

**TRAFFIC SIGNAL ANALYSIS
ON WASHINGTON BOULEVARD
BETWEEN FIDELIA AVENUE AND I-5 FREEWAY**

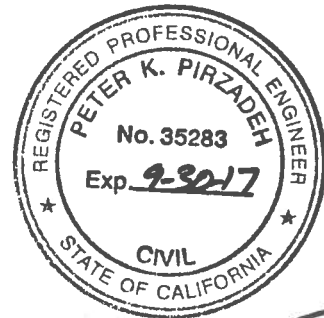
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A handwritten signature in black ink, appearing to read "Peter K. Pirzadeh", written over the bottom right of the seal.

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EXECUTIVE SUMMARY

This Traffic Signal Analysis is prepared in response to request from Staff to evaluate the potential impacts of a new traffic signal on Washington Boulevard between Fidelia Avenue and the I-5 (Santa Ana Freeway) Southbound On/Off-Ramps in the City of Commerce. This analysis will include discussions on the traffic signal warrants, intersection delay, queue lengths, and additional improvements at the intersection. The results of this analysis will demonstrate that the new traffic signal will not significantly impact the traffic operation and vehicular flow on Washington Boulevard during the AM and PM peak hours.

INTRODUCTION

The new traffic signal is proposed to be located on Washington Boulevard approximately 690 feet east of Fidelia Avenue and approximately 515 feet west of the I-5 (Santa Ana Freeway) Southbound On/Off-Ramps. It will provide signal control and full access for Commerce Square and the Celluphone building (6119 Washington Boulevard) to the north and Arco gas station to the south (see Attachment 1).

EXISTING CONDITIONS

The westerly driveway for Commerce Square (Driveway 1) is a full access driveway, the shared driveway for Commerce Square and the Celluphone building (Driveway 2) is a full access driveway, the Arco gas station driveway (Driveway 3) is a full access driveway, and the driveway for the Celluphone building (Driveway 4) is a right-turn in/out and left-turn in restricted access driveway. Washington Boulevard is currently under construction from Indiana Street to the I-5 Santa Ana Freeway to provide three through lanes for the eastbound and westbound directions. Construction started in January 2015 and it is anticipated to be complete in early 2017.

PROJECT IMPACT EVALUATION

As part of the Washington Boulevard improvements, Driveway 3 will be relocated to the west to align with Driveway 2. The project will also construct a raised center median with Driveway 1 becoming a right-turn in/out restricted driveway, Driveway 2 becoming a right-turn in/out and left-turn in restricted driveway, Driveway 3 becoming a right-turn in/out and left-turn in restricted driveway, and Driveway 4 becoming a right-turn in/out restricted driveway. The new traffic signal is proposed to be implemented after the completion of the street improvements and will provide full access to Driveway 2/Driveway 3. Without the new traffic signal, all outbound left-turn traffic will have to instead turn right onto Washington Boulevard then make an U-turn at the Fidelia signal. The additional U-turn traffic will negatively impact the operation of the Fidelia signal because U-turn traffic require additional time to complete the movement compared to left-turn traffic. The new traffic signal will also provide control and improve traffic safety at Driveway 2/Driveway 3 for the uncontrolled left-turn movements crossing 3 lanes of traffic. The left-turn movements will be served by a 90-foot eastbound lane with a 90-foot transition and a 55-foot westbound lane with a 90-foot two-way left-turn lane.

A. Traffic Counts

In order to determine the traffic volumes on Washington Boulevard between Fidelia Avenue and the I-5 Freeway, vehicle turning movement counts at the driveways and arterial machine counts were conducted on Tuesday, October 14, 2014 and on Wednesday, October 15, 2014 for 48 hours. Additional vehicle turning movement counts were conducted for the Fidelia Avenue and Washington Boulevard intersection on Tuesday, December 23, 2014 from 7 AM to 9 AM and from 3PM to 6 PM, including a westbound left-turn lane queuing study. A copy of the counts data is included in Appendix A. The arterial machine counts show that the AM peak hour is at 7 AM and the PM peak hour is at 4 PM. It should be noted that these counts from 2014 are still valid as the area has been under construction and the ambient growth is expected to be low.

