB:	40 MPH	WB: 35 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 150-250 feet from the intersection.						
Programmed Yellow Time:	NBT:	4.6 sec	EBT:	3.5 sec	SBT:	4.6 sec	WBT: 3.5 sec
	NBL:	3.5 sec	EBL:	-	SBL:	3.5 sec	WBL: -
COMMENTS:	All movements (left, thru, and right) for the northbound approach is equipped with red light running equipment. Cal Expo is west of and the Encina Preparatory High School is east of this intersection.						


MARTIN LUTHER KING JR BOULEVARD AT 47TH AVENUE							
Direction (approach equipped with RLR cameras):	Westbound on 47 th Avenue: 						
Agency:	County of Sacramento						
Date:	Tuesday, April 24, 2012						
Posted Speed Limit:	NB:	35 MPH	EB:	40 MPH	SB:	35 MPH	WB: 40 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 200-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	4.3 sec	EBT:	5.0 sec	SBT:	4.3 sec	WBT: 4.8 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	The exclusive westbound right-turn lane (number 5 lane) is not currently equipped for red light running enforcement. The intersection, currently operating on Multisonic 820 controller, is offline – yellow times taken from the field.						


MADISON AVENUE AT SUNRISE BOULEVARD							
Direction (approach equipped with RLR cameras):	Eastbound on Madison Avenue:						
							
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	45 MPH	EB:	45 MPH	SB:	40 MPH	WB: 50 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 150-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	5.0 sec	EBT:	4.8 sec	SBT:	4.8 sec	WBT: 4.8 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approach is equipped with red light running equipment. Heavy northbound/southbound left-turns observed during the PM peak period; however, there are signs restricting southbound u-turns during the hours of 9PM – 4AM.						


MADISON AVENUE AT DATE AVENUE							
Direction (approach equipped with RLR cameras):	Westbound on Madison Avenue:						
							
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	35 MPH	EB:	45 MPH	SB:	45 MPH	WB: 35 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 200-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.5 sec	EBT:	4.8 sec	SBT:	3.5 sec	WBT: 4.8 sec
	NBL:	-	EBL:	3.5 sec	SBL:	-	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the westbound approach is equipped with red light running equipment. Interstate 8 is west of this intersection, which generated a lot of eastbound traffic during the PM peak.						



FLORIN ROAD AT EAST AVENUE							
Direction (approach equipped with RLR cameras):	Eastbound on Florin Road:						
							
Agency:	County of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	35 MPH	EB:	40 MPH	SB:	35 MPH	WB: 40 MPH
RLR Signage:	SR-56 mounted on one post observed at all four approaches, approximately 250-350 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.5 sec	EBT:	4.3 sec	SBT:	3.5 sec	WBT: 4.8 sec
	NBL:	-	EBL:	3.5 sec	SBL:	-	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approach is equipped with red light running equipment. The northbound right-turn phase is overlapped with the westbound left-turn movement. The intersection, currently operating on Naztec 2070 controller, is offline – yellow times taken from the field.						


FLORIN ROAD AT FRANKLIN BOULEVARD							
Direction (approach equipped with RLR cameras):	Westbound on Florin Road: 						
Agency:	County of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	40 MPH	SB:	40 MPH	WB: 40 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed at all four approaches, approximately 200-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	4.3 sec	EBT:	4.6 sec	SBT:	4.6 sec	WBT: 4.6 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the westbound approach is equipped with red light running equipment. The intersection, currently operating on Naztec 2070 controller, is offline – yellow times taken from the field.						


MANZANITA AVENUE AT CYPRESS AVENUE							
Direction (approach equipped with RLR cameras):	Southbound on Manzanita Avenue:						
							
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	35 MPH	SB:	40 MPH	WB: 35 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post (northbound, southbound, and eastbound); advanced warning combination signs observed at all four approaches, approximately 300-600 feet from the intersection. The westbound approach is a driveway into a shopping center with SR-56 mounted on one post at the intersection.						
Programmed Yellow Time:	NBT:	4.8 sec	EBT:	3.5 sec	SBT:	4.8 sec	WBT: 3.5 sec
	NBL:	3.5 sec	EBL:	-	SBL:	3.5 sec	WBL: -
COMMENTS:	The southbound left-turn movement is not currently equipped with red light running equipment. The intersection, currently operating on an ASC/3 controller, is offline – yellow times taken from the field.						


EL CAMINO AVENUE AT EASTERN AVENUE							
Direction (approach equipped with RLR cameras):	Eastbound on El Camino Avenue: 						
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	40 MPH	SB:	40 MPH	WB: 40 MPH
RLR Signage:	SR-56 mounted on one post observed at all four approaches, approximately 200-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	4.6 sec	EBT:	4.6 sec	SBT:	4.6 sec	WBT: 4.8 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	Though the Redflex plans indicate that there should be loops, it was announced at the group meeting that the eastbound left-turn movement is not currently equipped with red light running equipment. This intersection is striped (yellow) for school crossing and the speed limit through the intersection is 25 mph when children are present. The intersection, currently operating on Multisonics 820 controller, is offline – yellow times taken from the field. An eastbound bus was observed blocking the thru movements during its stop and idling on the far side of the intersection.						


FLORIN ROAD AT LINDALE DRIVE								
Direction (approach equipped with RLR cameras):	Eastbound on Florin Road: 							
Agency:	County of Sacramento							
Date:	Monday, April 24, 2012							
Posted Speed Limit:	NB:	25 MPH	EB:	40 MPH	SB:	25 MPH	WB:	40 MPH
RLR Signage:	SR-56 mounted on the traffic signal pole above the mast arm was observed at all four approaches. SR-58 was observed mounted on one post approximately 200-300 feet east and west of the intersection.							
Programmed Yellow Time:	NBT:	3.5 sec	EBT:	4.8 sec	SBT:	3.5 sec	WBT:	4.6 sec
	NBL:	-	EBL:	3.5 sec	SBL:	-	WBL:	3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approach is equipped with red light running equipment. The northbound/southbound movements are currently operating as split phasing.							

ELKHORN BOULEVARD AT DON JULIO DRIVE							
Direction (approach equipped with RLR cameras):	Eastbound on Elkhorn Boulevard: 						
Agency:	County of Sacramento						
Date:	Monday, April 23, 2012						
Posted Speed Limit:	NB:	35 MPH	EB:	45 MPH	SB:	35 MPH	WB: 45 MPH
RLR Signage:	SR-56 mounted on one post observed at all four approaches, approximately 200-300 feet from the intersection. SR-58 was also observed, but in a different post approximately 50-100 feet away from SR-56 (eastbound/westbound). For the eastbound approach, it was noted that the sign was slightly blocked by tree branches, which prevents motorist from viewing the sign clearly, especially since this sign appears after the bend. A photo of the sign is shown to the right.						
Programmed Yellow Time:	NBT:	4.8 sec	EBT:	4.8 sec	SBT:	4.8 sec	WBT: 4.8 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approach is equipped with red light running equipment. The intersection, currently operating on Multisonics 820 controller, is offline – yellow times taken from the field.						

HIGHWAY 99 NORTHBOUND OFF-RAMP AT CALVINE ROAD								
Direction (approach equipped with RLR cameras):	Eastbound on Calvin Road:							
								
Agency:	County of Sacramento							
Date:	Monday, April 24, 2012							
Posted Speed Limit:	NB:	45 MPH	EB:	45 MPH	SB:	-	WB:	45 MPH
RLR Signage:	SR-56 mounted on one post observed for the eastbound approach.							
Programmed Yellow Time:	NBT:	4.7 sec	EBT:	4.7 sec	SBT:	-	WBT:	4.7 sec
	NBL:	-	EBL:	-	SBL:	-	WBL:	-
COMMENTS:	The eastbound thru approach is equipped with red light running equipment. This intersection, which is an off and on ramp to the state route 99 was recently installed prior to the field verification.							

MACK ROAD AT CENTER PARKWAY							
<i>Direction (approach equipped with RLR cameras):</i>	Eastbound on Mack Road:						
							
Agency:	City of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	40 MPH	EB:	45 MPH	SB:	35 MPH	WB: 45 MPH
RLR Signage:	SR-56 mounted on one post was observed at all four approaches, approximately 200-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.5 sec	EBT:	4.7 sec	SBT:	3.5 sec	WBT: 4.7 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL: 3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approaches are equipped with red light running equipment. High pedestrian activity was observed at the intersection and emergency vehicles were also observed.						

MACK ROAD AT VALLEY HIGH DRIVE / LA MANCHA WAY								
Direction (approach equipped with RLR cameras):	Westbound on Mack Road: 							
Agency:	City of Sacramento							
Date:	Monday, April 24, 2012							
Posted Speed Limit:	NB:	35 MPH	EB:	45 MPH	SB:	40 MPH	WB:	45 MPH
RLR Signage:	SR-56 on one post was observed at all four approaches, approximately 150-300 feet from the intersection.							
Programmed Yellow Time:	NBT:	4.3 sec	EBT:	4.7 sec	SBT:	4.3 sec	WBT:	4.7 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL:	3.5 sec
COMMENTS:	All movements (left, thru, and right) for the westbound approaches are equipped with red light running equipment. The northbound right-turn movement is currently overlapped with the westbound left-turn phase. High pedestrian activity was observed at the intersection. Due to its proximity to Kaiser Permanente Medical Center, it is anticipated there will be a frequency of emergency vehicles.							

21ST STREET AT BROADWAY							
Direction (approach equipped with RLR cameras):	Westbound on Broadway: 						
Agency:	City of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	25 MPH	EB:	25 MPH	SB:	25 MPH	WB: 25 MPH
RLR Signage:	SR-56 mounted on one post was observed at all four approaches, approximately 150-300 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.9 sec	EBT:	3.6 sec	SBT:	3.9 sec	WBT: 3.6 sec
	NBL:	-	EBL:	3.6 sec	SBL:	3.9 sec	WBL: 3.6 sec
COMMENTS:	All movements (left, thru, and right) for the westbound approaches are equipped with red light running equipment. The southbound approach has a protected permissive left-turn whereas the northbound approach is only permissive. High pedestrian activity was observed at this intersection, which also permits parallel on-street parking. The intersection, currently operating on McCain 170E controller, is offline – yellow times taken from the field.						

ALHAMBRA STREET AT J STREET

<p><i>Direction (approach equipped with RLR cameras):</i></p>	<p>Eastbound on J Street:</p> 
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Agency:	City of Sacramento
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Date:	Monday, April 24, 2012
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Posted Speed Limit:	<table border="1" style="font-size: small;"> <tr> <td style="background-color: #e1f5fe;">NB:</td> <td style="padding: 2px;">30 MPH</td> <td style="background-color: #e1f5fe;">EB:</td> <td style="padding: 2px;">30 MPH</td> <td style="background-color: #e1f5fe;">SB:</td> <td style="padding: 2px;">30 MPH</td> <td style="background-color: #e1f5fe;">WB:</td> <td style="padding: 2px;">30 MPH</td> </tr> </table>	NB:	30 MPH	EB:	30 MPH	SB:	30 MPH	WB:	30 MPH
NB:	30 MPH	EB:	30 MPH	SB:	30 MPH	WB:	30 MPH		

RLR Signage:	<p>SR-56 mounted on one post was observed for the eastbound, northbound, and southbound approaches, approximately 200-300 feet from the intersection and SR-58 was observed for the westbound and southbound approaches approximately 50-100 feet away. It was noted at the group meeting that the westbound approach will be getting an SR-56 sign.</p>
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Programmed Yellow Time:	<table border="1" style="font-size: small;"> <tr> <td style="background-color: #e1f5fe;">NBT:</td> <td style="padding: 2px;">3.6 sec</td> <td style="background-color: #e1f5fe;">EBT:</td> <td style="padding: 2px;">3.6 sec</td> <td style="background-color: #e1f5fe;">SBT:</td> <td style="padding: 2px;">3.6 sec</td> <td style="background-color: #e1f5fe;">WBT:</td> <td style="padding: 2px;">3.6 sec</td> </tr> <tr> <td style="background-color: #e1f5fe;">NBL:</td> <td style="padding: 2px;">-</td> <td style="background-color: #e1f5fe;">EBL:</td> <td style="padding: 2px;">3.6 sec</td> <td style="background-color: #e1f5fe;">SBL:</td> <td style="padding: 2px;">3.6 sec</td> <td style="background-color: #e1f5fe;">WBL:</td> <td style="padding: 2px;">-</td> </tr> </table>	NBT:	3.6 sec	EBT:	3.6 sec	SBT:	3.6 sec	WBT:	3.6 sec	NBL:	-	EBL:	3.6 sec	SBL:	3.6 sec	WBL:	-
NBT:	3.6 sec	EBT:	3.6 sec	SBT:	3.6 sec	WBT:	3.6 sec										
NBL:	-	EBL:	3.6 sec	SBL:	3.6 sec	WBL:	-										

COMMENTS:	<p>All movements (left, thru, and right) for the eastbound approaches are equipped with red light running equipment. The southbound approach has a protected permissive left-turn whereas the northbound approach is only permissive. High pedestrian activity was observed at this intersection. This intersection is striped (yellow) for school crossing with Sutter Middle School at the northeast corner.</p>
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EL CAMINO AVENUE AT EVERGREEN STREET

<p><i>Direction (approach equipped with RLR cameras):</i></p>	<p>Eastbound on El Camino Avenue:</p> 
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Agency:	City of Sacramento
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Date:	Monday, April 24, 2012
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Posted Speed Limit:	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 10%;">NB:</td> <td style="width: 20%;">30 MPH</td> <td style="width: 10%;">EB:</td> <td style="width: 20%;">35 MPH</td> <td style="width: 10%;">SB:</td> <td style="width: 20%;">30 MPH</td> <td style="width: 10%;">WB:</td> <td style="width: 20%;">35 MPH</td> </tr> </table>	NB:	30 MPH	EB:	35 MPH	SB:	30 MPH	WB:	35 MPH
NB:	30 MPH	EB:	35 MPH	SB:	30 MPH	WB:	35 MPH		



RLR Signage:	SR-56 and SR-58 mounted on one post or on the signal pole (above the mast arm) was observed for all four approaches, at either the intersection or approximately 150-300 feet from the intersection.
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Programmed Yellow Time:	<table border="1" style="width: 100%; text-align: center;"> <tr> <td style="width: 10%;">NBT:</td> <td style="width: 15%;">3.6 sec</td> <td style="width: 10%;">EBT:</td> <td style="width: 15%;">3.9 sec</td> <td style="width: 10%;">SBT:</td> <td style="width: 15%;">3.6 sec</td> <td style="width: 10%;">WBT:</td> <td style="width: 15%;">3.9 sec</td> </tr> <tr> <td>NBL:</td> <td>-</td> <td>EBL:</td> <td>3.9 sec</td> <td>SBL:</td> <td>-</td> <td>WBL:</td> <td>3.9 sec</td> </tr> </table>	NBT:	3.6 sec	EBT:	3.9 sec	SBT:	3.6 sec	WBT:	3.9 sec	NBL:	-	EBL:	3.9 sec	SBL:	-	WBL:	3.9 sec
NBT:	3.6 sec	EBT:	3.9 sec	SBT:	3.6 sec	WBT:	3.9 sec										
NBL:	-	EBL:	3.9 sec	SBL:	-	WBL:	3.9 sec										


COMMENTS:	All movements (left, thru, and right) for the eastbound approaches are equipped with red light running equipment. The northbound/southbound movements are operating as split phasing (phases 3 and 4); however, the concurrent pedestrian phases operates as an overlap for both phases (northbound / southbound pedestrian phase 8). The intersection, currently operating on an Traconex TMP-390 controller, is offline – yellow times taken from the field.
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HOWE AVENUE AT FAIR OAKS BOULEVARD								
Direction (approach equipped with RLR cameras):	Eastbound on Fair Oaks Boulevard:							
								
	Southbound on Howe Avenue:							
								
Agency:	City of Sacramento							
Date:	Monday, April 24, 2012							
Posted Speed Limit:	NB:	40 MPH	EB:	45 MPH	SB:	40 MPH	WB:	45 MPH
RLR Signage:	SR-58 mounted on one post was observed at all four approaches, approximately 200-300 feet from the intersection.							
Programmed Yellow Time:	NBT:	4.3 sec	EBT:	4.7 sec	SBT:	4.3 sec	WBT:	4.7 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL:	3.5 sec
COMMENTS:	All movements (left, thru, and right) for the eastbound approaches and the thru and right movements for the southbound approaches are equipped with red light running equipment. The California State University of Sacramento is located less than a mile from this intersection, which was observed to experience some student traffic.							

FOLSOM BOULEVARD AT POWER INN ROAD / HOWE AVENUE								
Direction (approach equipped with RLR cameras):	Southbound on Howe Avenue:							
								
Agency:	City of Sacramento							
Date:	Monday, April 24, 2012							
Posted Speed Limit:	NB:	45 MPH	EB:	45 MPH	SB:	40 MPH	WB:	45 MPH
RLR Signage:	SR-56 mounted on one post; advanced warning sign observed at all four approaches, approximately 200-300 feet from the intersection.							
Programmed Yellow Time:	NBT:	4.3 sec	EBT:	4.7 sec	SBT:	4.3 sec	WBT:	4.7 sec
	NBL:	3.5 sec	EBL:	3.5 sec	SBL:	3.5 sec	WBL:	3.5 sec
COMMENTS:	All movements (left and thru) for the southbound approaches are equipped with red light running equipment. The intersection, currently operating on Econolite ASC/2 controller, is offline – yellow times taken from the field. North of the intersection is access to the US Route 50 and south of the intersection is an underpass to the light rail station.							

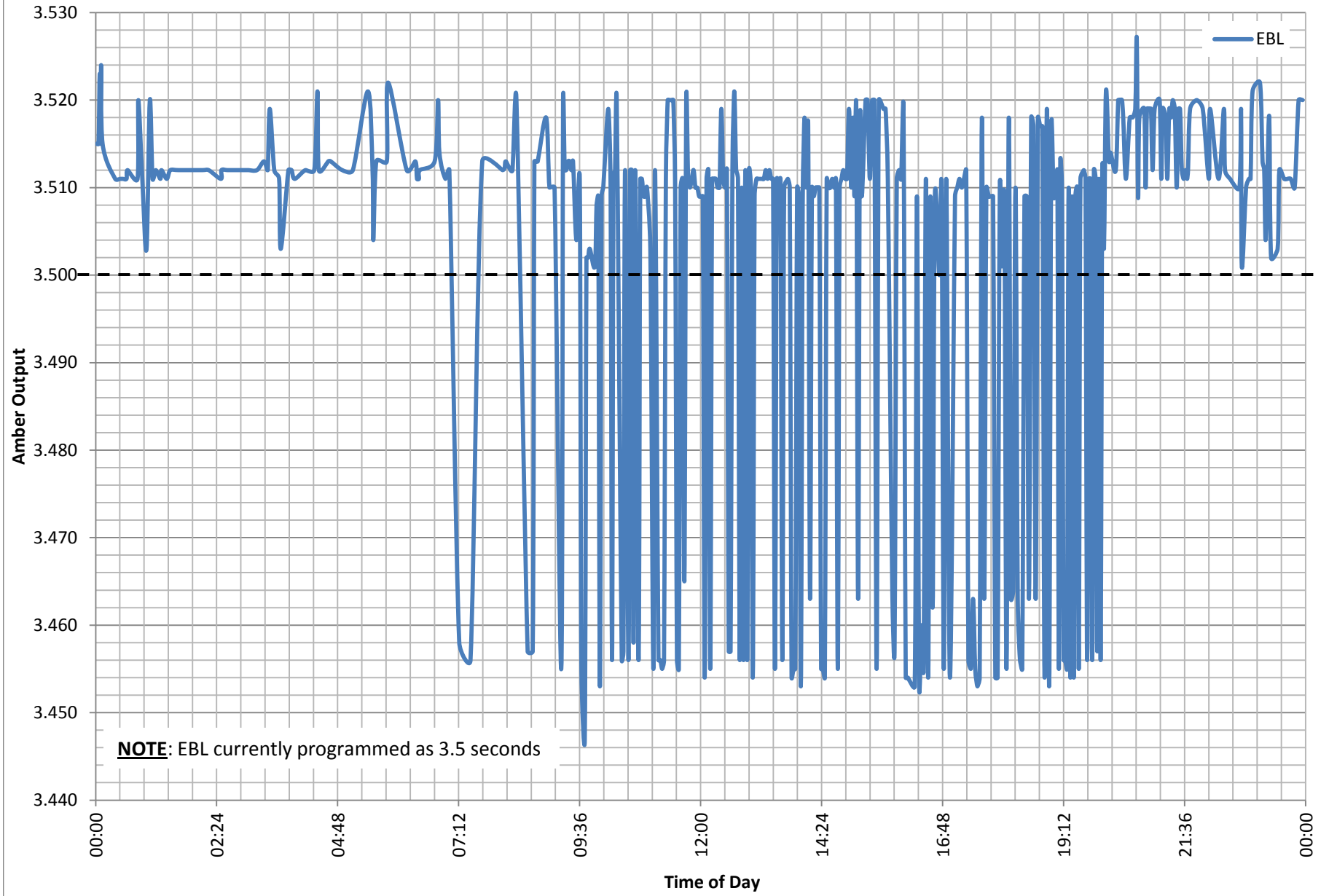
5TH STREET AT I STREET							
Direction (approach equipped with RLR cameras):	Westbound on I Street:						
							
Agency:	City of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	30 MPH	EB:	-	SB:	25 MPH	WB: 25 MPH
RLR Signage:	SR-56 and SR-58 mounted on one post; advanced warning combination signs observed for the westbound approach, approximately 200 feet from the intersection. The northbound approach has SR-56 mounted on the street name (picture to the right) and northbound approach has SR-56 mounted on one post approximately 50-100 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.7 sec	EBT:	-	SBR:	3.5 sec	WBT: 3.5 sec
	NBL:	3.5 sec	EBL:	-	SBL:	-	WBL: -
COMMENTS:	All movements (thru and right) for the westbound approaches are equipped with red light running equipment. I Street is a one way street westbound, 5 th Street is one way northbound on the south leg and two ways on the north leg (southbound right-turn only). The westbound approach leads into the multiple freeway accesses (5, 80, and 99) whose signs may be distracting to the motorists, especially if they are from out of town and trying to find their way out of downtown.						