B. Traffic Signal Warrants

Using the traffic counts for Washington Boulevard, traffic signal warrants have been prepared for the Driveway 2/Driveway 3 and Washington Boulevard intersection to determine if a traffic signal is warranted. The warrants are based on worksheets contained in the California Manual on Uniform Traffic Control Devices 2014 Edition Revision 1 and a copy is included in Attachment 2. As discussed previously, Driveway 1 and Driveway 4 will become right-turn in/out restricted access drives after the construction on Washington Boulevard is complete. Therefore, the left-turn inbound and outbound volumes at these two driveways are added to the corresponding left-turn movements at Driveway 2. The worksheets show that the traffic volumes at this intersection satisfies Warrant 1, Warrant 2, and Warrant 3. Therefore, the new traffic signal is justified.

C. Intersection Delay and Queue

To quantify the delay that motorists will experience at this new traffic signal, a model of this intersection has been prepared using Synchro 8 for the AM peak hour and the PM peak hour. Consistent with what was done for the traffic signal warrants, the left-turn inbound and outbound volumes at Driveway 1 and Driveway 2 are added to the corresponding left-turn movements at Driveway 2. A copy of the reports are included in Attachment 3. As shown in the reports, during the AM peak hour the northbound direction experiences 10 seconds of delay, the eastbound direction experiences 7 seconds of delay, the southbound direction experiences 0.2 seconds of delay, and the westbound direction experiences 6 seconds of delay. Overall this intersection experiences 6.5 seconds of delay, which equates to Level of Service A. During the PM peak hour, the northbound direction experience 10.5 seconds of delay, the eastbound direction experiences 5.9 seconds of delay, the southbound direction experiences 6.3 seconds of delay, and the westbound direction experiences 4 seconds of delay. Overall this intersection experiences 5.3 seconds of delay, which equates to Level of Service A. With the implementation of the proposed signal, the delay experienced by the eastbound and westbound movements on Washington Boulevard will increase. However, as discussed above and shown in Attachment 3, even with the additional delay the proposed signal is still projected to operate at Level of Service A during the AM and PM peak hours. In addition by providing a left-turn out access, the number of vehicles making an U-turn at the intersection of Fidelia Avenue and Washington Boulevard will decrease.

Also shown in the reports, during the AM peak hour the 95th percentile queue for the eastbound through direction is 80 feet with 32 feet for the eastbound left-turn direction and the westbound through direction is 127 feet with 79 feet for the westbound left-turn direction. The 90-foot eastbound left-turn lane with a 90-foot transition and the 55-foot westbound left-turn lane with a 90-foot two-way left-turn lane can accommodate the projected queue lengths. During the PM peak hour the 95th percentile queue for the eastbound through direction is 170 feet with 25 feet for the eastbound left-turn direction and the westbound through direction is 85 feet with 37 feet for the westbound left-turn direction. Again, the eastbound and westbound left-turn lanes can accommodate the projected queue lengths. The distance from the eastbound limit line of the new traffic signal to the crosswalk of the Fidelia signal is approximately 640 feet. The 170 feet of eastbound through movement queue during the PM peak hour will not impact the operation of the Fidelia signal. The distance from the westbound limit line of the new traffic signal to the crosswalk of the signal at the I-5 SB On/Off-Ramps is approximately 460 feet. The 127 feet of westbound through movement queue during the AM peak hour will not impact the operation of the ramp signal.