ARDEN WAY AT CHALLENGE WAY																	
Direction (approach equipped with RLR cameras):	Eastbound on Arden Way: 																
Agency:	County of Sacramento																
Date:	Monday, April 24, 2012																
Posted Speed Limit:	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">NB:</td> <td style="width: 20%;">30 MPH</td> <td style="width: 10%;">EB:</td> <td style="width: 20%;">40 MPH</td> <td style="width: 10%;">SB:</td> <td style="width: 20%;">25 MPH</td> <td style="width: 10%;">WB:</td> <td style="width: 20%;">40 MPH</td> </tr> </table>	NB:	30 MPH	EB:	40 MPH	SB:	25 MPH	WB:	40 MPH								
NB:	30 MPH	EB:	40 MPH	SB:	25 MPH	WB:	40 MPH										
RLR Signage:	SR-56 mounted on one post was observed at all, except the southbound approach out of the mall, with a distance of approximately 50-200 feet from the intersection.																
Programmed Yellow Time:	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">NBT:</td> <td style="width: 15%;">3.7 sec</td> <td style="width: 10%;">EBT:</td> <td style="width: 15%;">4.7 sec</td> <td style="width: 10%;">SBT:</td> <td style="width: 15%;">3.5 sec</td> <td style="width: 10%;">WBT:</td> <td style="width: 15%;">4.0 sec</td> </tr> <tr> <td>NBL:</td> <td>-</td> <td>EBL:</td> <td>3.5 sec</td> <td>SBL:</td> <td>-</td> <td>WBL:</td> <td>3.5 sec</td> </tr> </table>	NBT:	3.7 sec	EBT:	4.7 sec	SBT:	3.5 sec	WBT:	4.0 sec	NBL:	-	EBL:	3.5 sec	SBL:	-	WBL:	3.5 sec
NBT:	3.7 sec	EBT:	4.7 sec	SBT:	3.5 sec	WBT:	4.0 sec										
NBL:	-	EBL:	3.5 sec	SBL:	-	WBL:	3.5 sec										
COMMENTS:	All movements (left, thru, and right) for the eastbound approaches are equipped with red light running equipment. Arden mall is located on the north side of the intersection, which generates heavy amount of traffic, especially west of the intersection from I-80.																

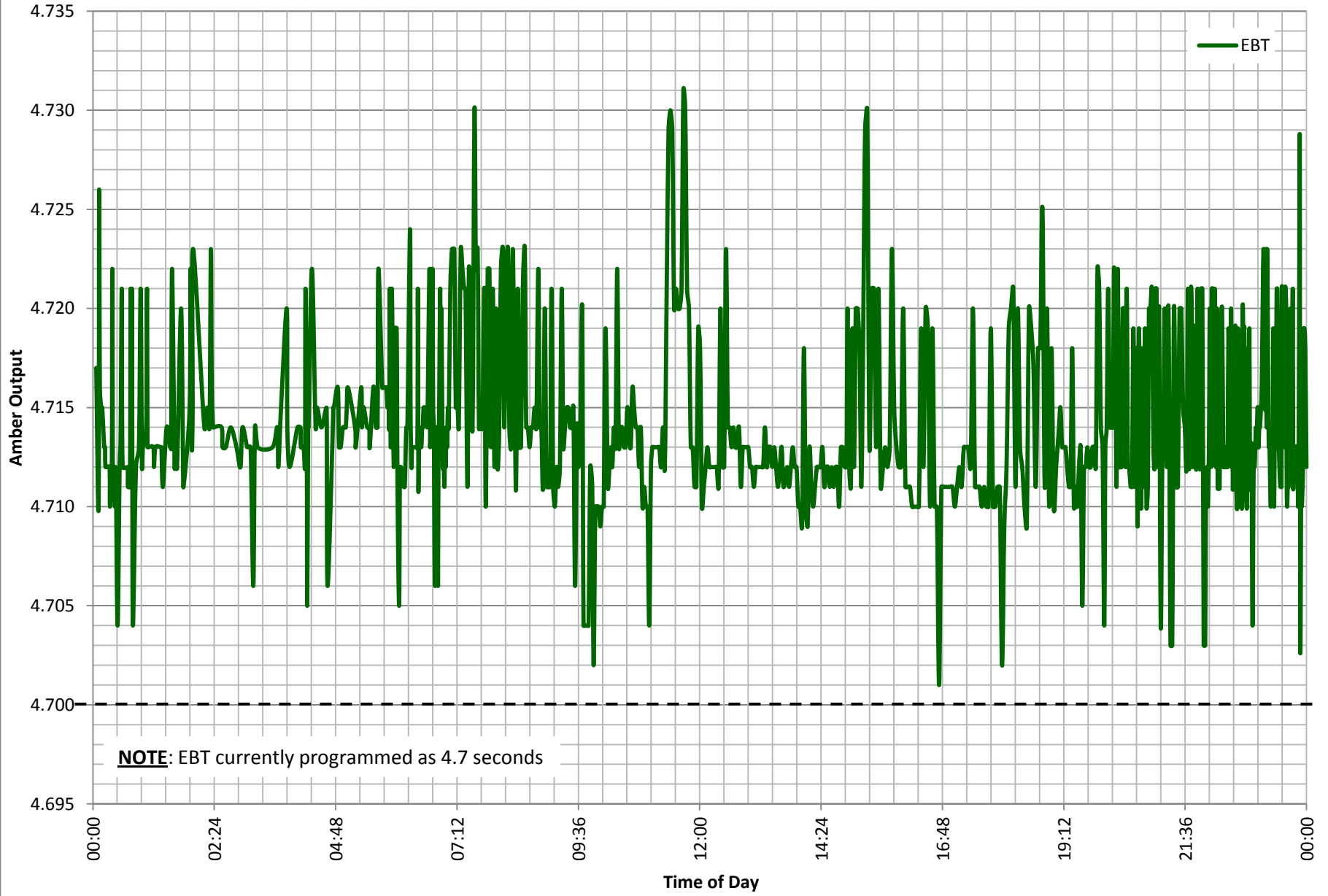
16 TH STREET AT W STREET (under construction)							
Direction (approach equipped with RLR cameras):	Northbound on 16 th Street:						
							
Agency:	City of Sacramento						
Date:	Monday, April 24, 2012						
Posted Speed Limit:	NB:	30 MPH	EB:	-	RAMP:	35 MPH	WB: 35 MPH
RLR Signage:	SR-56 mounted on one post observed at all three approaches, including the off-ramp, at the intersection to approximately 150 feet from the intersection.						
Programmed Yellow Time:	NBT:	3.9 sec	EBT:	-	RAMPT:	3.5 sec	WBT: 3.9 sec
	NBL:	-	EBL:	-	RAMPL:	-	WBL: -
COMMENTS:	During the field visit, this intersection was still under construction. The northbound (left and thru) movements will be equipped with red light running equipment. The intersection, currently operating with an Intelight 2070 controller, is offline – yellow times taken from the field. The I-80 WB off-ramp is the fifth leg into this intersection; however, this movement will not be equipped with red light running capabilities.						

APPENDIX B: AMBER OUTPUT PLOTS

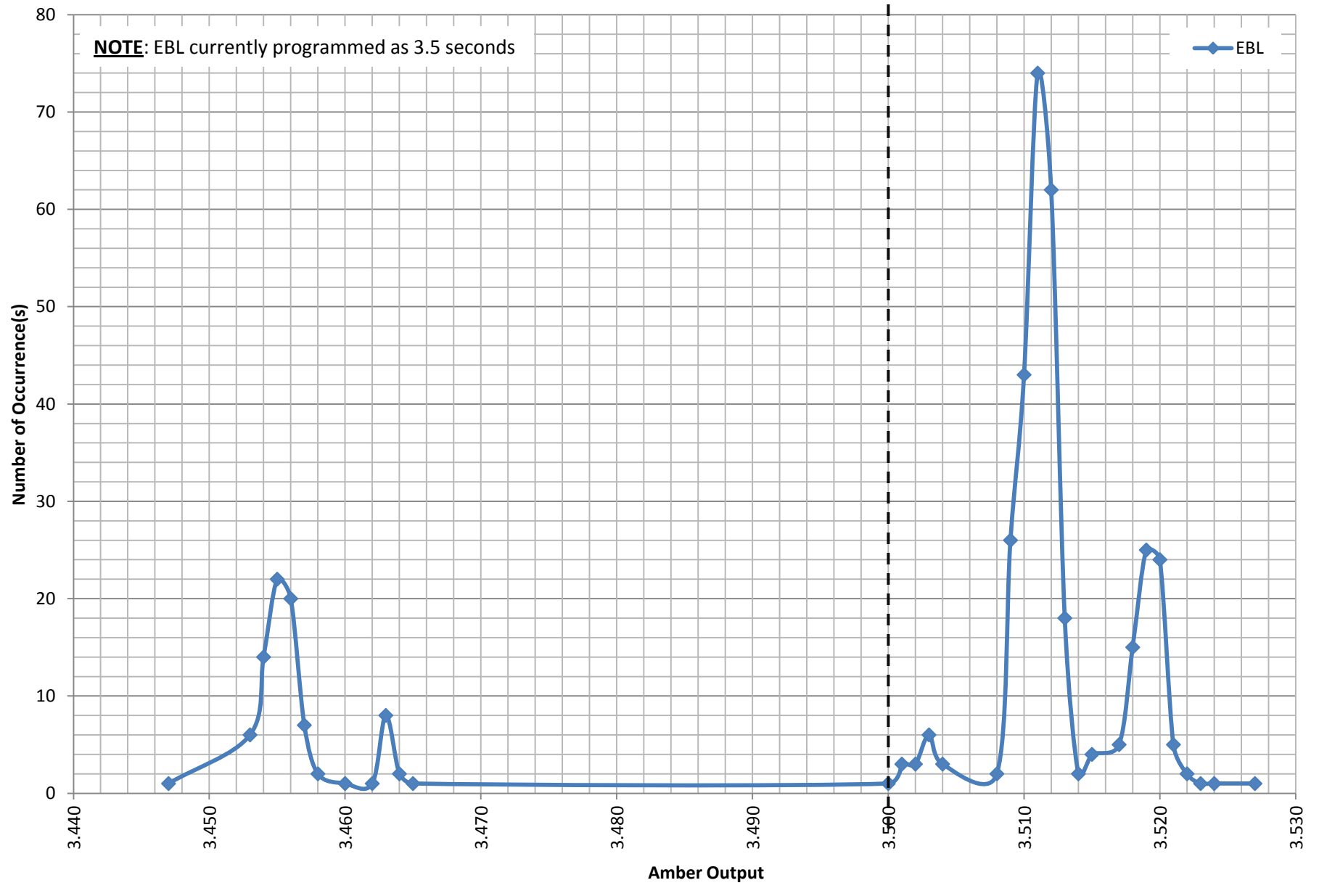
Arden Way at Challenge Way - Eastbound Left-Turn (7/11/12)



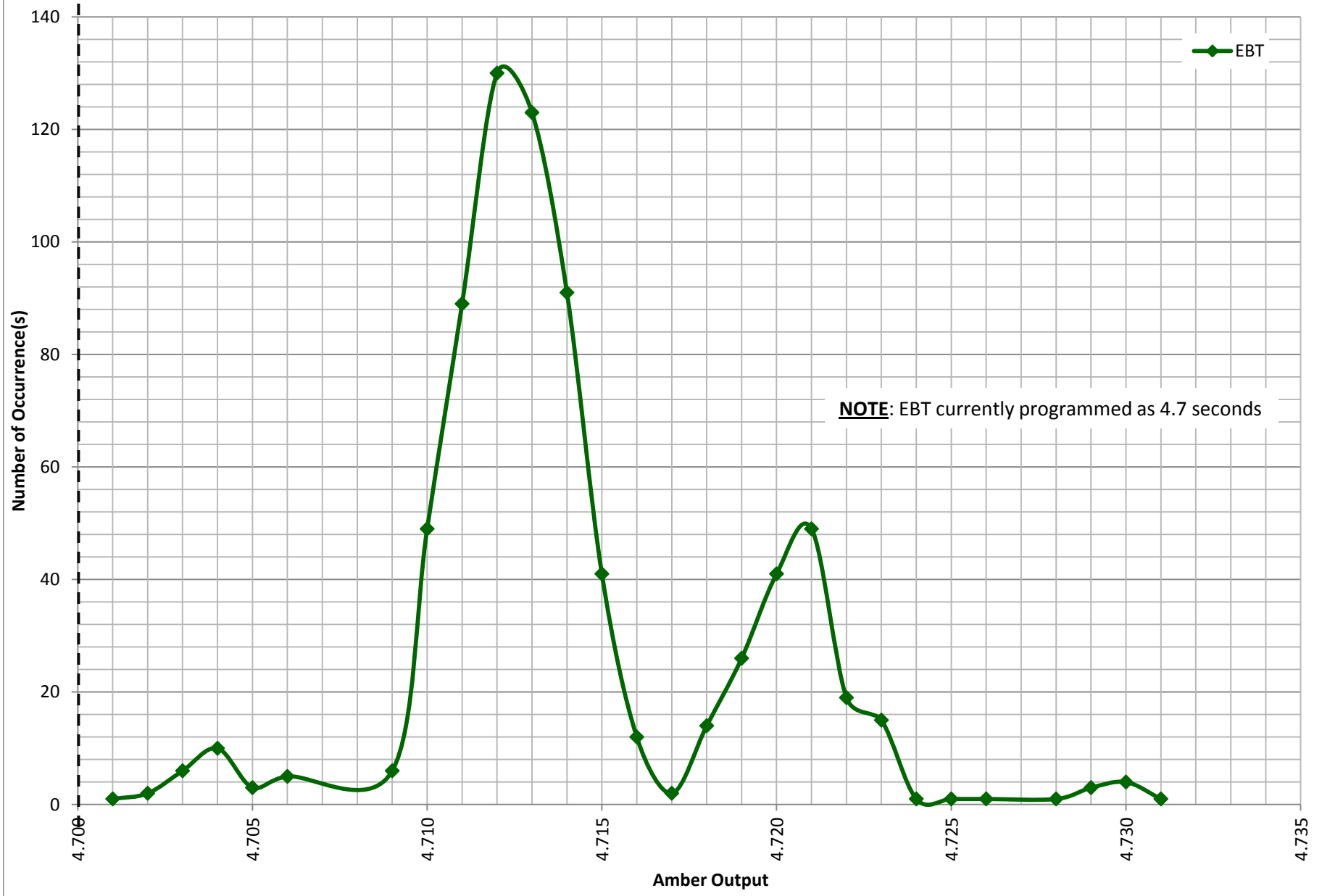
Arden Way at Challenge Way - Eastbound Thru (7/11/12)



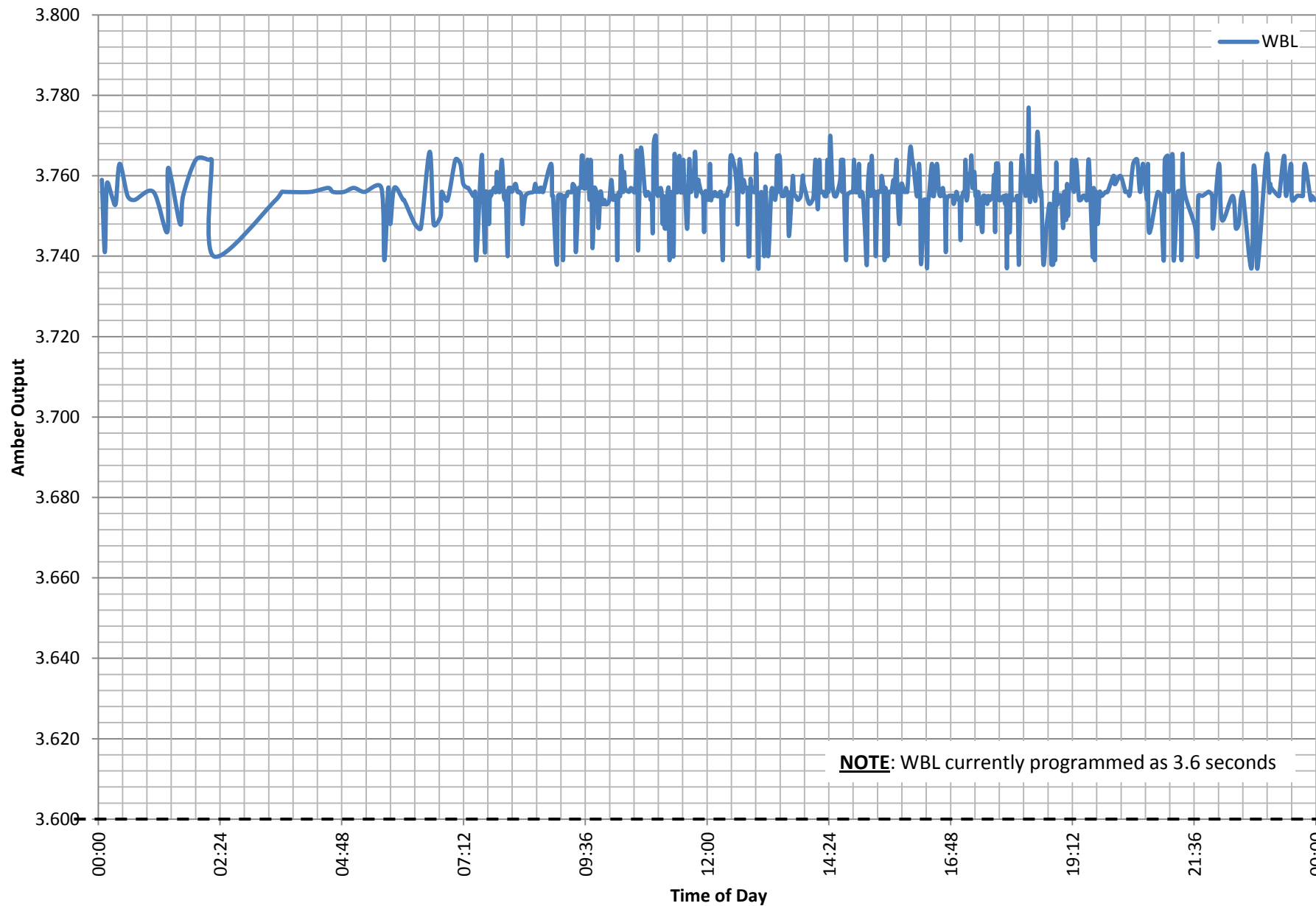
Arden Way at Challenge Way - Eastbound Left-Turn (7/11/12)



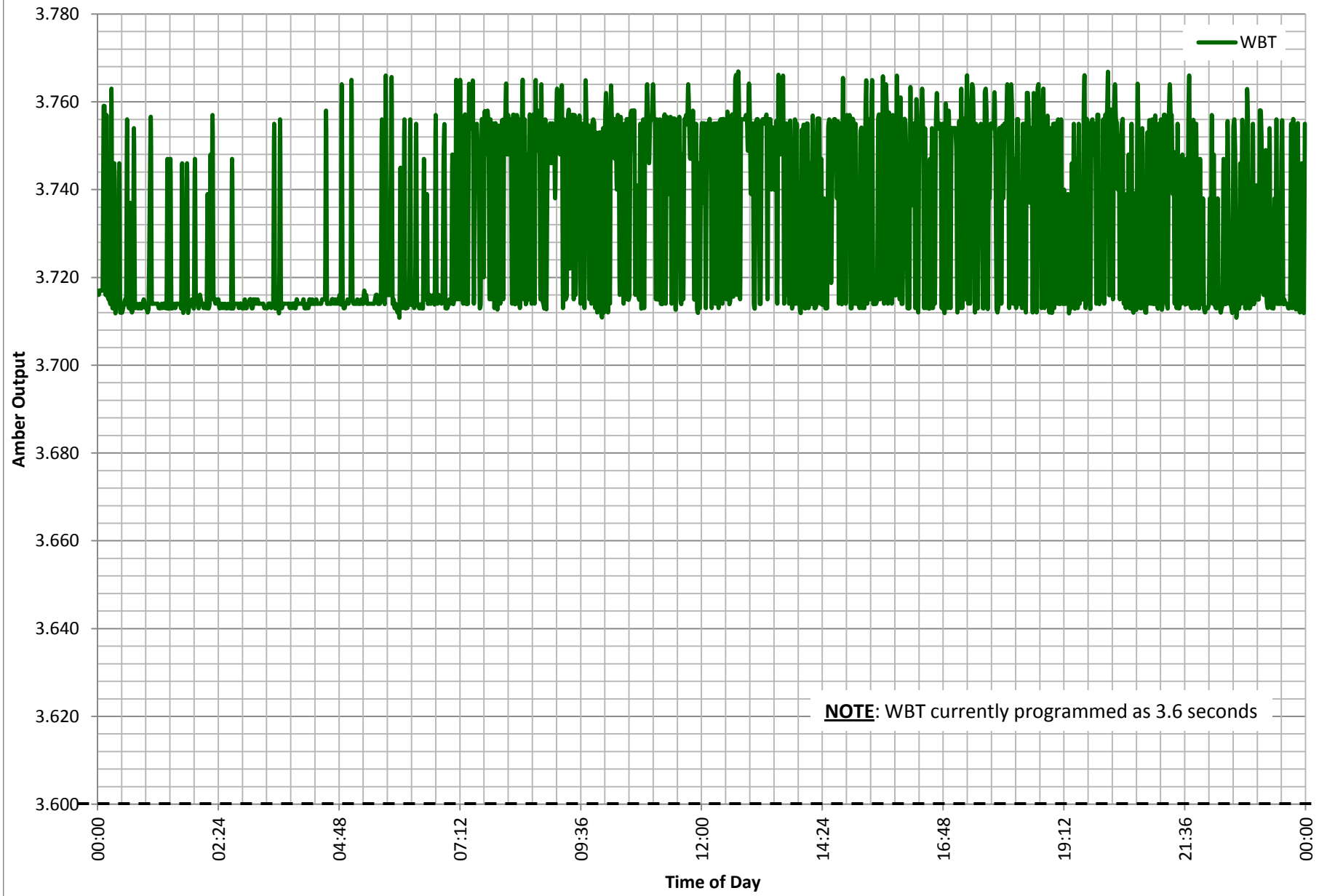
Arden Way at Challenge Way - Eastbound Thru (7/11/12)



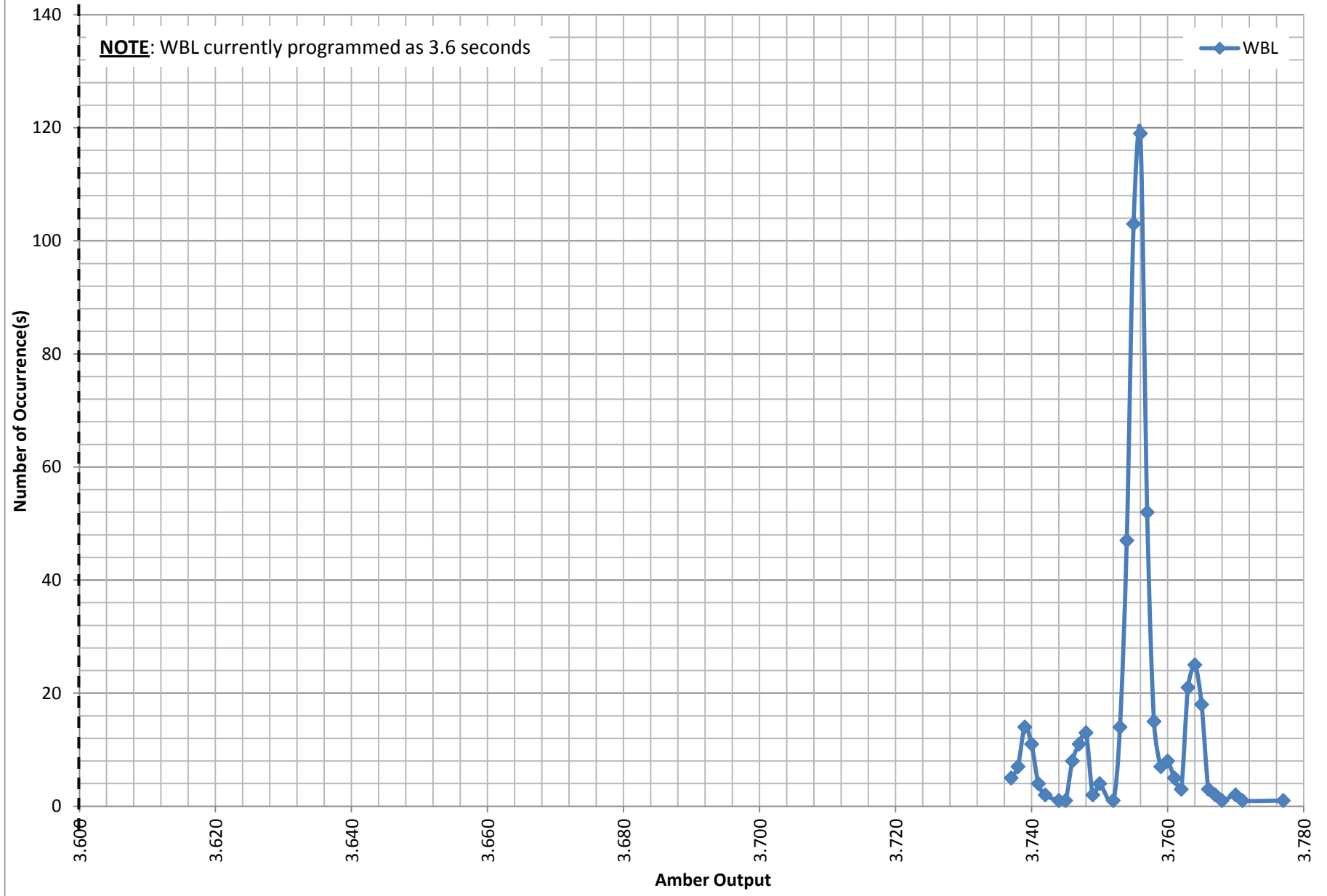
Broadway at 21st Street - Westbound Left-Turn (7/11/12)



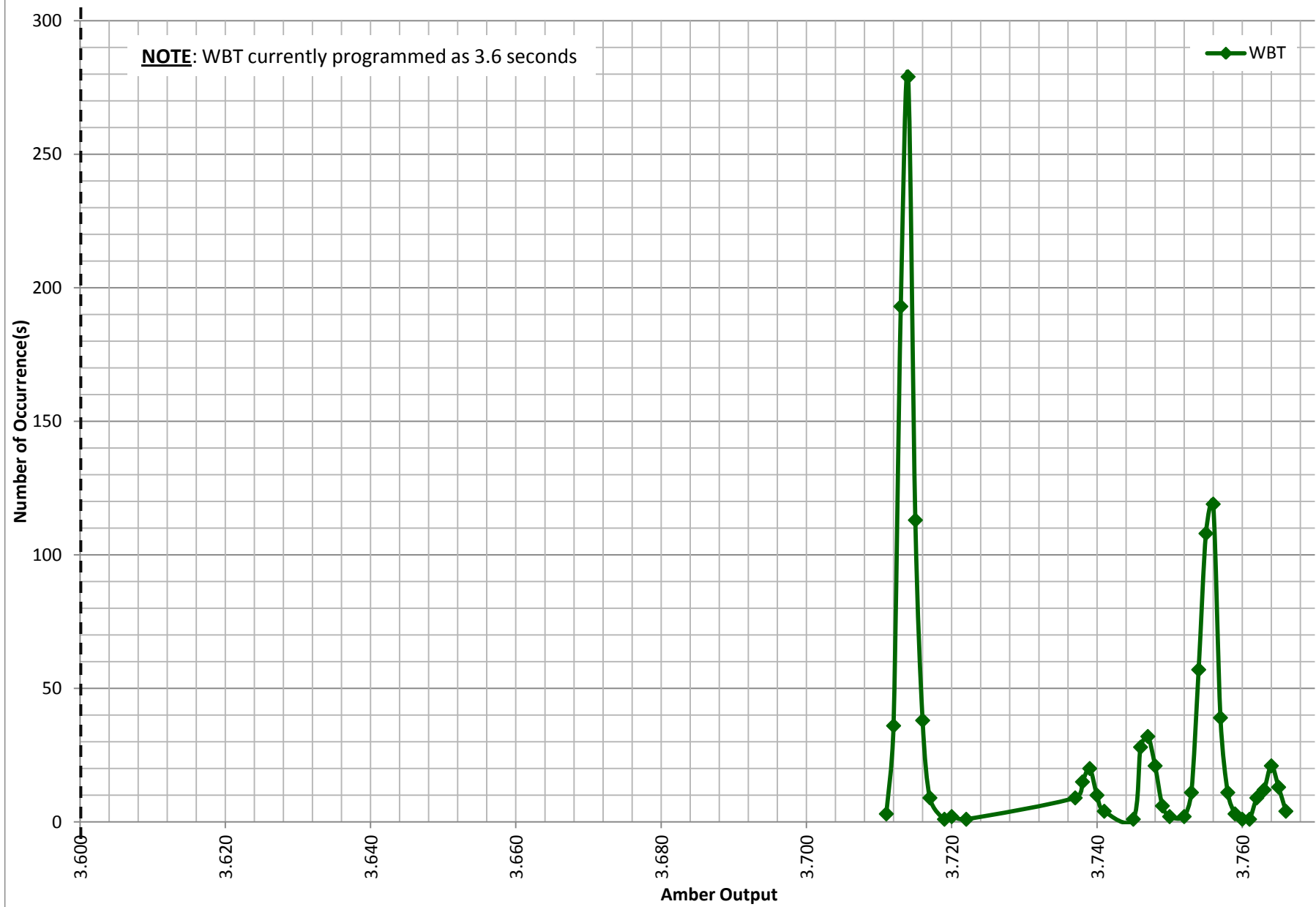
Broadway at 21st Street - Westbound Thru (7/11/12)



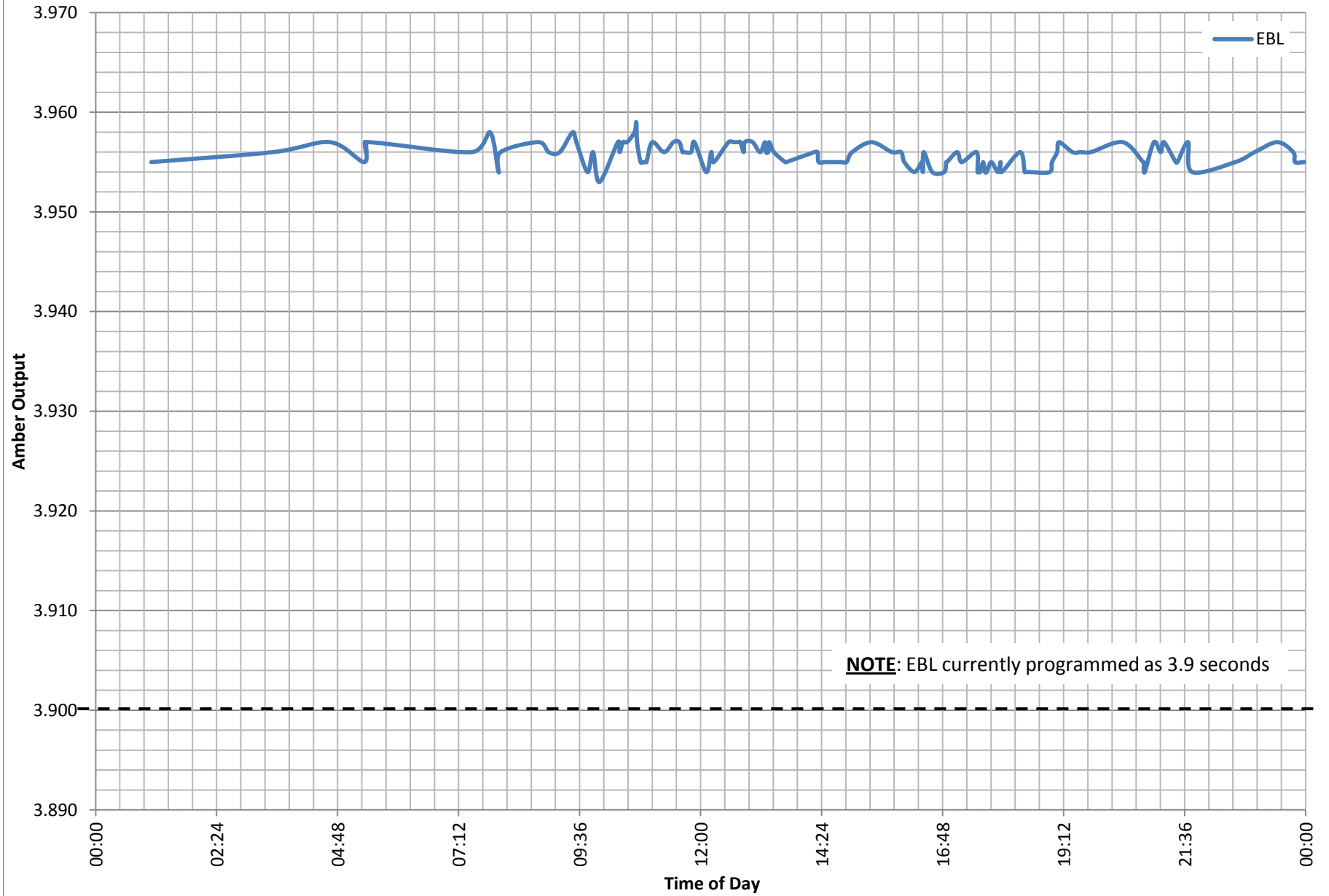
Broadway at 21st Street - Westbound Left-Turn (7/11/12)



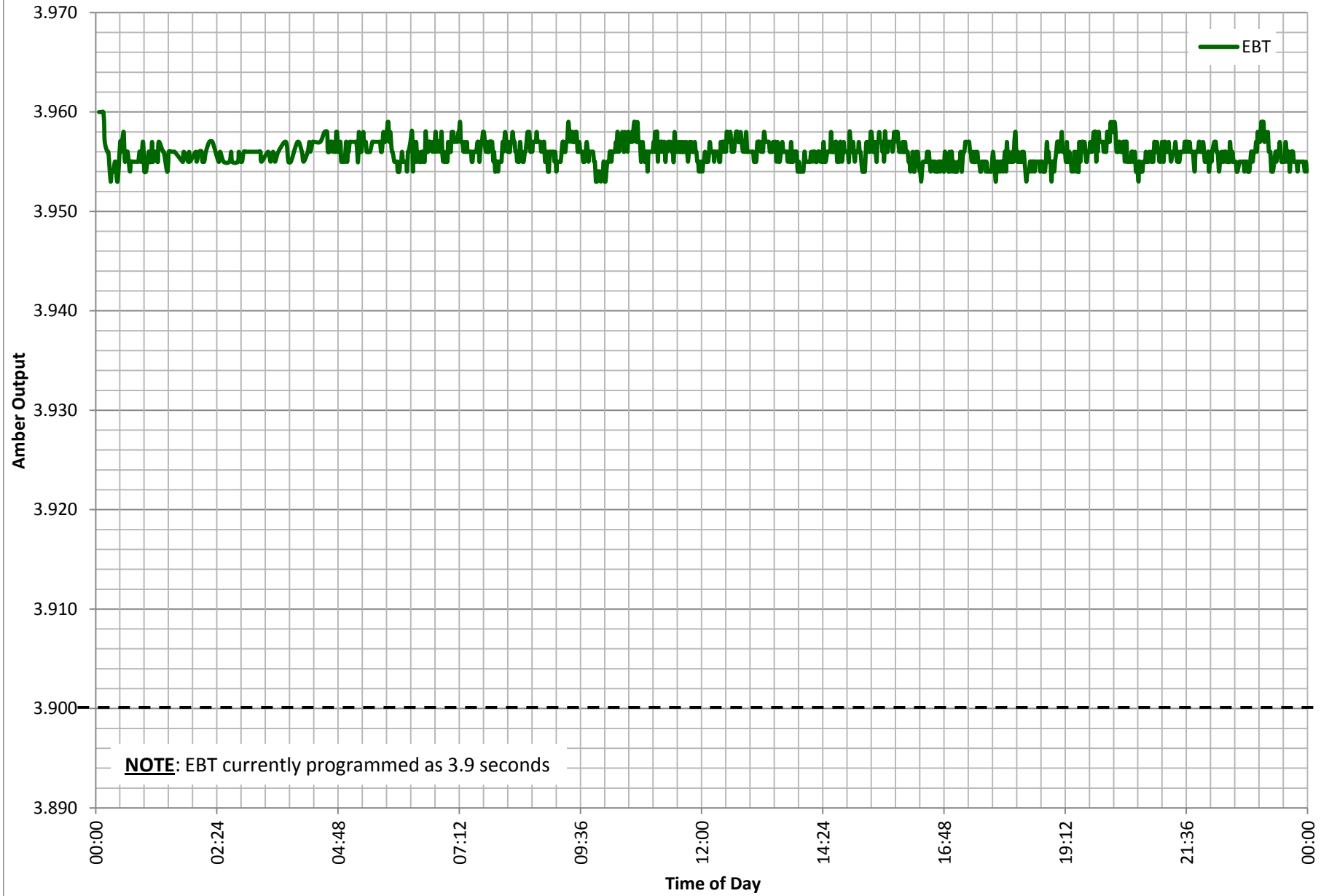
Broadway at 21st Street - Westbound Thru (7/11/12)



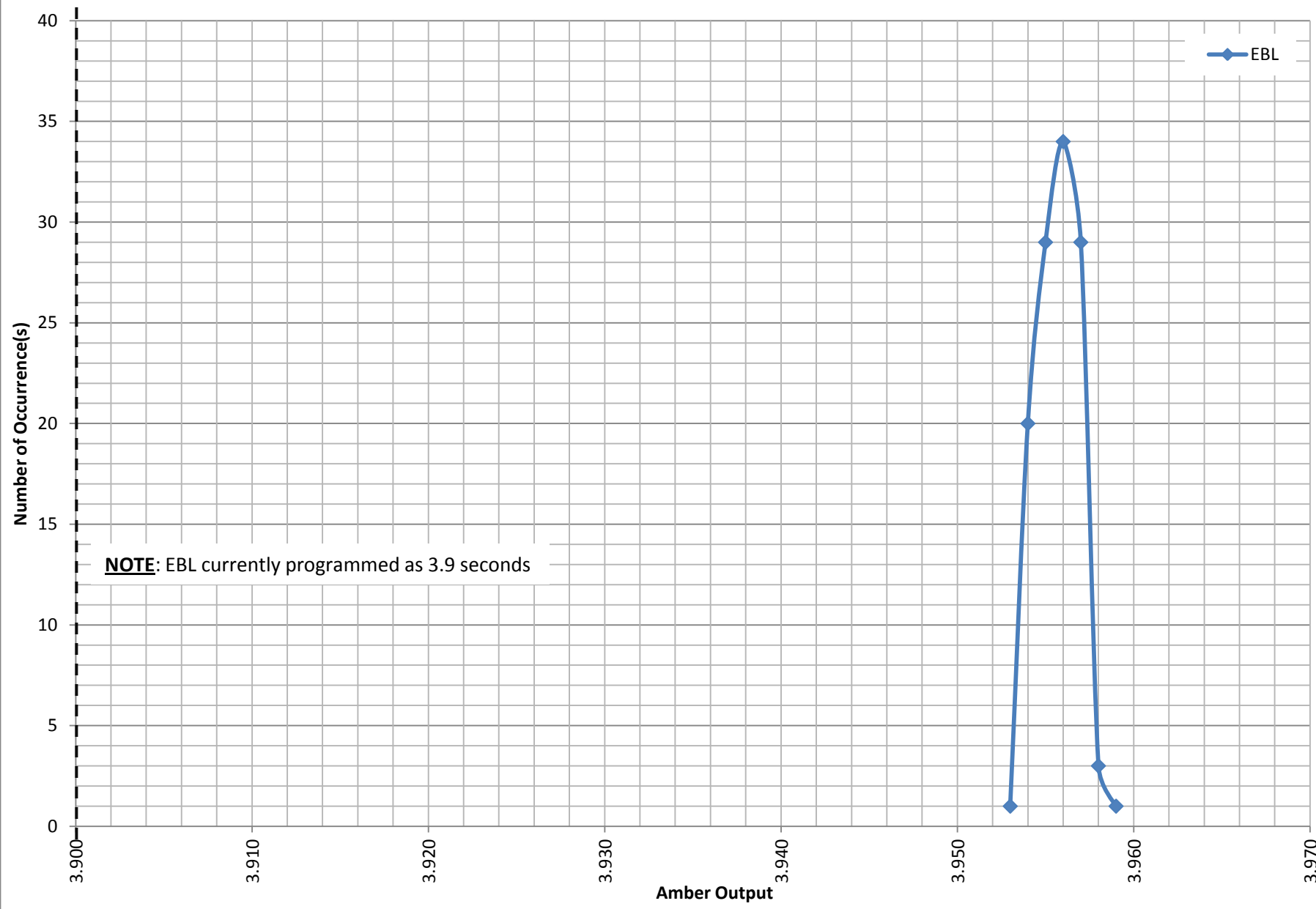
El Camino Avenue at Evergreen Street - Eastbound Left-Turn (7/11/12)