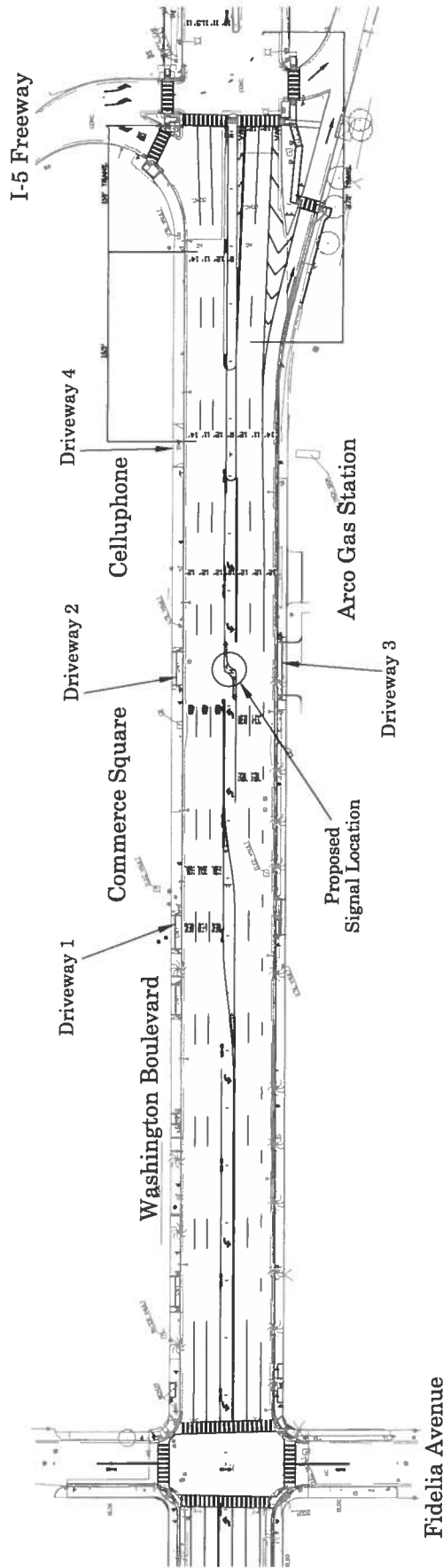
ADDITIONAL IMPROVEMENTS

The other goal of the Washington Boulevard improvements is to enhance the beautification of this arterial through the implementation of landscaping along the curb and in the raised center medians. The raised center median between the westbound left-turn lane at Fidelia and the eastbound left-turn lane at Driveway 2 will be landscaped, the median between the eastbound left-turn lane and the westbound left-turn lane at Driveway 2 will not be landscaped, and the median between the westbound left-turn lane at Driveway 2 and Caltrans Right-of-Way will be landscaped. The new traffic signal at Driveway 2/Driveway 3 and Washington Boulevard will remove the raised center median but this median will not be landscaped. In addition, with the implementation of the signal, the westbound left-turn lane can be modified to a 100-foot lane with a 45-foot transition. The 45 feet of transition will increase the raised center median area on Washington Boulevard and allow the installation of additional groundcover and up to 3 palm trees. Therefore, the new traffic signal will have the added benefit of increasing the raised center median landscaping which is consistent with the street beautification goal.

CONCLUSIONS

As documented above, multiple traffic counts have been conducted at the driveways and the Washington Boulevard arterial. Using the data from these counts, traffic signal warrants were conducted based on California Manual on Uniform Traffic Control Devices 2014 Edition Revision 1 requirements. The warrants show that the Driveway 2/Driveway 3 and Washington Boulevard intersection satisfies Warrant 1, Warrant 2, and Warrant 3. Therefore, the installation of a new traffic signal at this intersection is warranted. Also using these counts, a model of this intersection was created with Synchro 8. The results of this model show that in the AM peak hour, the eastbound movement experiences 7 seconds of delay while the westbound movement experiences 6 seconds of delay. In the PM peak hour, the eastbound movement experiences 5.9 seconds of delay while the westbound movement experiences 4 seconds of delay. In the absence of the new traffic signal, as stated in previous sections, delays at the Fidelia signal will increase due to additional westbound U-turn vehicles. The model also shows that the 95th percentile queue during the AM peak hour for the eastbound through movement is 80 feet with 32 feet for the left-turn and the westbound

through movement is 127 feet with 79 feet for the left-turn. During the PM peak hour, the queue for the eastbound through movement is 170 feet with 25 feet for the left-turn and the westbound through movement is 85 feet with 37 feet for the left-turn. The eastbound and westbound left-turn lanes at the new traffic signal will accommodate the 95th percentile queue lengths and will not impact the operation of the Fidelia signal and the ramp signal. Finally, the new traffic signal will eliminate the non-landscaped raised center median in front of Driveway 2 and Driveway 3. However, the westbound left-turn lane can be modified with the implementation of the new traffic signal to provide a 100-foot lane with a 45-foot transition. The transition will increase the amount of raised center median on Washington Boulevard and will allow the installation of additional groundcover and up to 3 palm trees. Therefore, the new traffic signal is warranted, will not significantly impact the operation of Washington Boulevard, will increase the safety of the left-turn movements across three lanes by providing signal control, and will provide an opportunity to enhance the beautification of this arterial in the City of Commerce.



1/9/17 Source: Washington Boulevard Reconstruction Plans

Proposed Traffic Signal Location
 Driveway 2/Driveway 3 and Washington Boulevard
 City of Commerce, CA



Attachment 2

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 1 of 5)

COUNT DATE 10/15/14
 CALC PH DATE 10/26/16
 CHK _____ DATE _____

7 LA _____
 DIST CO RTE PM

Major St: Washington Blvd. Critical Approach Speed 40 mph
 Minor St: Driveway 2/Driveway 3 Critical Approach Speed _____ mph

Speed limit or critical speed on major street traffic > 40 mph..... ☐ or ☐ } RURAL (R)
 In built up area of isolated community of < 10,000 population..... ☐ }
☒ URBAN (U)

WARRANT 1 - Eight Hour Vehicular Volume SATISFIED YES ☒ NO ☐
 (Condition A or Condition B or combination of A and B must be satisfied)

Condition A - Minimum Vehicle Volume 100% SATISFIED YES ☐ NO ☒

APPROACH LANES	MINIMUM REQUIREMENTS (80% SHOWN IN BRACKETS)				5:00 PM	1:30 PM	4:00 PM	2:30 PM	12:00 PM	11:00 AM	6:00 PM	6:00 AM	Hour
	U	R	U	R									
Both Approaches Major Street	1		2 or More		1768	2072	1983	2174	1794	1625	1564	1630	
Highest Approach Minor Street	150 (120)	105 (84)	200 (160)	140 (112)	182	149	134	134	128	117	115	107	

Condition B - Interruption of Continuous Traffic 100% SATISFIED YES ☒ NO ☐

APPROACH LANES	MINIMUM REQUIREMENTS (80% SHOWN IN BRACKETS)				5:00 PM	1:30 PM	4:00 PM	2:30 PM	12:00 PM	11:00 AM	6:00 PM	6:00 AM	Hour
	U	R	U	R									
Both Approaches Major Street	1		2 or More		1768	2072	1983	2174	1794	1625	1564	1630	
Highest Approach Minor Street	75 (60)	53 (42)	100 (80)	70 (56)	182	149	134	134	128	117	115	107	

Combination of Conditions A & B SATISFIED YES ☐ NO ☒

REQUIREMENT	CONDITION	✓	FULFILLED
TWO CONDITIONS SATISFIED 80%	A. MINIMUM VEHICULAR VOLUME	<input type="checkbox"/>	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
	AND, B. INTERRUPTION OF CONTINUOUS TRAFFIC	<input type="checkbox"/>	
AND, AN ADEQUATE TRIAL OF OTHER ALTERNATIVES THAT COULD CAUSE LESS DELAY AND INCONVENIENCE TO TRAFFIC HAS FAILED TO SOLVE THE TRAFFIC PROBLEMS			Yes <input type="checkbox"/> No <input type="checkbox"/>

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 2 of 5)

WARRANT 2 - Four Hour Vehicular Volume

SATISFIED* YES ☒ NO ☐

Record hourly vehicular volumes for any four hours of an average day.

APPROACH LANES	One	2 or More	5 PM	1:00 PM	4 PM	5:00 PM	Hour
Both Approaches - Major Street		<input checked="" type="checkbox"/>	1768	2072	1983	2174	
Higher Approach - Minor Street	<input checked="" type="checkbox"/>		182	149	134	134	

*All plotted points fall above the applicable curve in Figure 4C-1. (URBAN AREAS)	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
<u>OR</u> , All plotted points fall above the applicable curve in Figure 4C-2. (RURAL AREAS)	Yes <input type="checkbox"/>	No <input type="checkbox"/>

**WARRANT 3 - Peak Hour
(Part A or Part B must be satisfied)**

SATISFIED YES ☒ NO ☐

PART A

SATISFIED YES ☐ NO ☐

(All parts 1, 2, and 3 below must be satisfied for the same one hour, for any four consecutive 15-minute periods)

1. The total delay experienced by traffic on one minor street approach (one direction only) controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach, or five vehicle-hours for a two-lane approach; <u>AND</u>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
2. The volume on the same minor street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; <u>AND</u>	Yes <input type="checkbox"/>	No <input type="checkbox"/>
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches.	Yes <input type="checkbox"/>	No <input type="checkbox"/>

PART B

SATISFIED YES ☒ NO ☐

APPROACH LANES	One	2 or More	5:00 PM	Hour
Both Approaches - Major Street		<input checked="" type="checkbox"/>	1768	
Higher Approach - Minor Street	<input checked="" type="checkbox"/>		182	