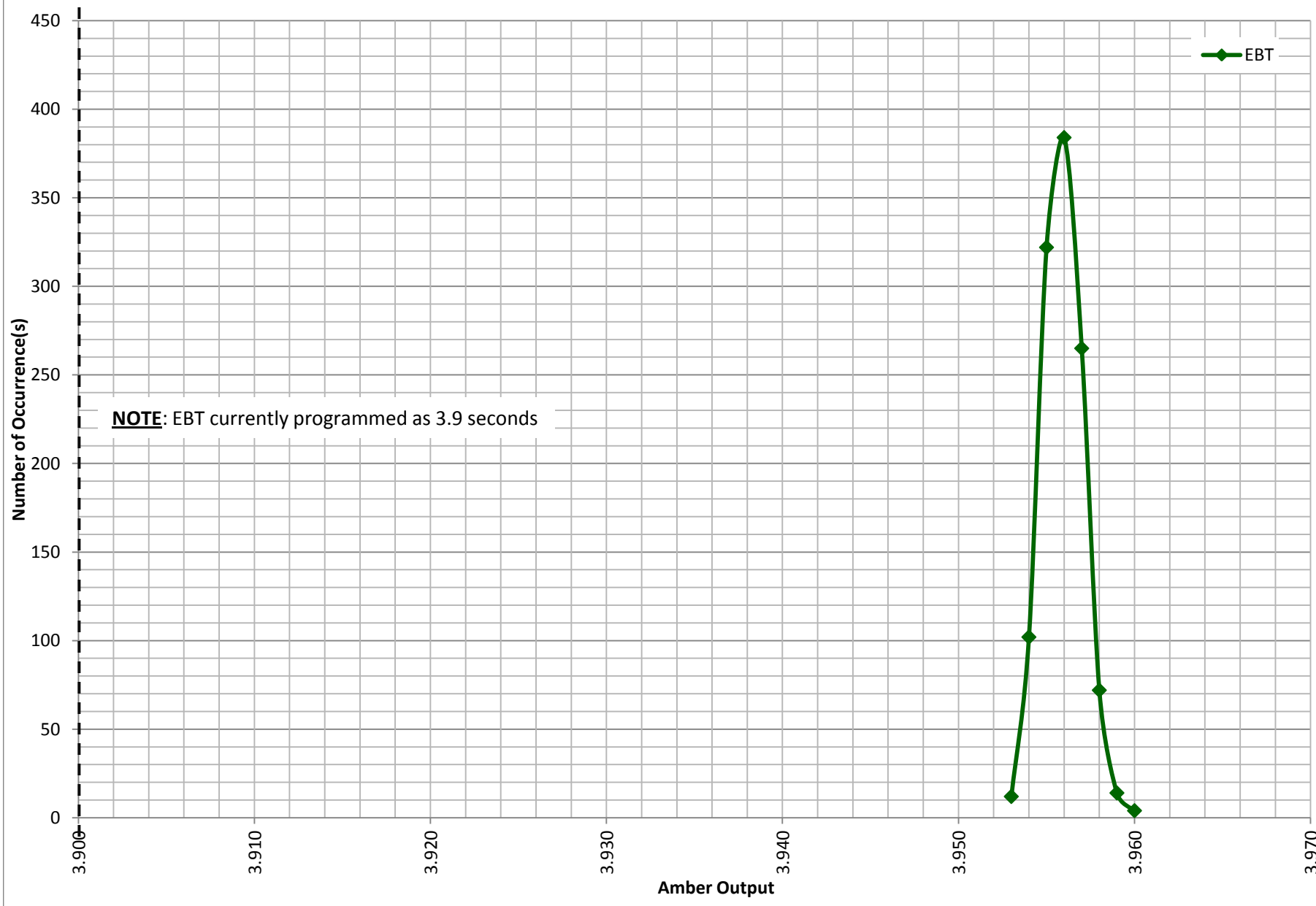
El Camino Avenue at Evergreen Street - Eastbound Thru (7/11/12)



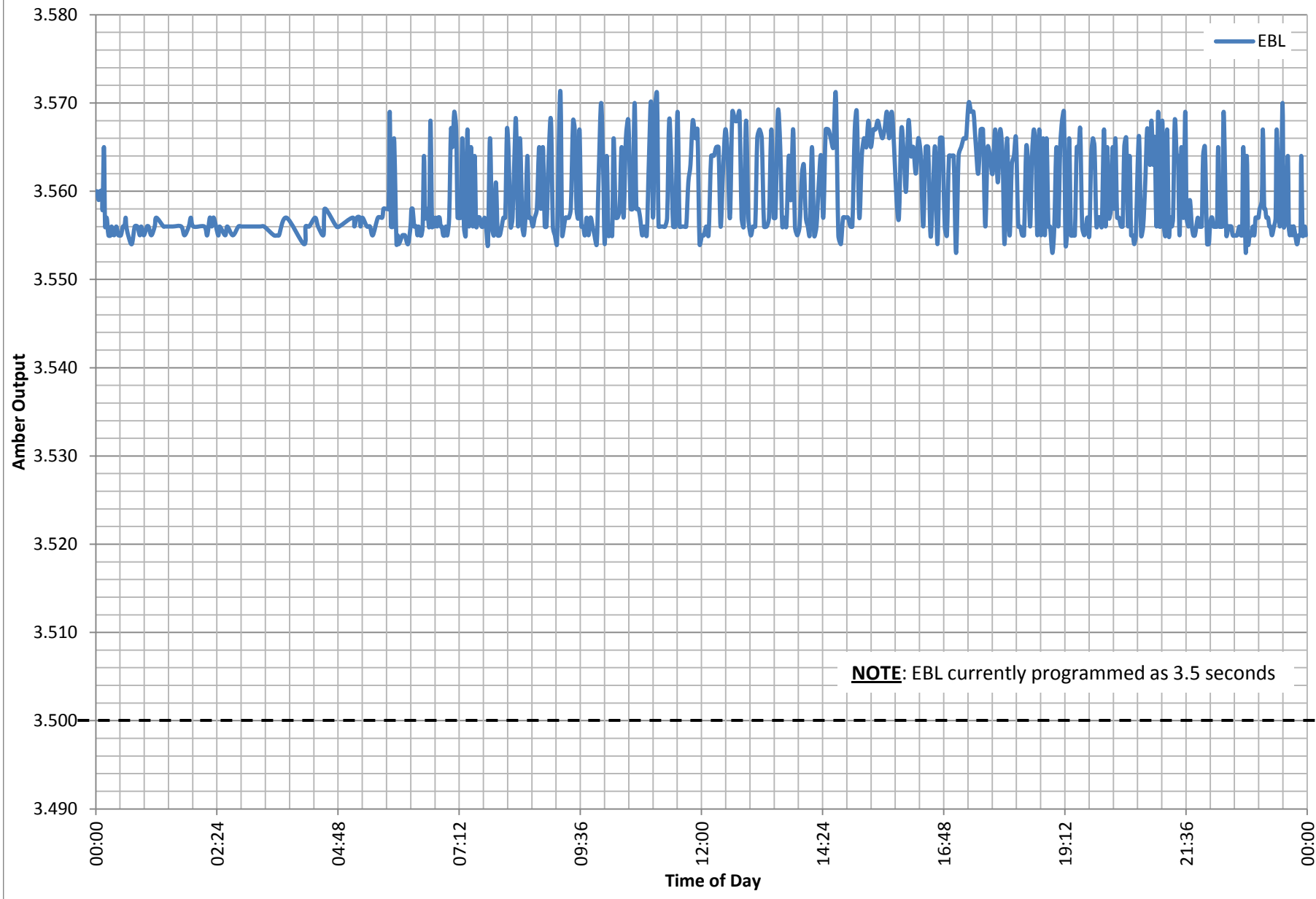
El Camino Avenue at Evergreen Street - Eastbound Left-Turn (7/11/12)



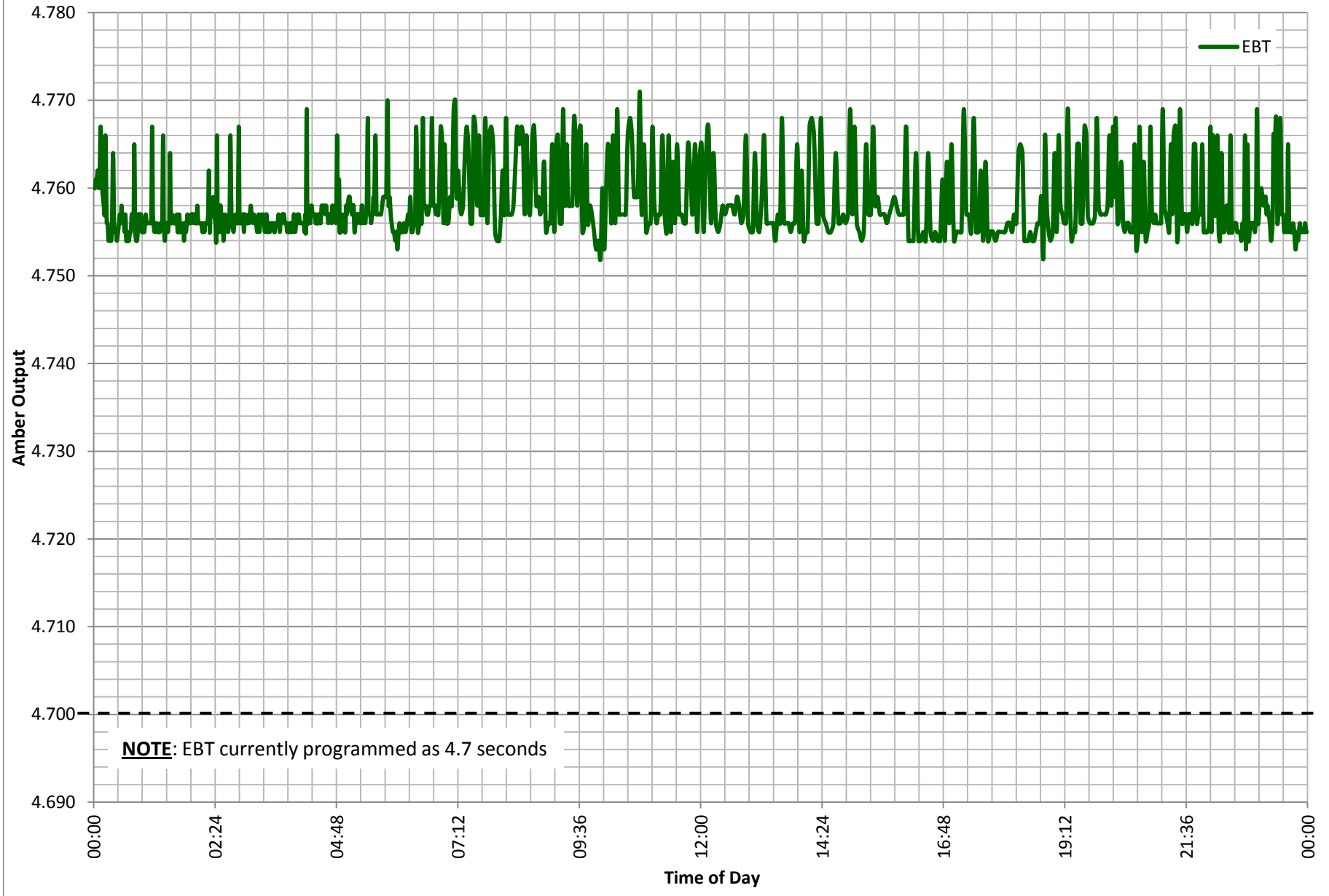
El Camino Avenue at Evergreen Street - Eastbound Thru (7/11/12)



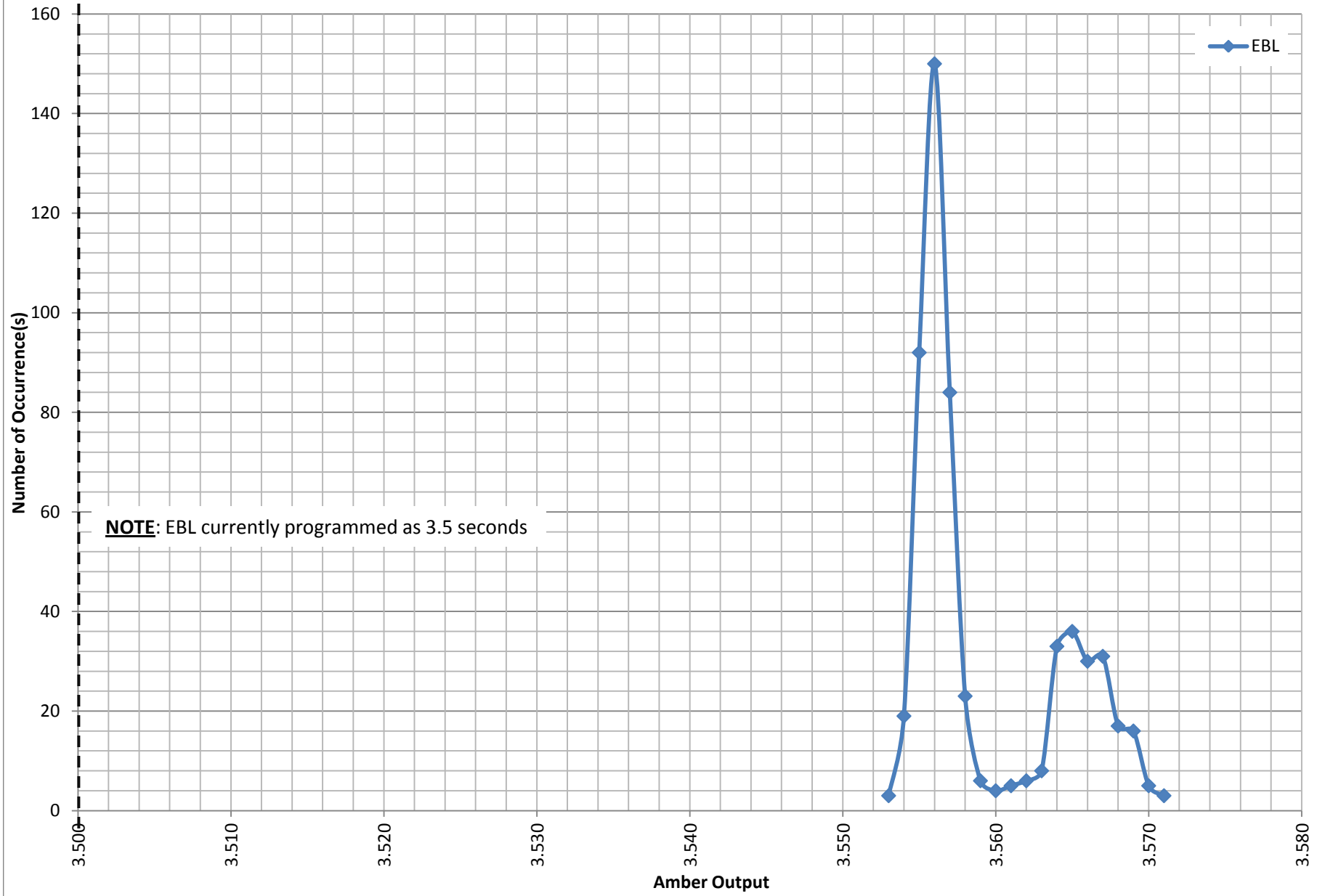
Fair Oaks Boulevard at Howe Avenue - Eastbound Left-Turn (7/11/12)



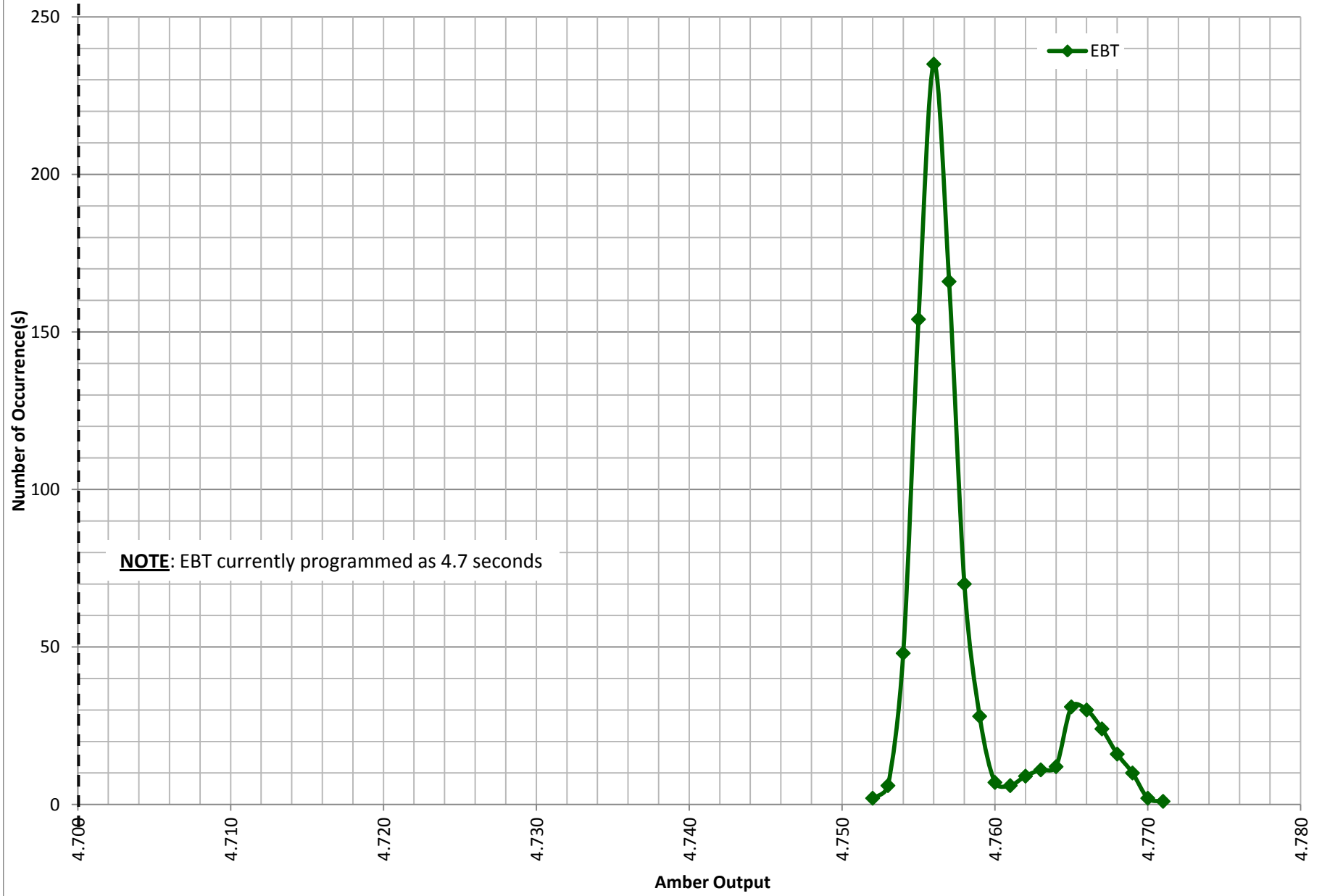
Fair Oaks Boulevard at Howe Avenue - Eastbound Thru (7/11/12)