The plotted point falls above the applicable curve in Figure 4C-3. (URBAN AREAS)	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>
<u>OR</u> , The plotted point falls above the applicable curve in Figure 4C-4. (RURAL AREAS)	Yes <input type="checkbox"/>	No <input type="checkbox"/>

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 3 of 5)

WARRANT 4 - Pedestrian Volume
(Parts 1 and 2 Must Be Satisfied)

SATISFIED YES ☐ NO ☐

Part 1 (Parts A or B must be satisfied)
Hours -->

A	Vehicles per hour for any 4 hours				
	Pedestrians per hour for any 4 hours				

Figure 4C-5 or Figure 4C-6
SATISFIED YES ☐ NO ☐

B
Hours -->

Vehicles per hour for any 1 hour				
Pedestrians per hour for any 1 hour				

Figure 4C-7 or Figure 4C-8
SATISFIED YES ☐ NO ☐

Part 2

SATISFIED YES ☐ NO ☐

<u>AND</u> , The distance to the nearest traffic signal along the major street is greater than 300 ft	Yes <input type="checkbox"/> No <input type="checkbox"/>
<u>OR</u> , The proposed traffic signal will not restrict progressive traffic flow along the major street	Yes <input type="checkbox"/> No <input type="checkbox"/>

WARRANT 5 - School Crossing
(Parts A and B Must Be Satisfied)

SATISFIED YES ☐ NO ☐

Part A
Gap/Minutes and # of Children

SATISFIED YES ☐ NO ☐

Gaps vs Minutes	Minutes Children Using Crossing	Hour
	Number of Adequate Gaps	
School Age Pedestrians Crossing Street / hr		

Gaps < Minutes YES ☐ NO ☐

AND Children > 20/hr YES ☐ NO ☐

<u>AND</u> , Consideration has been given to less restrictive remedial measures.	Yes <input type="checkbox"/> No <input type="checkbox"/>
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Part B

SATISFIED YES ☐ NO ☐

The distance to the nearest traffic signal along the major street is greater than 300 ft	Yes <input type="checkbox"/> No <input type="checkbox"/>
<u>OR</u> , The proposed signal will not restrict the progressive movement of traffic.	Yes <input type="checkbox"/> No <input type="checkbox"/>

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 4 of 5)

WARRANT 6 - Coordinated Signal System
(All Parts Must Be Satisfied)

SATISFIED YES ☐ NO ☒

MINIMUM REQUIREMENTS	DISTANCE TO NEAREST SIGNAL	
≥ 1000 ft	N _____ ft, S _____ ft, E 690 ft, W 515 ft	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.		Yes <input type="checkbox"/> No <input type="checkbox"/>
OR, On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.		

WARRANT 7 - Crash Experience Warrant
(All Parts Must Be Satisfied)

SATISFIED YES ☐ NO ☐

Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency.		Yes <input type="checkbox"/> No <input type="checkbox"/>
REQUIREMENTS	Number of crashes reported within a 12 month period susceptible to correction by a traffic signal, and involving injury or damage exceeding the requirements for a reportable crash.	Yes <input type="checkbox"/> No <input type="checkbox"/>
5 OR MORE		
REQUIREMENTS	CONDITIONS	✓
ONE CONDITION SATISFIED 80%	Warrant 1, Condition A - Minimum Vehicular Volume	
	OR, Warrant 1, Condition B - Interruption of Continuous Traffic	Yes <input type="checkbox"/> No <input type="checkbox"/>
	OR, Warrant 4, Pedestrian Volume Condition Ped Vol ≥ 152 for any hour	
	OR, Ped Vol ≥ 80 for any 4 hours	

WARRANT 8 - Roadway Network
(All Parts Must Be Satisfied)

SATISFIED YES ☐ NO ☒

MINIMUM VOLUME REQUIREMENTS	ENTERING VOLUMES - ALL APPROACHES	✓	FULFILLED
1000 Veh/Hr	During Typical Weekday Peak Hour _____ Veh/Hr and has 5-year projected traffic volumes that meet one or more of Warrants 1, 2, and 3 during an average weekday.	✓	Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
	OR During Each of Any 5 Hrs. of a Sat. or Sun _____ Veh/Hr		
CHARACTERISTICS OF MAJOR ROUTES		MAJOR ROUTE A	MAJOR ROUTE B
Hwy. System Serving as Principal Network for Through Traffic		✓	
Rural or Suburban Highway Outside Of, Entering, or Traversing a City			
Appears as Major Route on an Official Plan		✓	
Any Major Route Characteristics Met, Both Streets			Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 5 of 5)

WARRANT 9 - Intersection Near a Grade Crossing
(Both Parts A and B Must Be Satisfied)

SATISFIED YES ☐ NO ☐

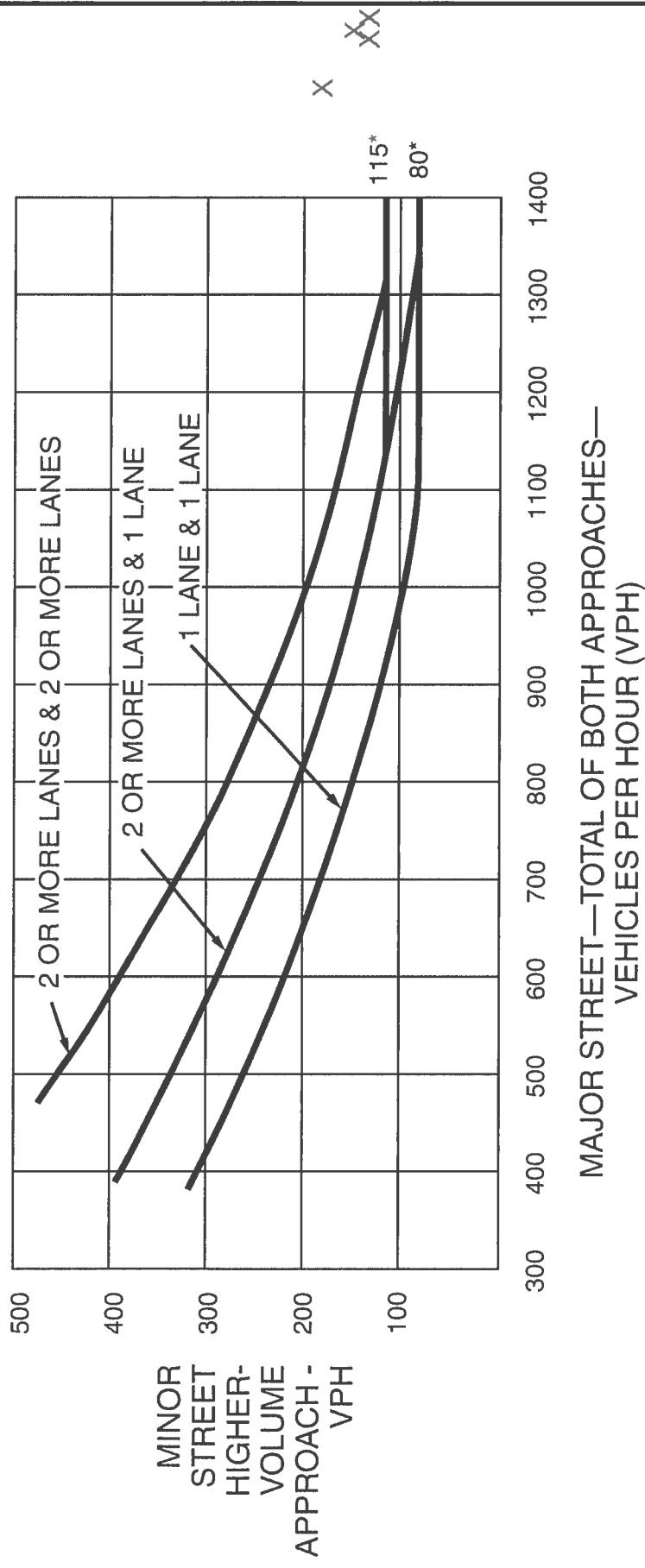
<p>PART A</p> <p>A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach. Track Center Line to Limit Line _____ ft</p>	<p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>
<p>PART B</p> <p>There is one minor street approach lane at the track crossing - During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point falls above the applicable curve in Figure 4C-9.</p> <p>Major Street - Total of both approaches: _____ VPH Minor Street - Crosses the track (one direction only, approaching the intersection): _____ VPH X AF (Use Tables 4C-2, 3, & 4 below to calculate AF) = _____ VPH</p> <hr/> <p>OR, There are two or more minor street approach lanes at the track crossing - During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point falls above the applicable curve in Figure 4C-10.</p> <p>Major Street - Total of both approaches : _____ VPH Minor Street - Crosses the track (one direction only, approaching the intersection): _____ VPH X AF (Use Tables 4C-2, 3, & 4 below to calculate AF) = _____ VPH</p>	<p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>

The minor street approach volume may be multiplied by up to three following adjustment factors (AF) as described in Section 4C.10.