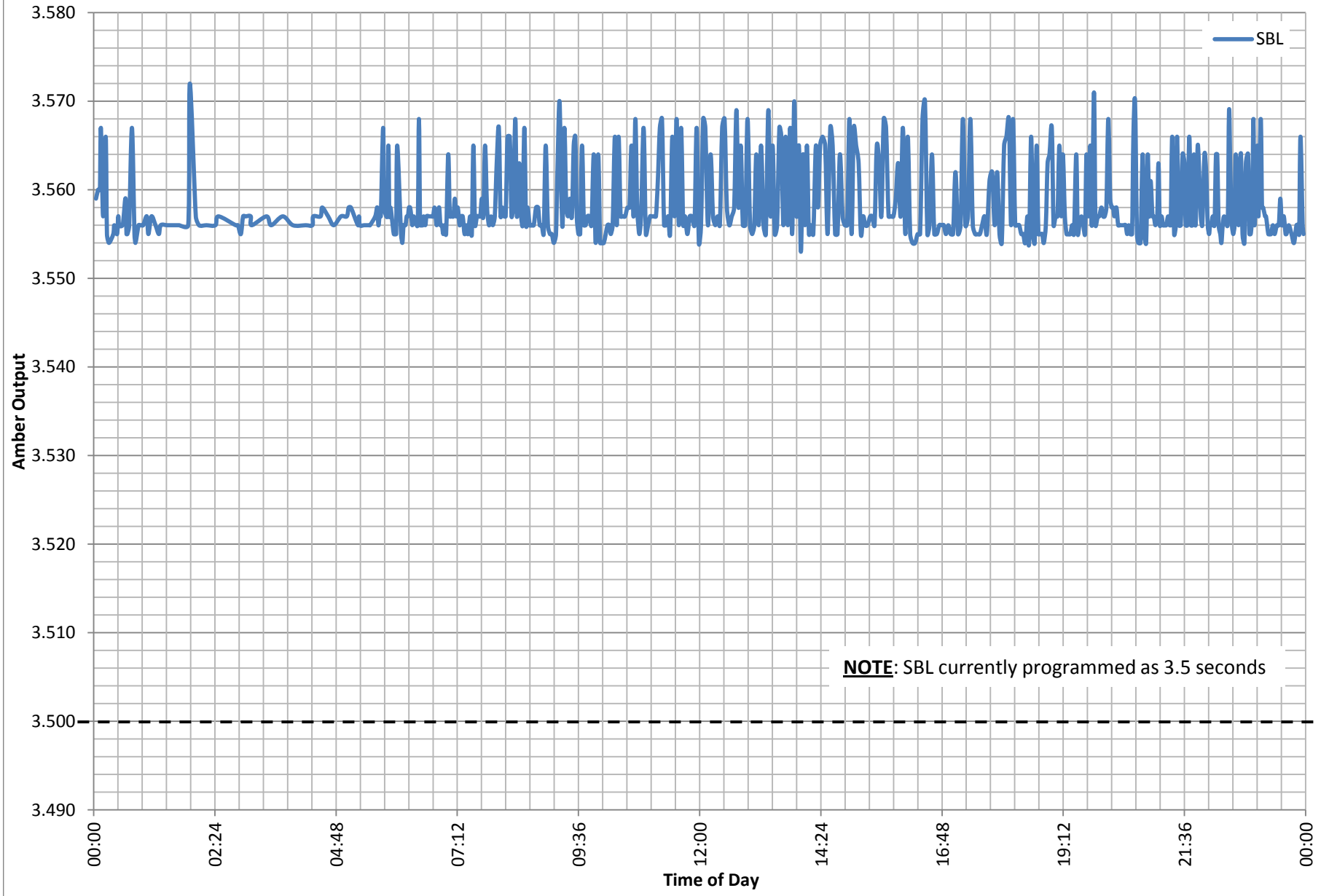
Fair Oaks Boulevard at Howe Avenue - Eastbound Left-Turn (7/11/12)



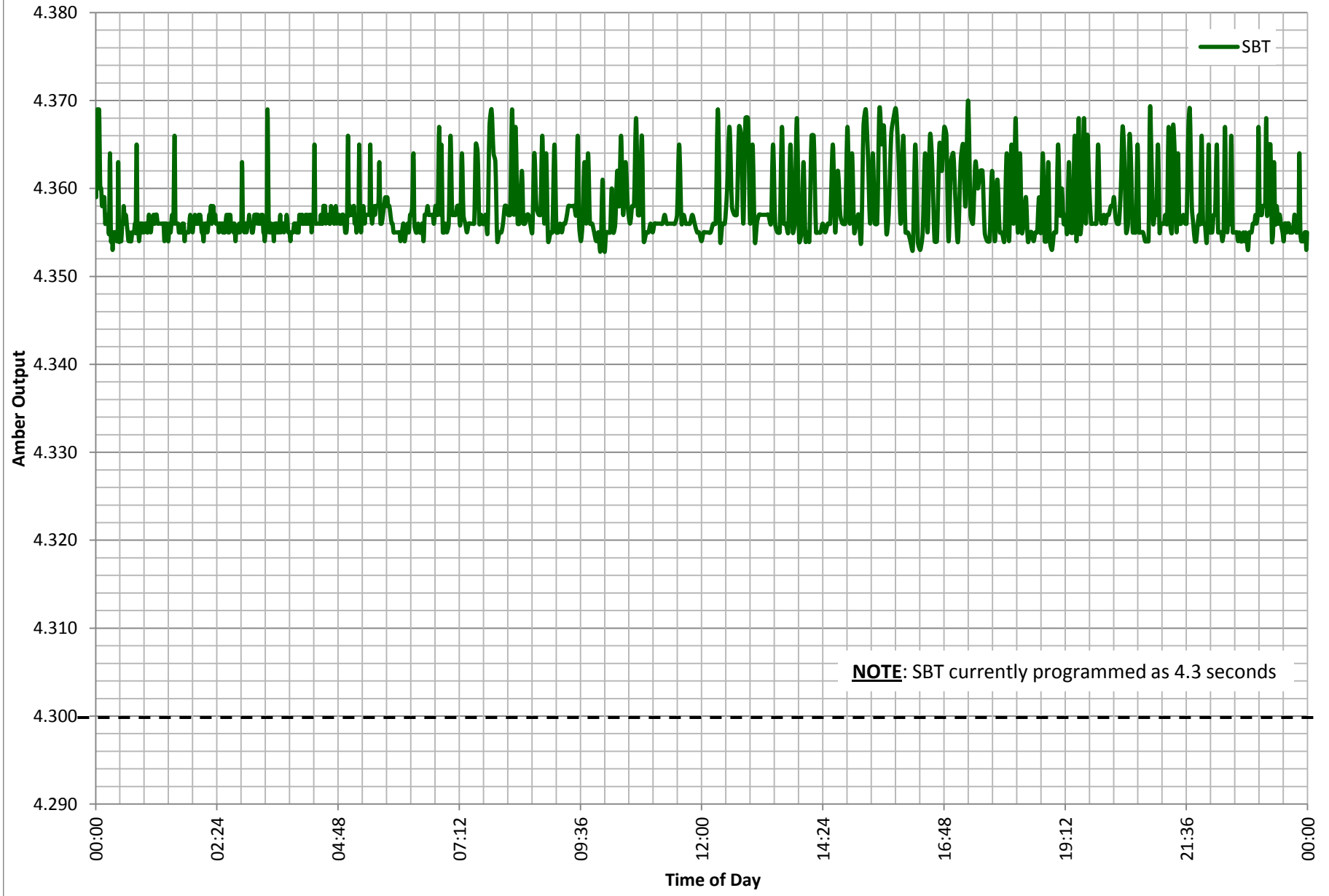
Fair Oaks Boulevard at Howe Avenue - Eastbound Thru (7/11/12)



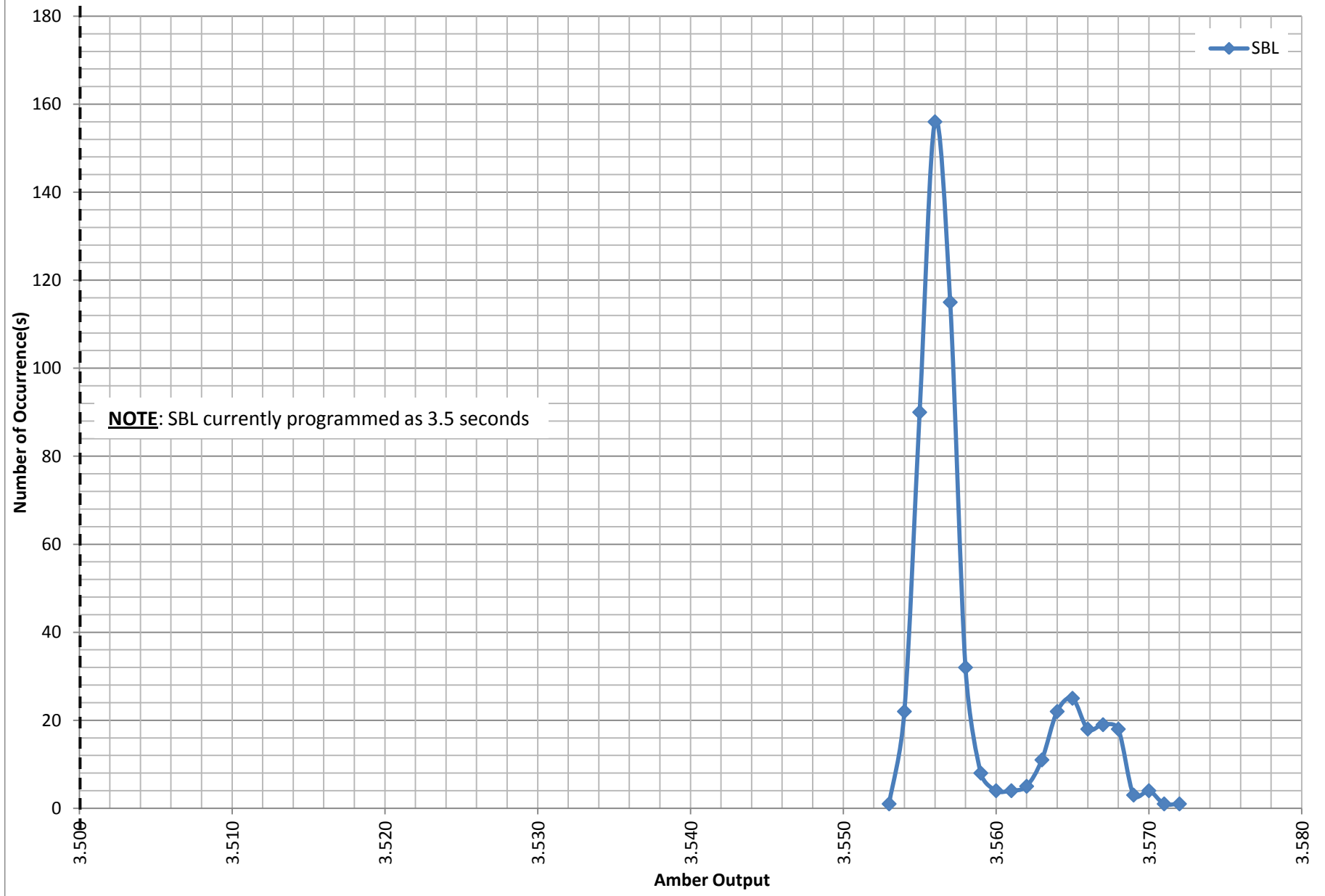
Howe Avenue at Fair Oaks Boulevard - Southbound Left-Turn (7/11/12)



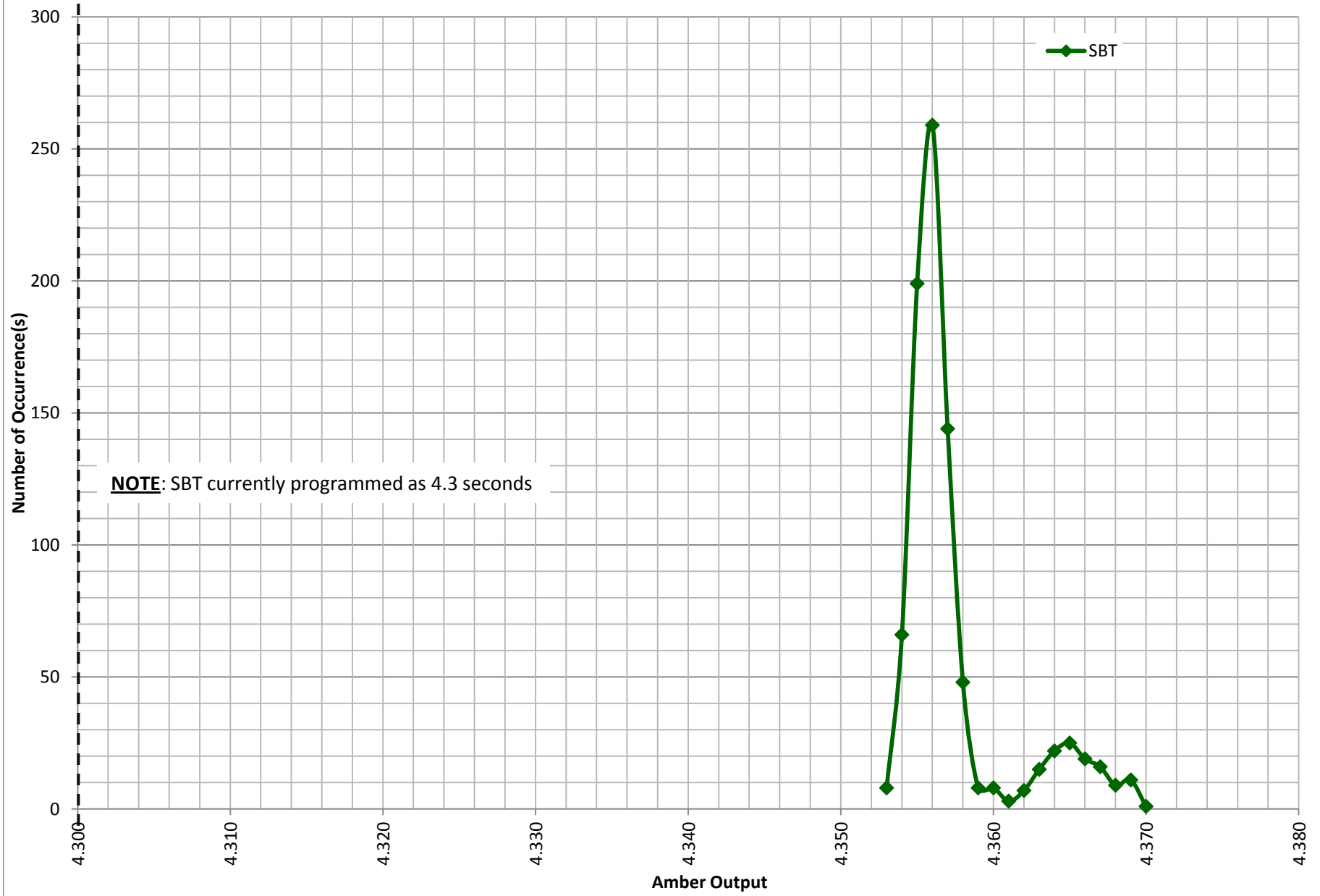
Howe Avenue at Fair Oaks Boulevard - Southbound Thru (7/11/12)



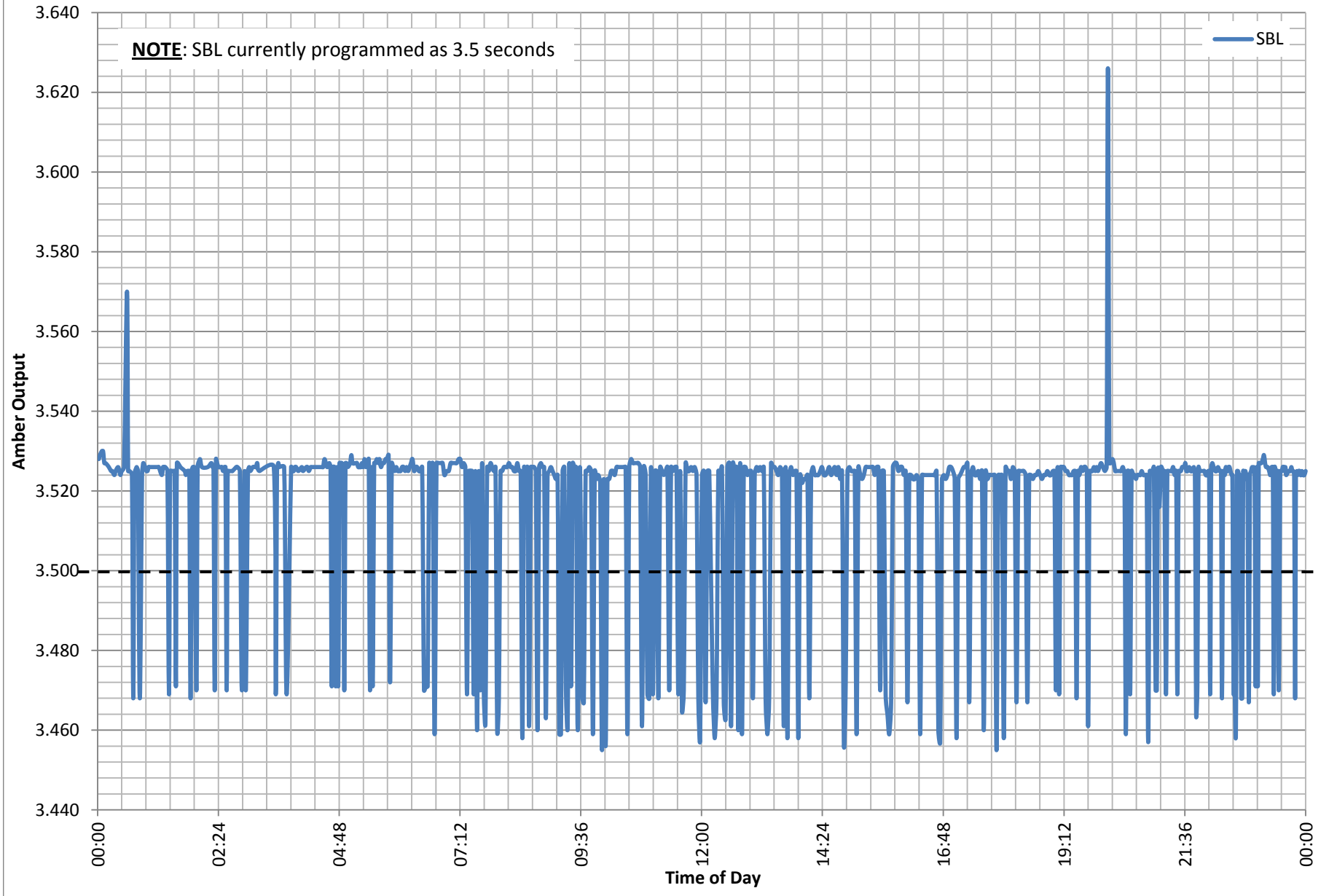
Howe Avenue at Fair Oaks Boulevard - Southbound Left-Turn (7/11/12)



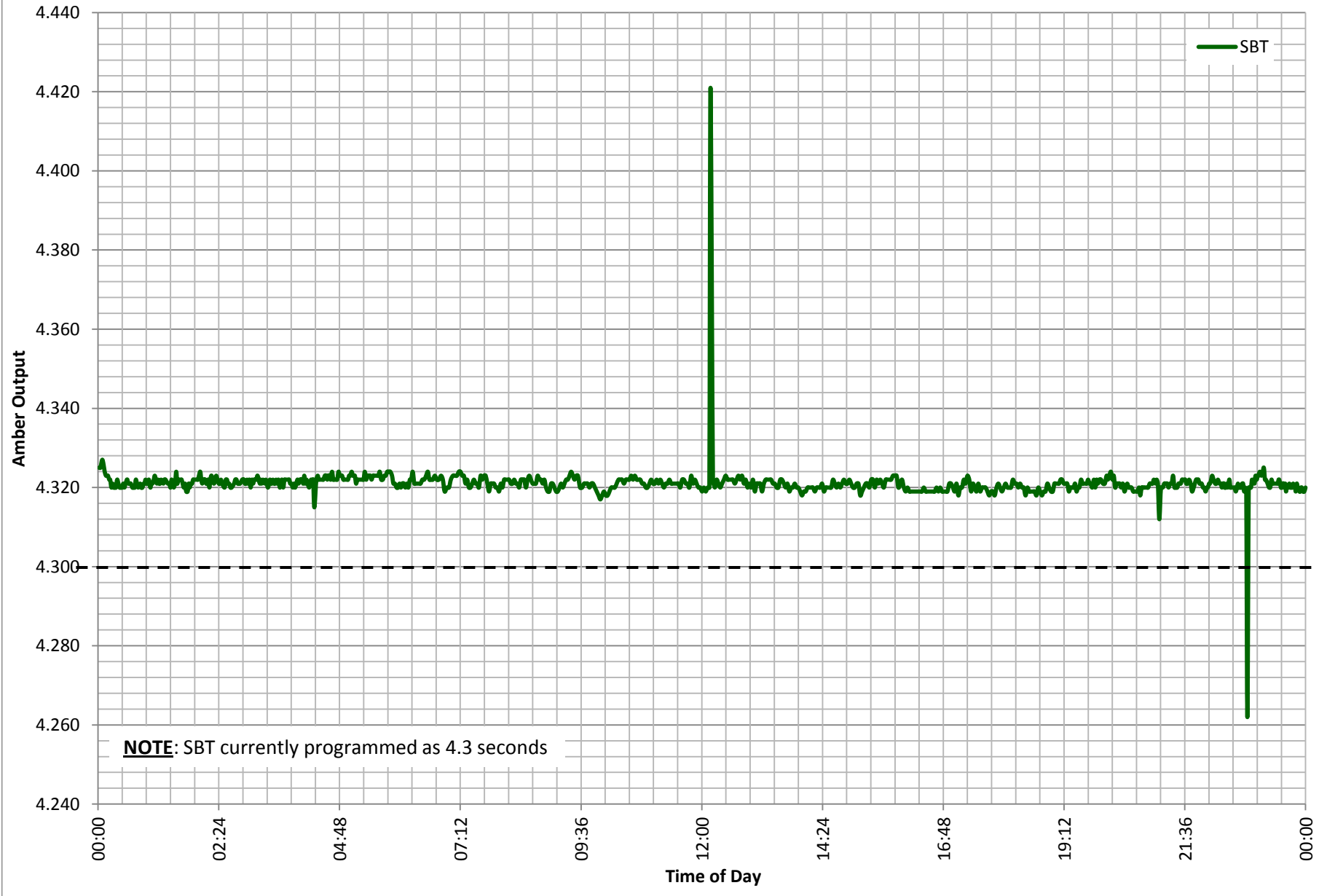
Howe Avenue at Fair Oaks Boulevard - Southbound Thru (7/11/12)