- 1- Number of Rail Traffic per Day _____ Adjustment factor from table 4C-2 _____
- 2- Percentage of High-Occupancy Buses on Minor Street Approach _____ Adjustment factor from table 4C-3 _____
- 3- Percentage of Tractor-Trailer Trucks on Minor Street Approach _____ Adjustment factor from table 4C-4 _____

NOTE: If no data is available or known, then use AF = 1 (no adjustment)

Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume

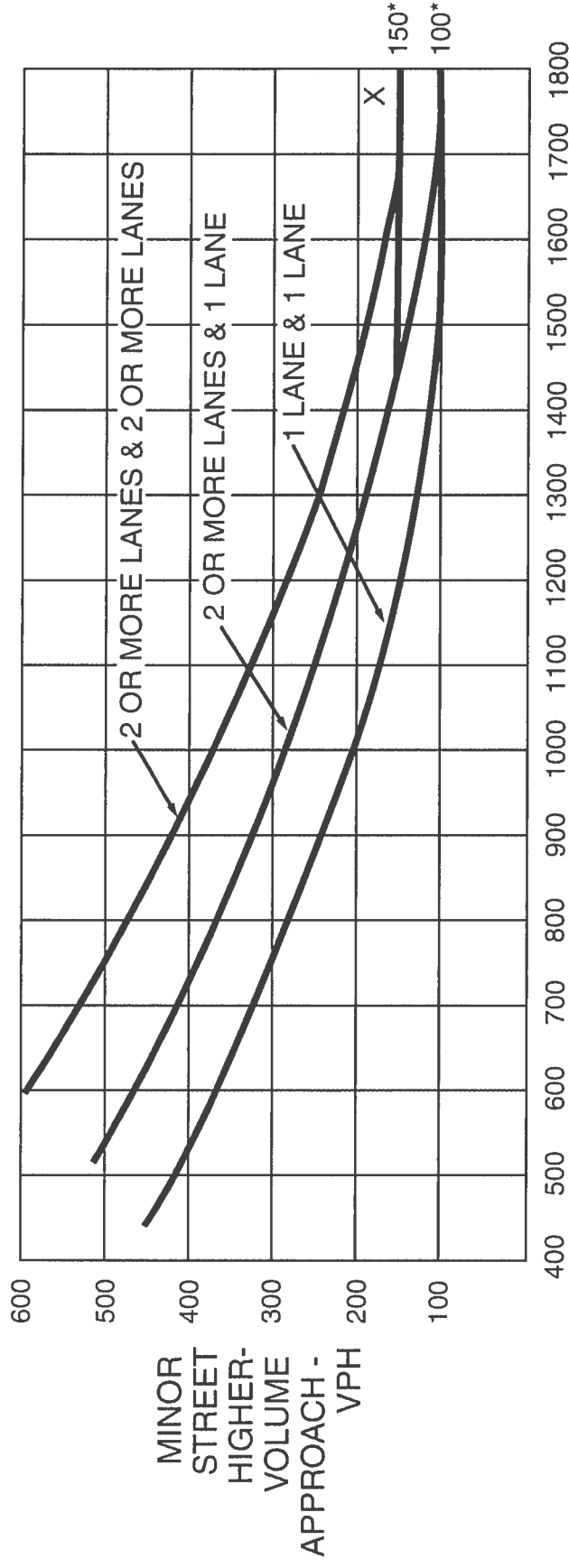


*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

10/26/16

Warrant 2
Existing Volumes with Street Improvements
Washington Blvd. and Driveway 2/Arco Driveway

Figure 4C-3. Warrant 3, Peak Hour



MAJOR STREET—TOTAL OF BOTH APPROACHES—VEHICLES PER HOUR (VPH)

*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

10/26/16

Warrant 3

Existing Volumes with Street Improvements
Washington Blvd. and Driveway 2/Arco Driveway