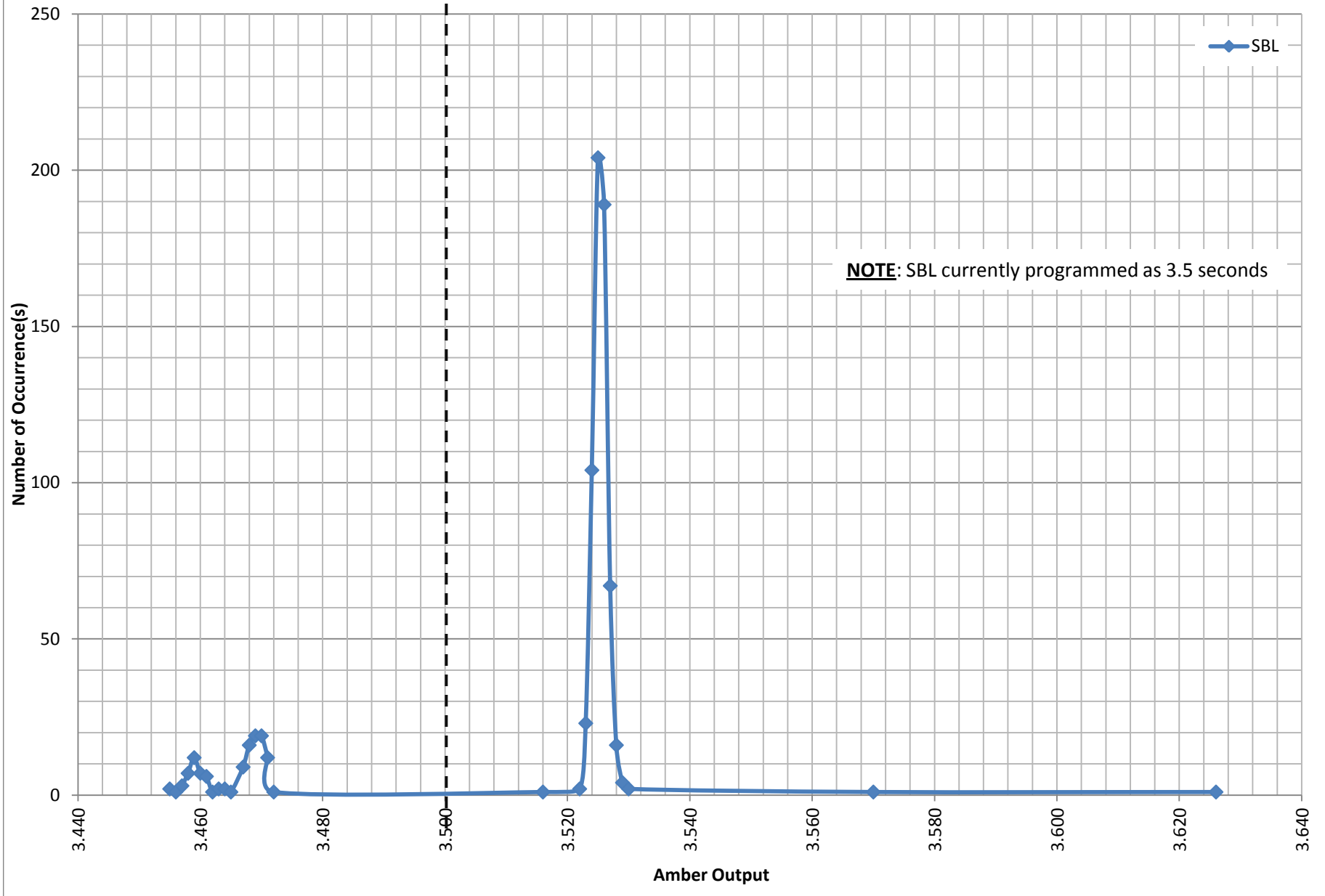
Howe Avenue at Folsom Boulevard - Southbound Left-Turn (7/11/12)



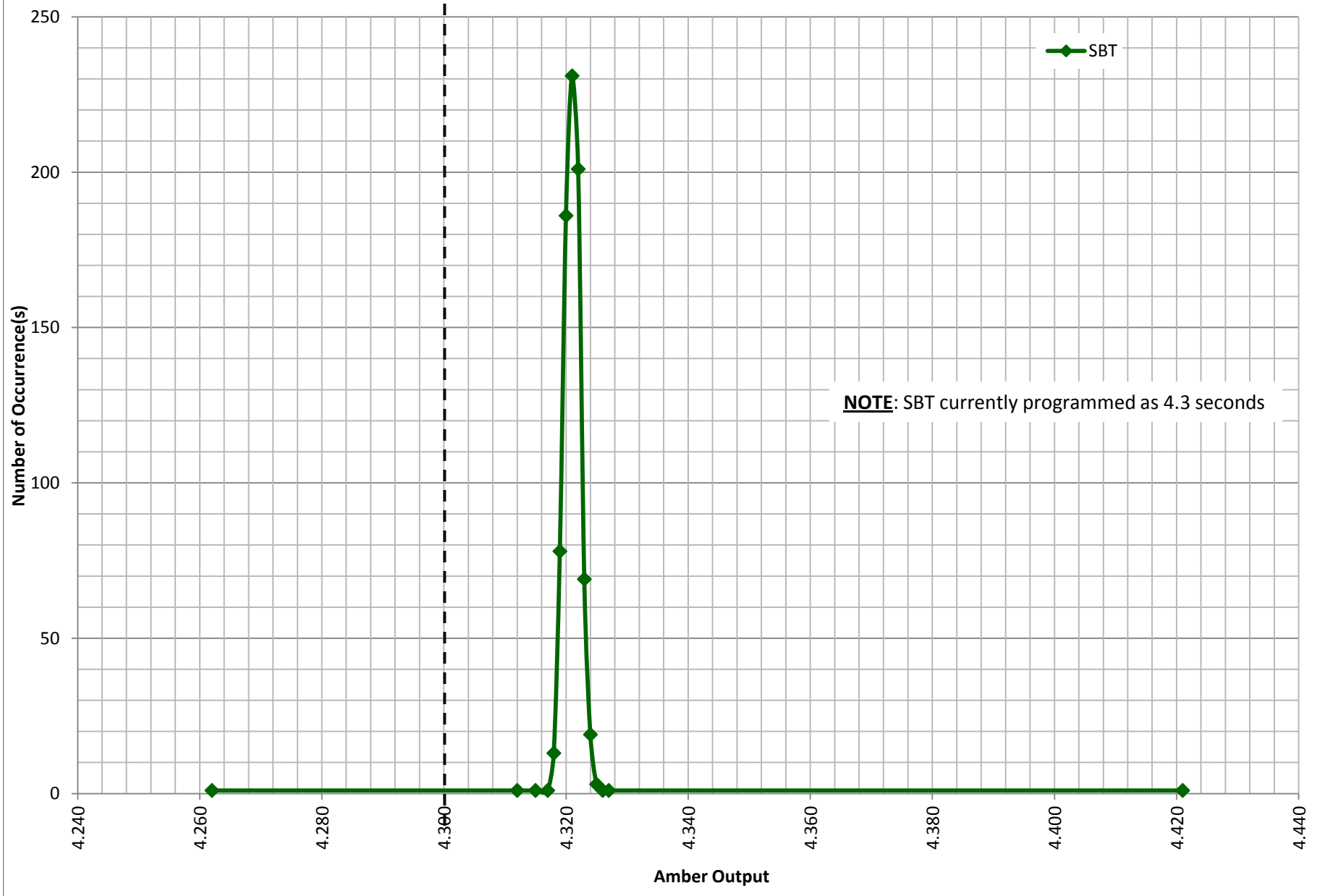
Howe Avenue at Folsom Boulevard - Southbound Thru (7/11/12)



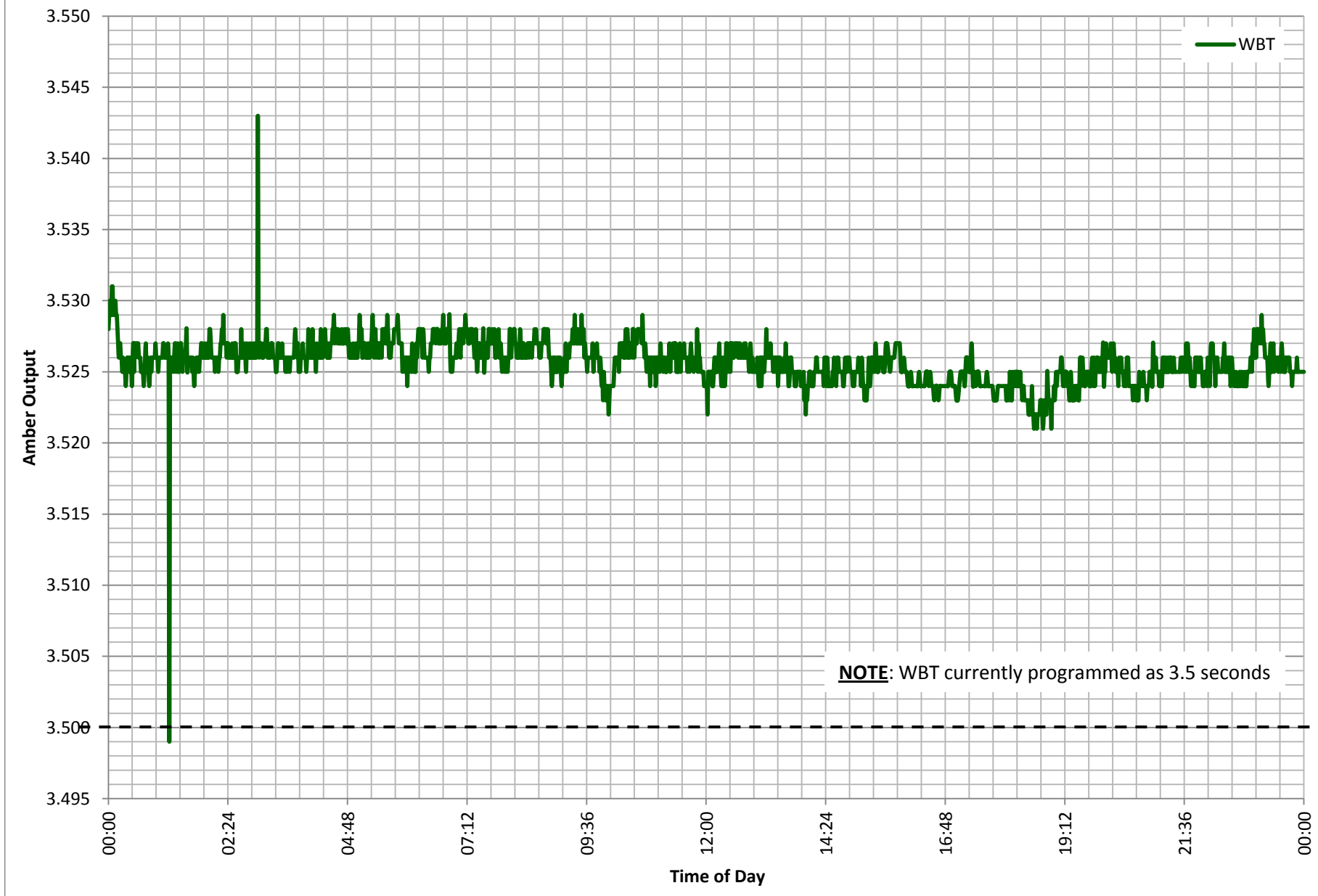
Howe Avenue at Folsom Boulevard - Southbound Left-Turn (7/11/12)



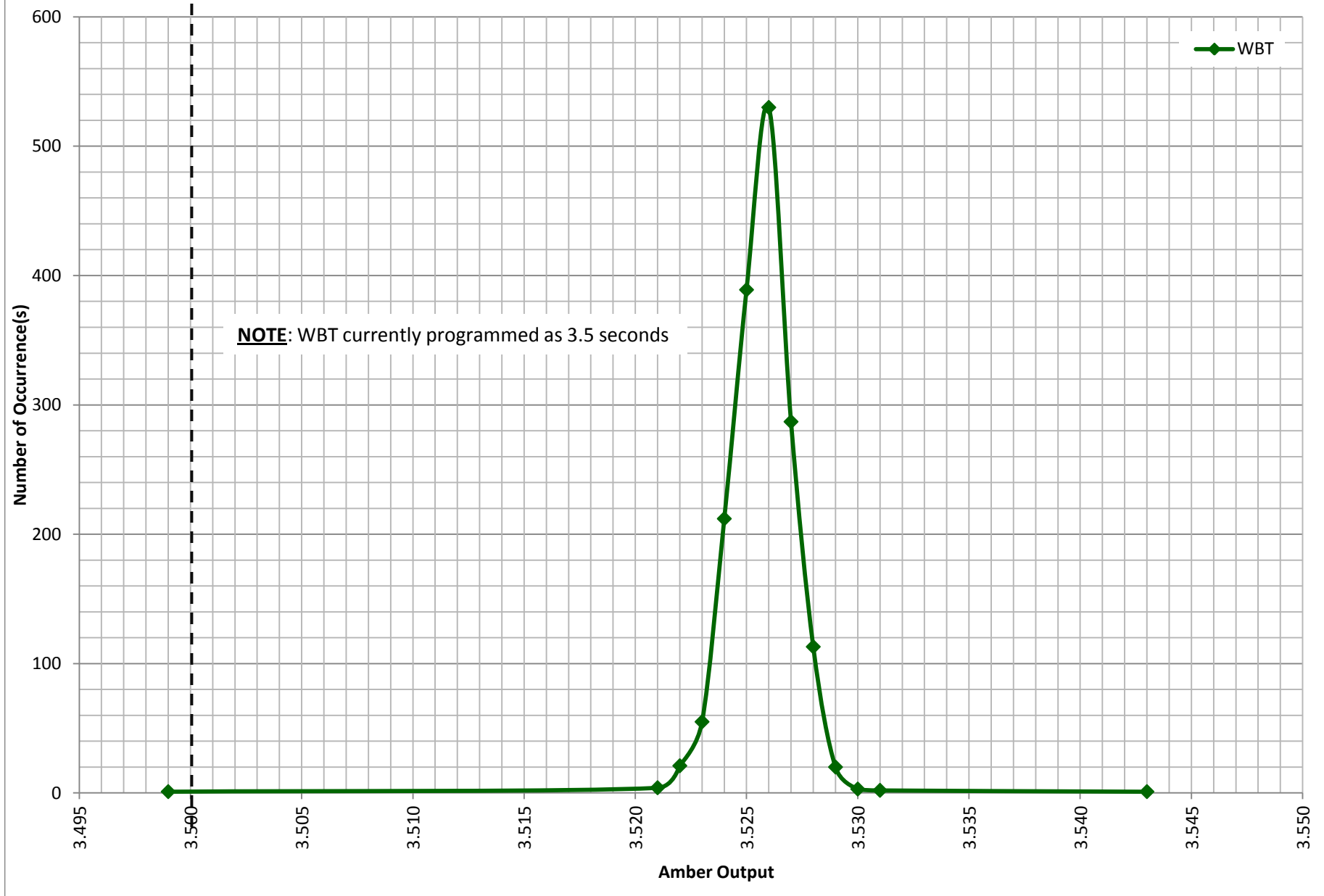
Howe Avenue at Folsom Boulevard - Southbound Thru (7/11/12)



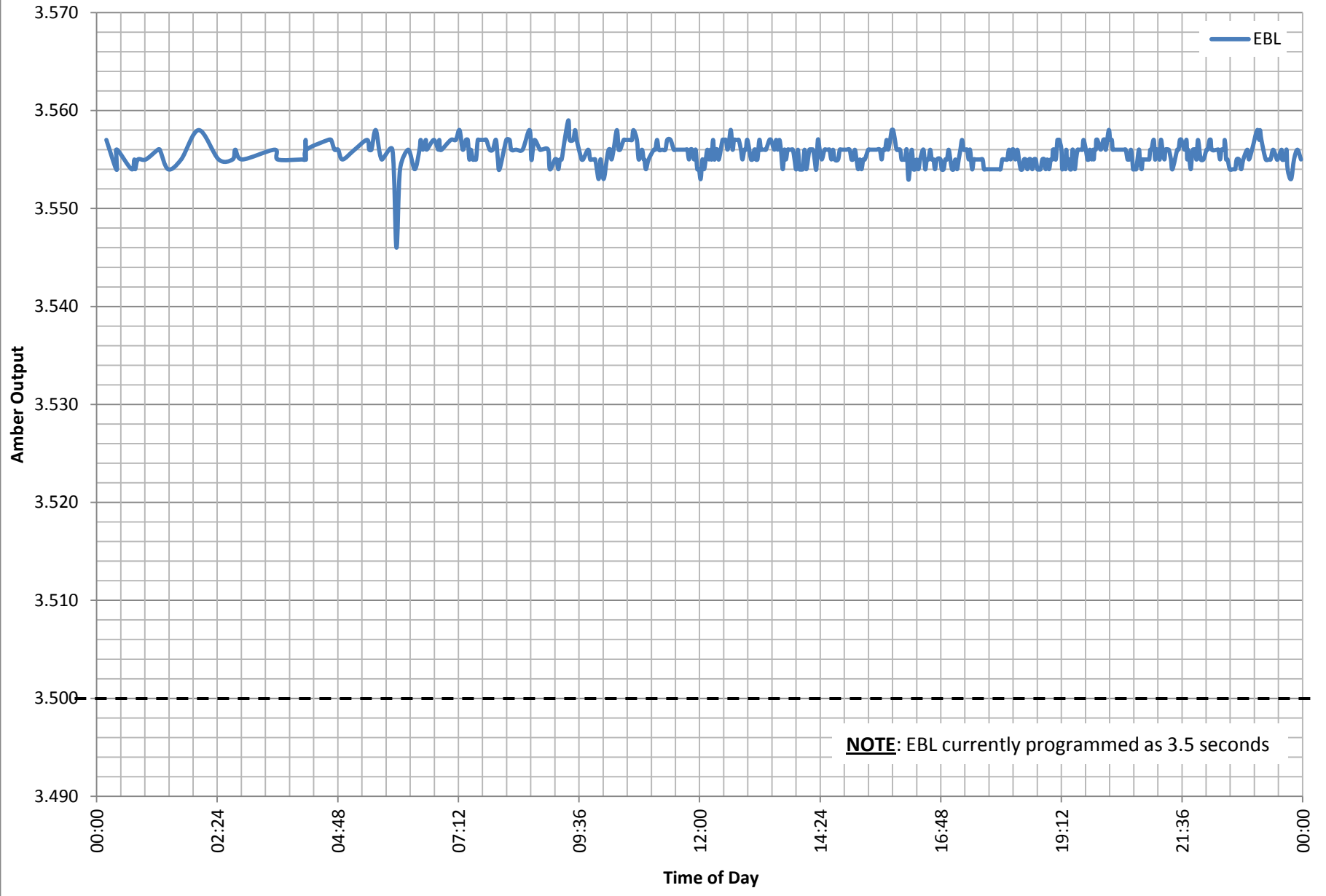
I Street to 5th Street - Westbound Thru (7/11/12)



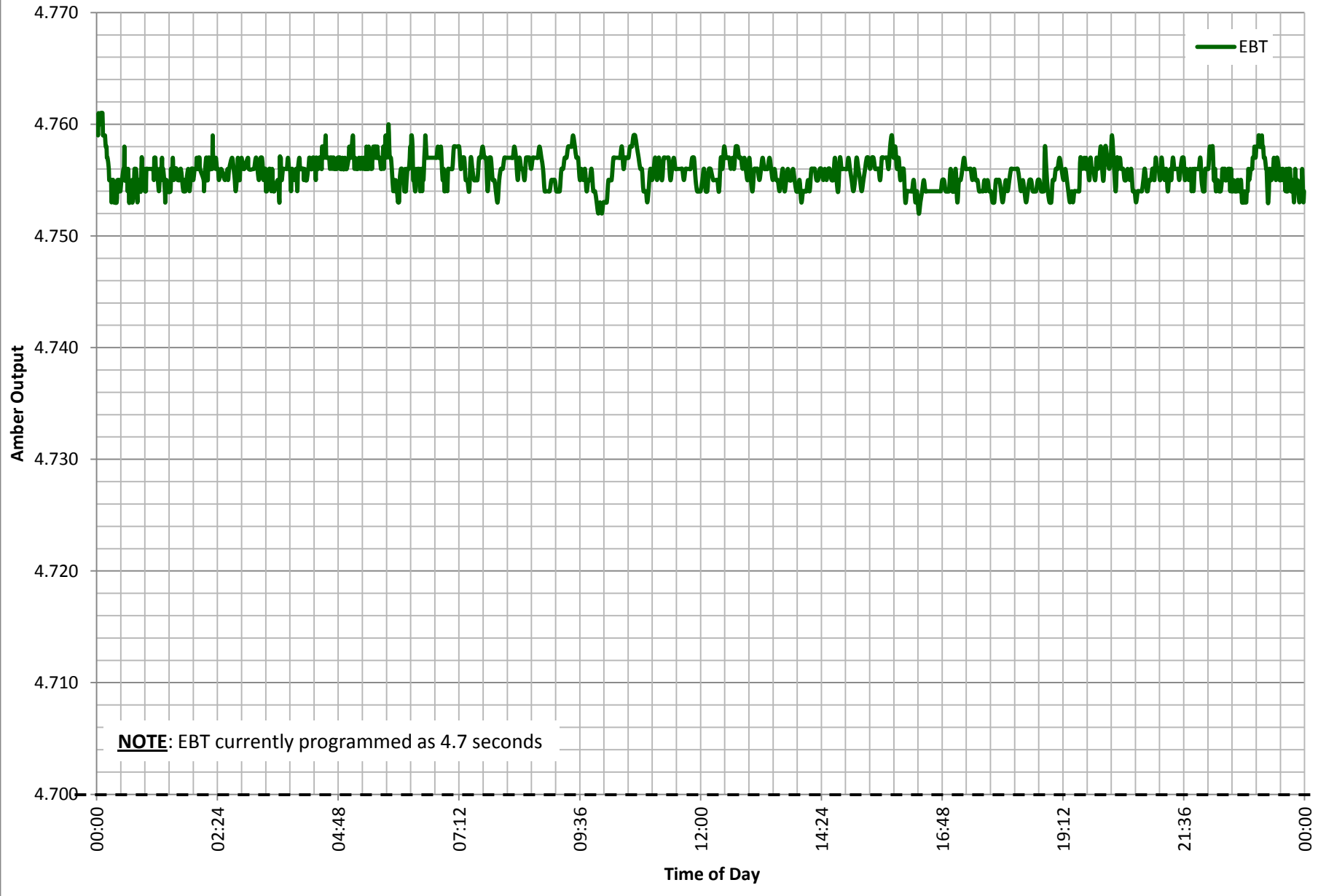
I Street to 5th Street - Westbound Thru (7/11/12)



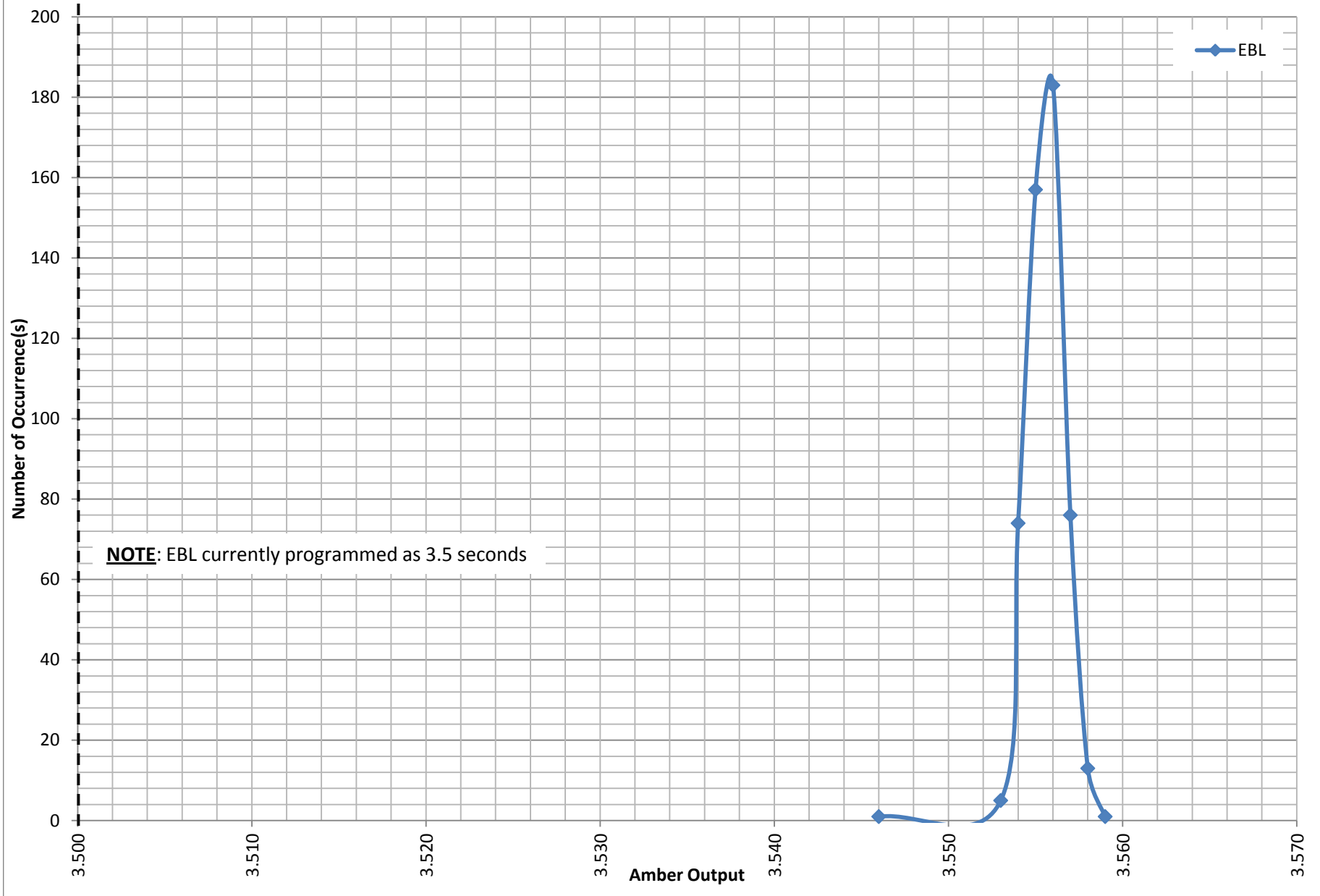
Mack Road at Center Parkway - Eastbound Left-Turn (7/11/12)



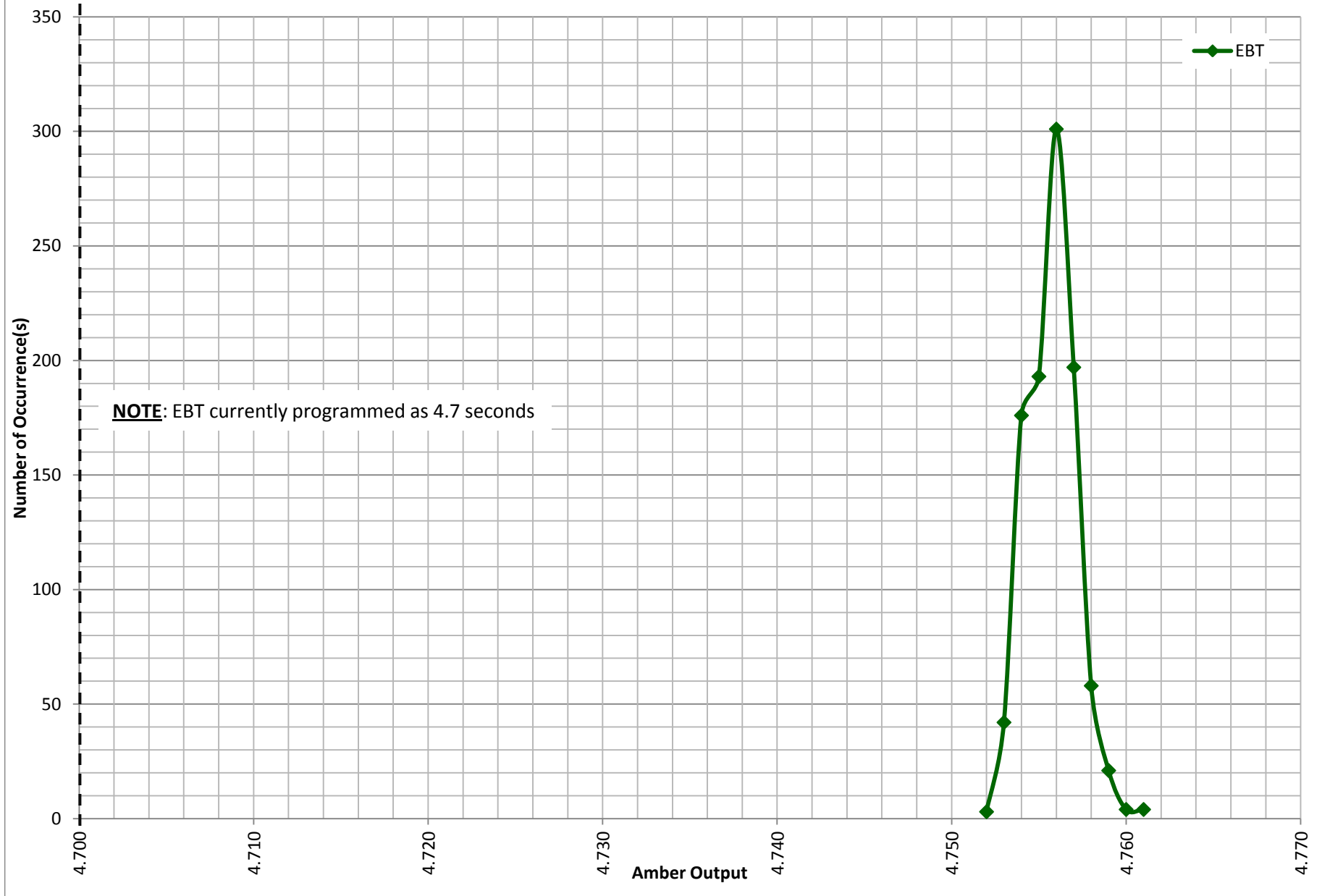
Mack Road at Center Parkway - Eastbound Thru (7/11/12)



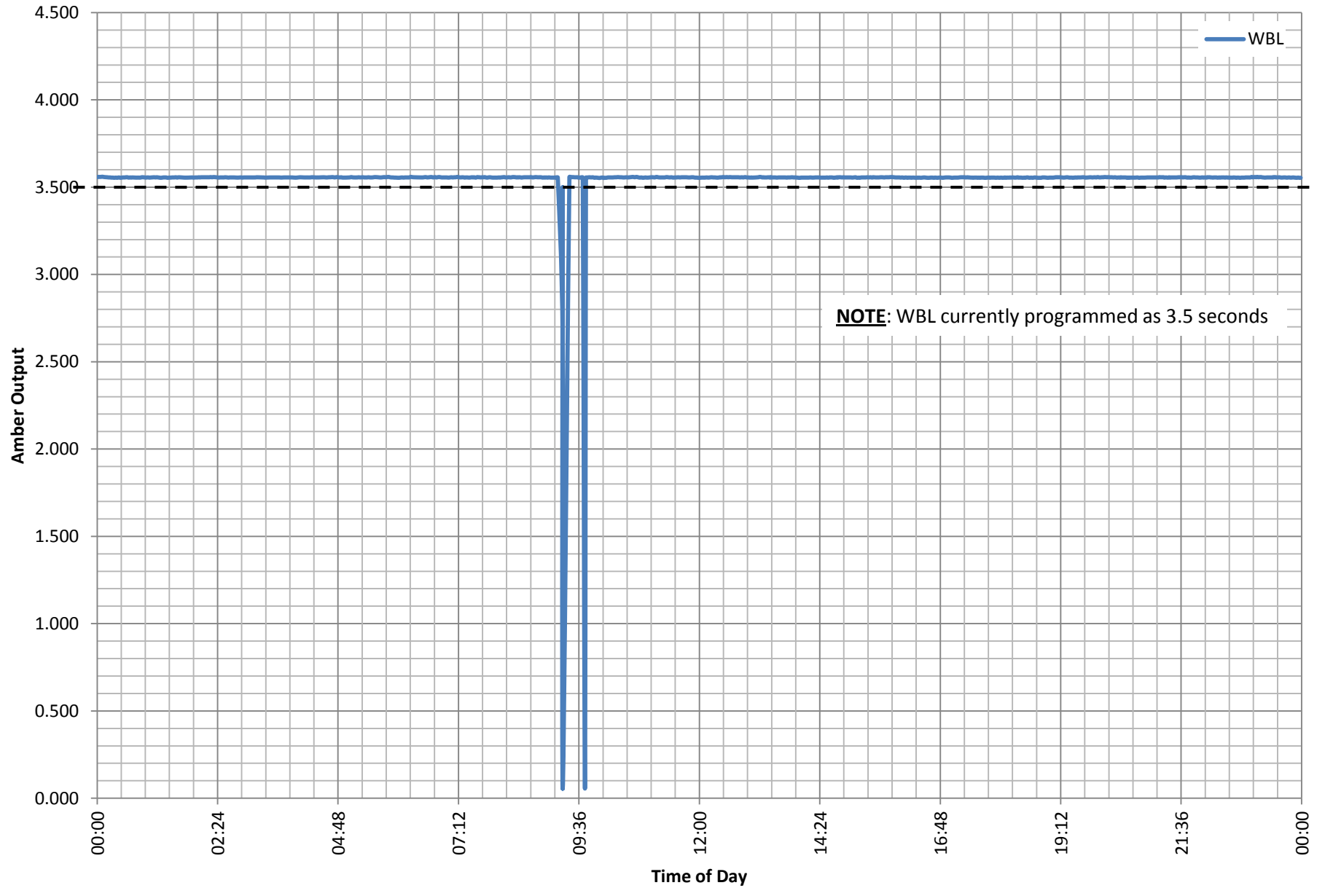
Mack Road at Center Parkway - Eastbound Left-Turn (7/11/12)



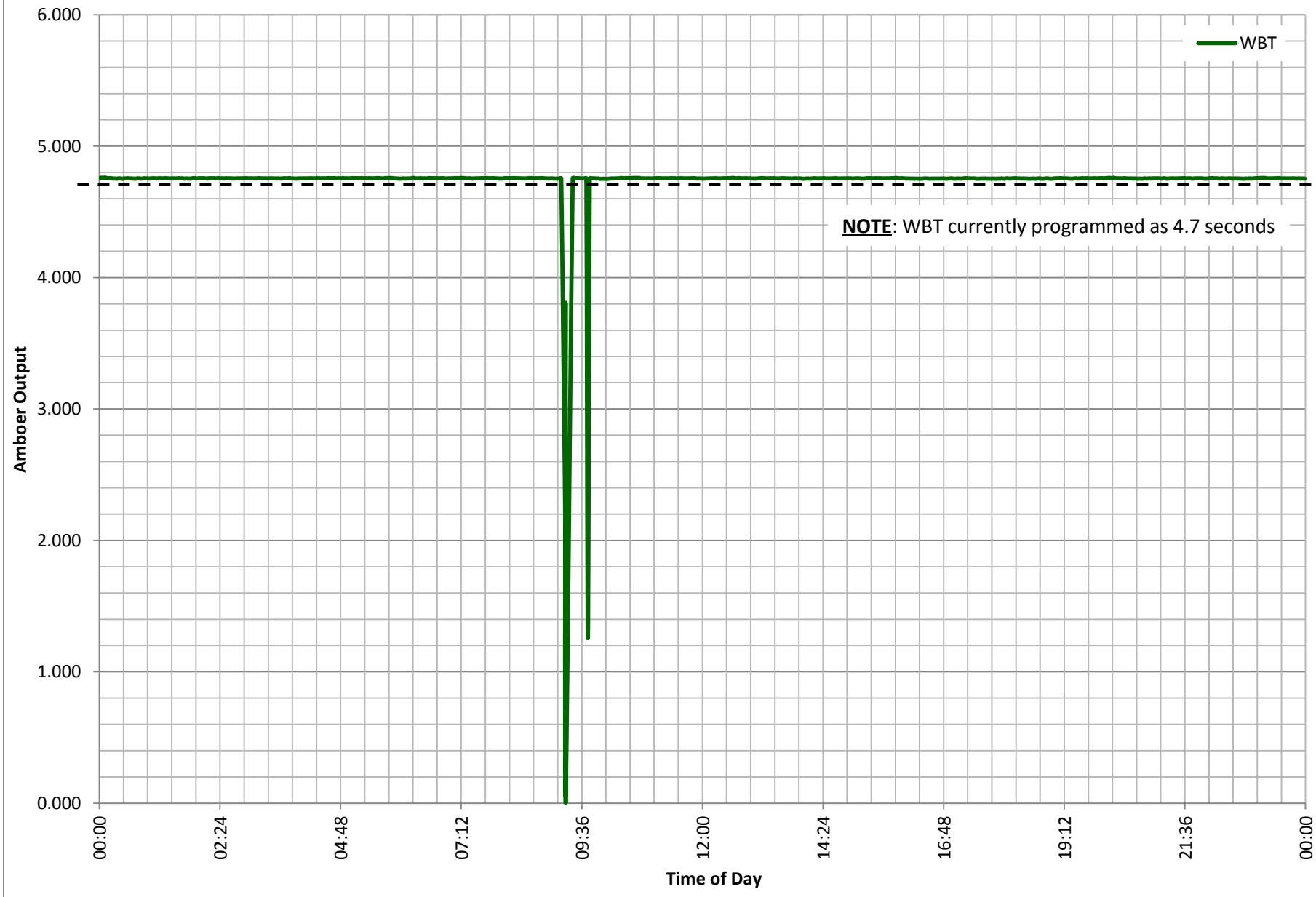
Mack Road at Center Parkway - Eastbound Thru (7/11/12)



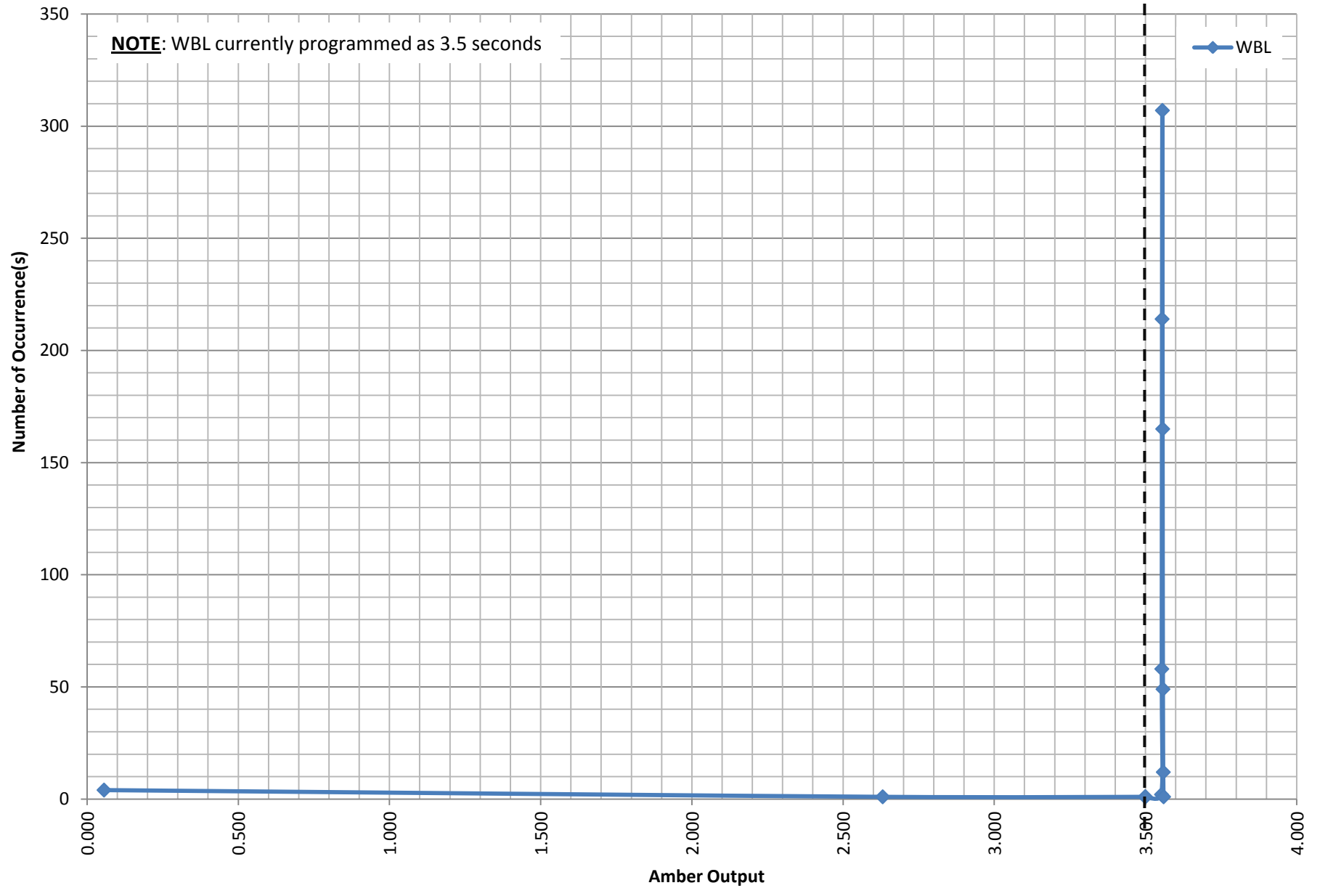
Mack Road at Valley High Drive - Westbound Left-Turn (7/11/12)



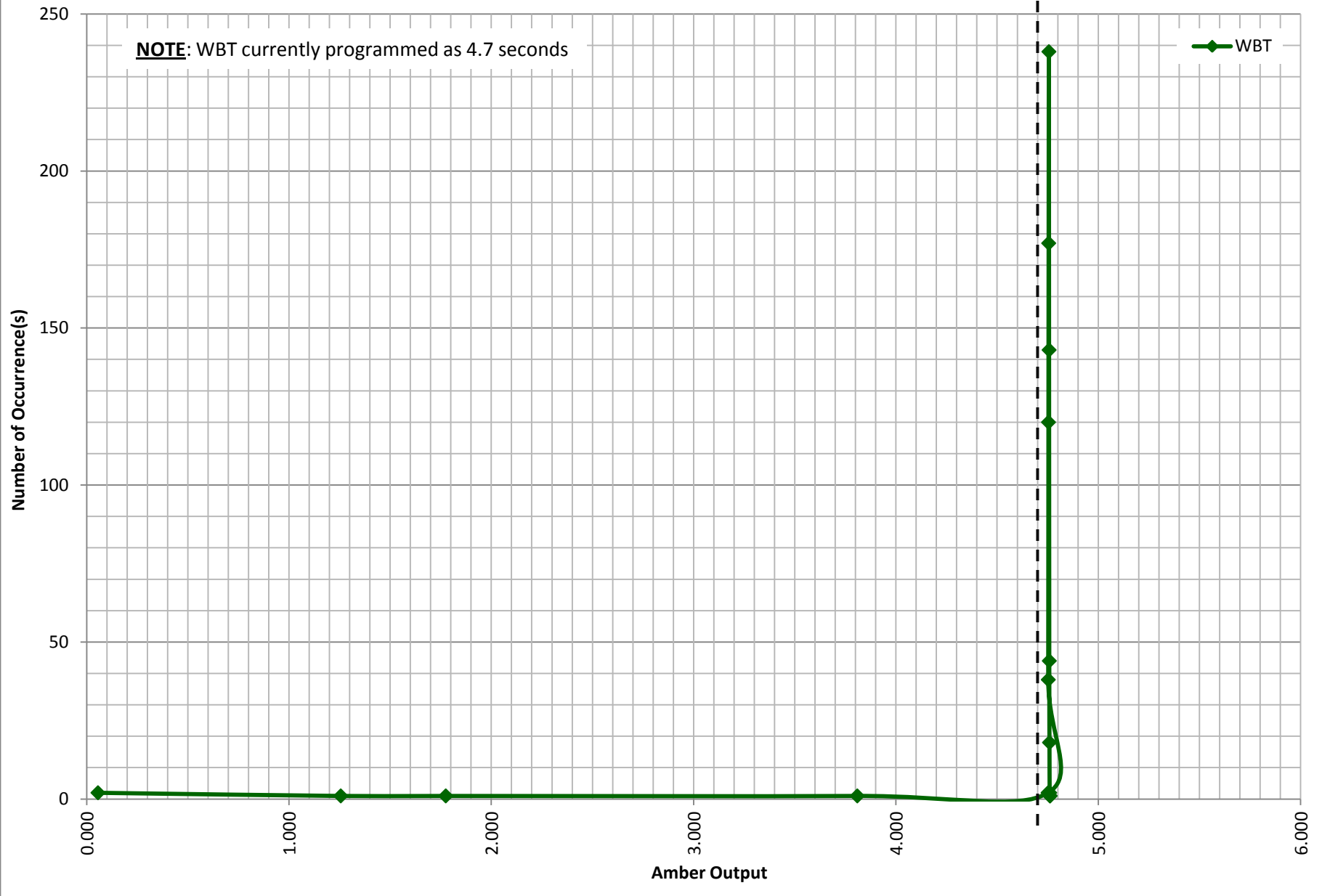
Mack Road at Valley High Drive - Westbound Thru (7/11/12)



Mack Road at Valley High Drive - Westbound Left-Turn (7/11/12)



Mack Road at Valley High Drive - Westbound Thru (7/11/12)



APPENDIX C: CLEARANCE INTERVAL REVIEW



COUNTY OF SACRAMENTO SHERIFF'S DEPARTMENT

Red Light Enforcement

YELLOW TIME COMPARISON

MAINTAINING AGENCY	ID		INTERSECTION		φ DIRECTION								SPEED LIMIT (mph)																							
	Location	Agency	N-S Street	E-W Street									POSTED								85TH PERCENTILE								90TH PERCENTILE							
					1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
County	1	58	Watt Avenue	Fair Oaks Boulevard	NL	ST	EL	WT	SL	NT	WL	ET	40	40	40	40	40	40	40	40	55	49	47	43	49	55	43	47	60	55	50	45	55	60	45	50
County	2	57	Watt Avenue	Arden Way	NL	ST	EL	WT	SL	NT	WL	ET	40	40	40	40	40	40	40	40	50	53	50	42	53	50	42	50	55	55	55	45	55	55	45	55
County	3	126	Howe Avenue	Hurley Way	NL	ST	ET	WT	SL	NT	-	-	40	40	35	35	40	40	-	-	45	45	-	-	45	45	-	-	50	50	-	-	50	50	-	-
County	4	123	Martin Luther King Boulevard	47th Avenue	EL	WT	NL	ST	WL	ET	SL	NT	40	40	35	35	40	40	35	35	41	47	38	38	47	41	38	38	45	50	40	40	50	45	40	40
County	5	129	Madison Avenue	Sunrise Boulevard	NL	ST	EL	WT	SL	NT	WL	ET	45	40	45	50	40	45	50	45	51	43	45	46	43	51	46	45	55	50	50	50	50	55	50	50
County	6	196	Madison Avenue	Date Avenue	EL	WT	NT	ST	WL	ET	-	-	45	45	35	35	45	45	-	-	45	47	-	-	47	45	-	-	50	50	-	-	50	50	-	-
County	7	58	East Avenue	Florin Road	EL	WT	ST	NT	WL	ET	-	-	40	40	35	35	40	40	-	-	35	46	-	-	46	35	-	-	40	50	-	-	50	40	-	-
County	8	72	Franklin Boulevard	Florin Road	EL	WT	NL	ST	WL	ET	SL	NT	40	40	40	40	40	40	40	40	42	42	37	40	42	42	40	37	45	45	40	45	45	45	45	40
County	9	142	Manzanita Avenue	Cypress Avenue	NL	ST	ET	WT	SL	NT	-	-	40	40	35	35	40	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
County	10	98	Eastern Avenue	El Camino Avenue	EL	WT	NL	ST	WL	ET	SL	NT	40	40	40	40	40	40	40	40	42	46	43	43	46	42	43	43	45	50	45	45	50	45	45	45
County	11	199	Lindale Drive	Florin Road	EL	WT	ST	NT	WL	ET	-	-	40	40	25	25	40	40	-	-	49	50	-	-	50	49	-	-	55	55	-	-	55	55	-	-
County	12	395	Don Julio Drive	Elkhorn Boulevard	EL	WT	NL	ST	WL	ET	SL	NT	45	45	35	35	45	45	35	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
County	13	629	Hwy 99 NB Offramp	Calvine Road	-	WT	-	NT	-	ET	-	-	-	45	-	45	-	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
City	14	418	Center Parkway	Mack Road	WL	ET	SL	NT	EL	WT	NL	ST	-	45	-	40	-	45	-	35	-	46	-	41	46	38	-	-	-	-	-	-	-	-	-	
City	15	419	Valley High Drive / La Mancha Way	Mack Road	EL	WT	NL	ST	WL	ET	SL	NT	-	45	-	40	-	45	-	35	-	46	-	44	46	44	-	-	-	-	-	-	-	-	-	
City	16	79	21st Street	Broadway	EL	WT	-	ST	WL	ET	SL	NT	-	25	-	25	-	25	-	25	-	31	-	30	33	30	-	-	-	-	-	-	-	-	-	
City	17	116	Alhambra Street	J Street	EL	WT	SL	NT	-	ET	-	ST	-	30	-	30	-	30	-	30	-	29	-	31	-	34	-	31	-	-	-	-	-	-	-	
City	18	485	Evergreen Street	El Camino Avenue	EL	WT	NT	ST	ET	WL	-	PD	-	35	30	30	35	35	-	30	-	39	37	37	39	-	-	-	-	-	-	-	-	-	-	
City	19	281	Howe Avenue	Fair Oaks Boulevard	EL	WT	NL	ST	WL	ET	SL	NT	-	45	40	40	-	45	-	40	-	47	-	44	48	44	-	-	-	-	-	-	-	-	-	
City	20	324	Power Inn Road / Howe Avenue	Folsom Boulevard	EL	WT	SL	NT	WL	ET	NL	ST	-	45	-	45	-	45	-	45	-	49	-	49	49	43	-	-	-	-	-	-	-	-	-	-
City	21	152	5th Street	I Street	-	NT	-	WT	SR	NL	-	-	-	30	-	25	25	30	-	-	-	35	-	27	35	-	-	-	-	-	-	-	-	-	-	
City	22	255	Challenge Way	Arden Way	WT	EL	-	-	WL	ET	ST	NT	40	-	-	-	-	40	25	30	44	-	-	-	44	35	-	-	-	-	-	-	-	-	-	
City	23	305	16th Street	W Street	-	WT	RP	NT	-	-	-	-	-	35	35	30	-	-	-	-	-	37	-	36	-	-	-	-	-	-	-	-	-	-	-	

NOTES/ LEGEND:

N Northbound phase S Southbound phase E Eastbound phase W Westbound phase
T Thru Movement L Left turn R Right turn PD Pedestrian phase

EX: Existing Value - Source: Timing Sheet uploaded from TMC or directly taken from the field (controller)
CA: Proposed Value based on the latest California MUTCD (2012)
ST: Standard Value per agency standards (below)

* ST Value used:
- All left-turn phases (City & County Locations) = 3.5 seconds
- All thru phases (City Locations) = Modified CA MUTCD table using 85th percentile speeds, rounded up to the nearest 5 mph
- All phases (County Locations) = Modified CA MUTCD table using 90th percentile speeds, rounded to the nearest 5 mph



COUNTY OF SACRAMENTO SHERIFF'S DEPARTMENT

Red Light Enforcement

YELLOW TIME COMPARISON

MAINTAINING AGENCY	ID		INTERSECTION		φ DIRECTION								SPEED LIMIT (mph) FOR YELLOW CALCULATIONS								YELLOW TIMES*																							
	Location	Agency	N-S Street	E-W Street																	1			2			3			4			5			6			7			8		
					1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	EX	CA	ST	EX	CA	ST	EX	CA	ST	EX	CA	ST	EX	CA	ST	EX	CA	ST	EX	CA	ST	EX	CA	ST
County	1	58	Watt Avenue	Fair Oaks Boulevard	NL	ST	EL	WT	SL	NT	WL	ET	60	55	50	45	55	60	45	50	3.5	3.0	3.5	5.0	4.7	5.0	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	5.1	5.0	5.1	3.5	3.0	3.5	4.8	4.7	4.8
County	2	57	Watt Avenue	Arden Way	NL	ST	EL	WT	SL	NT	WL	ET	55	55	55	45	55	55	45	55	3.5	3.0	3.5	5.0	5.0	5.0	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	5.0	4.7	5.0	3.5	3.0	3.5	4.8	4.7	5.0
County	3	126	Howe Avenue	Hurley Way	NL	ST	EL	WT	SL	NT	-	-	50	50	35	35	50	50	-	-	3.5	3.0	3.5	4.6	4.3	4.8	3.5	3.6	3.9	3.5	3.6	3.9	3.5	3.0	3.5	4.6	4.3	4.8	-	-	-	-	-	-
County	4	123	Martin Luther King Boulevard	47th Avenue	EL	WT	NL	ST	WL	ET	SL	NT	45	50	40	40	50	45	40	40	3.5	3.0	3.5	4.8	4.7	4.8	3.5	3.0	3.5	4.3	3.9	4.3	3.5	3.0	3.5	5.0	4.3	4.6	3.5	3.0	3.5	4.3	3.9	4.3
County	5	129	Madison Avenue	Sunrise Boulevard	NL	ST	EL	WT	SL	NT	WL	ET	55	50	50	50	50	55	50	50	3.5	3.0	3.5	4.8	4.3	4.8	3.5	3.0	3.5	4.8	4.7	4.8	3.5	3.0	3.5	5.0	5.0	5.0	3.5	3.0	3.5	4.8	4.3	4.8
County	6	196	Madison Avenue	Date Avenue	EL	WT	NT	ST	WL	ET	-	-	50	50	35	35	50	50	-	-	3.5	3.0	3.5	4.8	4.7	4.8	3.5	3.6	3.9	3.5	3.6	3.9	3.5	3.0	3.5	4.8	4.3	4.8	-	-	-	-	-	-
County	7	58	East Avenue	Florin Road	EL	WT	ST	NT	WL	ET	-	-	40	50	35	35	50	40	-	-	3.5	3.0	3.5	4.8	4.7	4.8	3.5	3.6	3.9	3.5	3.6	3.9	3.5	3.0	3.5	4.3	3.6	4.3	-	-	-	-	-	-
County	8	72	Franklin Boulevard	Florin Road	EL	WT	NL	ST	WL	ET	SL	NT	45	45	40	45	45	45	45	40	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	4.6	3.9	4.6	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	4.3	3.9	4.3
County	9	142	Manzanita Avenue	Cypress Avenue	NL	ST	EL	WT	SL	NT	-	-	40	40	35	35	40	40	-	-	3.5	3.0	3.5	4.8	3.9	4.3	3.5	3.6	3.9	3.5	3.6	3.9	3.5	3.0	3.5	4.8	3.9	4.3	-	-	-	-	-	-
County	10	98	Eastern Avenue	El Camino Avenue	EL	WT	NL	ST	WL	ET	SL	NT	45	50	45	45	50	45	45	45	3.5	3.0	3.5	4.8	4.7	4.8	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	4.6	4.3	4.6	3.5	3.0	3.5	4.6	4.3	4.6
County	11	199	Lindale Drive	Florin Road	EL	WT	ST	NT	WL	ET	-	-	55	55	25	25	55	55	-	-	3.5	3.0	3.5	4.6	4.7	5.0	3.5	3.0	3.9	3.5	3.0	3.9	3.5	3.0	3.5	4.8	4.7	5.0	-	-	-	-	-	-
County	12	395	Don Julio Drive	Elkhorn Boulevard	EL	WT	NL	ST	WL	ET	SL	NT	45	45	35	35	45	45	35	35	3.5	3.0	3.5	4.8	4.3	4.6	3.5	3.0	3.5	4.8	3.6	3.9	3.5	3.0	3.5	4.8	4.3	4.6	3.5	3.0	3.5	4.8	3.6	3.9
County	13	629	Hwy 99 NB Offramp	Calvine Road	-	WT	-	NT	-	ET	-	-	-	45	-	45	-	45	-	-	-	-	-	4.7	4.3	4.6	-	-	-	4.7	4.3	4.6	-	-	-	4.7	4.3	4.6	-	-	-	-	-	-
City	14	418	Center Parkway	Mack Road	WL	ET	SL	NT	EL	WT	NL	ST	-	50	-	45	-	50	-	40	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	3.5	4.3	4.3	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	3.5	3.9	3.9
City	15	419	Valley High Drive / La Mancha Way	Mack Road	EL	WT	NL	ST	WL	ET	SL	NT	-	50	-	45	-	50	-	45	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.3	4.3	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.3	4.3
City	16	79	21st Street	Broadway	EL	WT	-	ST	WL	ET	SL	NT	-	35	-	30	-	35	-	30	3.6	3.0	3.5	3.6	3.6	3.7	-	-	-	3.9	3.2	3.5	3.6	3.0	3.5	3.6	3.6	3.7	3.9	3.0	3.5	3.9	3.2	3.5
City	17	116	Alhambra Street	J Street	EL	WT	SL	NT	-	ET	-	ST	-	30	-	35	-	35	-	35	3.6	3.0	3.5	3.6	3.2	3.5	3.6	3.0	3.5	3.6	3.6	3.7	-	-	-	3.6	3.6	3.7	-	-	-	3.6	3.6	3.7
City	18	485	Evergreen Street	El Camino Avenue	EL	WT	NT	ST	ET	WL	-	PD	-	40	40	40	40	35	-	30	3.9	3.0	3.5	3.9	3.9	3.9	3.6	3.9	3.9	3.6	3.9	3.9	3.9	3.9	3.9	3.0	3.5	-	-	-	3.6	3.0	3.5	
City	19	281	Howe Avenue	Fair Oaks Boulevard	EL	WT	NL	ST	WL	ET	SL	NT	-	50	40	45	-	50	-	45	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.3	4.3	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.3	4.3
City	20	324	Power Inn Road / Howe Avenue	Folsom Boulevard	EL	WT	SL	NT	WL	ET	NL	ST	-	50	-	50	-	50	-	45	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.7	4.7	3.5	3.0	3.5	4.7	4.7	4.7	3.5	3.0	3.5	4.3	4.3	4.3
City	21	152	5th Street	I Street	-	NT	-	WT	SR	NL	-	-	-	35	-	30	25	35	-	-	-	-	3.7	3.6	3.7	-	-	-	3.5	3.2	3.5	3.5	3.0	3.5	3.5	3.0	3.5	-	-	-	-	-	-	
City	22	255	Challenge Way	Arden Way	WT	EL	-	-	WL	ET	ST	NT	45	-	-	-	45	25	35	4.0	4.3	4.3	3.5	3.0	3.5	-	-	-	-	-	-	3.5	3.0	3.5	4.7	4.3	4.3	3.5	3.0	3.5	3.7	3.6	3.7	
City	23	305	16th Street	W Street	-	WT	RP	NT	-	-	-	-	-	40	35	40	-	-	-	-	-	-	3.9	3.9	3.9	3.5	3.6	3.7	3.9	3.9	3.9	-	-	-	-	-	-	-	-	-	-	-	-	

NOTES/ LEGEND:

N Northbound phase S Southbound phase E Eastbound phase W Westbound phase
 T Thru Movement L Left turn R Right turn PD Pedestrian phase

EX: Existing Value - Source: Timing Sheet uploaded from TMC or directly taken from the field (controller)
 CA: Proposed Value based on the latest California MUTCD (2012)
 ST: Standard Value per agency standards (below)

* ST Value used:
 - All left-turn phases (City & County Locations) = 3.5 seconds
 - All thru phases (City Locations) = Modified CA MUTCD table using 85th percentile speeds, rounded up to the nearest 5 mph
 - All phases (County Locations) = Modified CA MUTCD table using 90th percentile speeds, rounded to the nearest 5 mph

SPEED (mph)	YELLOW TIME (sec)		
	MUTCD	City	County
< 25	3.0	3.5	3.9
30	3.2	3.5	3.9
35	3.6	3.7	3.9
40	3.9	3.9	4.3
45	4.3	4.3	4.6
50	4.7	4.7	4.8
55	5.0	5.0	5.0
60	5.4	5.4	5.1
65	5.8	5.8	-

NOTE(S):

= Existing Yellow Time equals Standard Yellow Time per agency standards
 # = Calculated Yellow Time (per agency standard) is lower than existing
 # = Calculated Yellow time (per agency standard) is higher than existing
 # = Yellow Time per CA MUTCD standard is higher than existing
 # = Movement is equipped with Red Light Running Enforcement Camera

