TRAFFIC SIGNAL WARRANT STUDY

for the intersection of

JOSEY LANE AND COOKSCREEK PLACE/WINTERGREEN ROAD

Prepared

for

City of Farmers Branch

May 7, 2014

By

Binkley & Barfield | C&P
consulting engineers

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INTRODUCTION

At the City of Farmers Branch request, Binkley & Barfield | C&P Consulting Engineers (BBCPI) has completed a traffic signal warrant study for the intersection of Josey Lane at Cookscreek Place/Wintergreen Road. This report documents the results of that study including: study area conditions, data collections, analyses, findings, and recommendations. **Figure 1** provides the location of the study intersection.

STUDY AREA CONDITIONS

Provided below is a summary of the existing conditions which encompassed the study area.

ROADWAY SYSTEM

Josey Lane is a six-lane divided arterial. At the study intersection Josey Lane is 80' wide. Exclusive northbound and southbound left-turn bays are provided on Josey lane to Cookscreek Place and Wintergreen Road. The turn bays provide approximately 100' of storage each. The posted speed limit on Josey Lane is 35 mph.

Cookscreek Place is a two-lane undivided local roadway. At the study intersection Cookscreek is 39' wide. It intersects on the east side of Josey Lane and is offset to the south of Wintergreen Road. Cookscreek Place ends approximately 1,100' east of Josey Lane. The westbound approach to Josey Lane is approximately 20' wide and can effectively operate as a two lane approach with an exclusive left-turn lane and a shared thru and right-turn lane. From the stop bar on Cookscreek Place, sight distance to the south along Josey Lane can be obstructed by the Cookscreek Apartment sign. Vehicles must pull into the crosswalk in order to achieve sufficient sight distance for entering the roadway. The posted speed limit on Cookscreek Place is 20 mph.

Wintergreen Road is a two-lane undivided local roadway. At the study intersection Wintergreen is 25' wide. It intersects on the west side of Josey Lane and is offset to the north of Cookscreek Place and dead ends approximately 1,800' west of Josey Lane. From the stop on Wintergreen Road, sight distance to the north along Josey Lane can be obstructed by the O'Reilly Auto Parts store sign and the utility poles long Josey Lane. A vehicle must pull into the crosswalk to achieve adequate sight distance along Josey Lane. There was no observed posted speed limit on Wintergreen Road, therefore the assumed speed limit is 30 mph.

The next signalized intersection south of the study intersection is Valwood Parkway which is approximately 1,100' away. To the north, the next signalized intersection is Pleasant Run Road/Rollingdale Lane and it is approximately 970' away.

ADJACENT LAND USES

There are varied land uses in the area of the study intersection. Provided below is a summary of the developments in each of the quadrants of the intersection.

- Northwest Quadrant – O'Reilly Auto Parts Store
- Northeast Quadrant – Shell Gas Station
- Southeast Quadrant – Cookscreek Apartments
- Southwest Quadrant – Posco Beer & Wine, Fox Creek Apartments

Cookscreek Place provides access to a multi-family development while Wintergreen Road provides access to a residential neighborhood west of the study intersection.

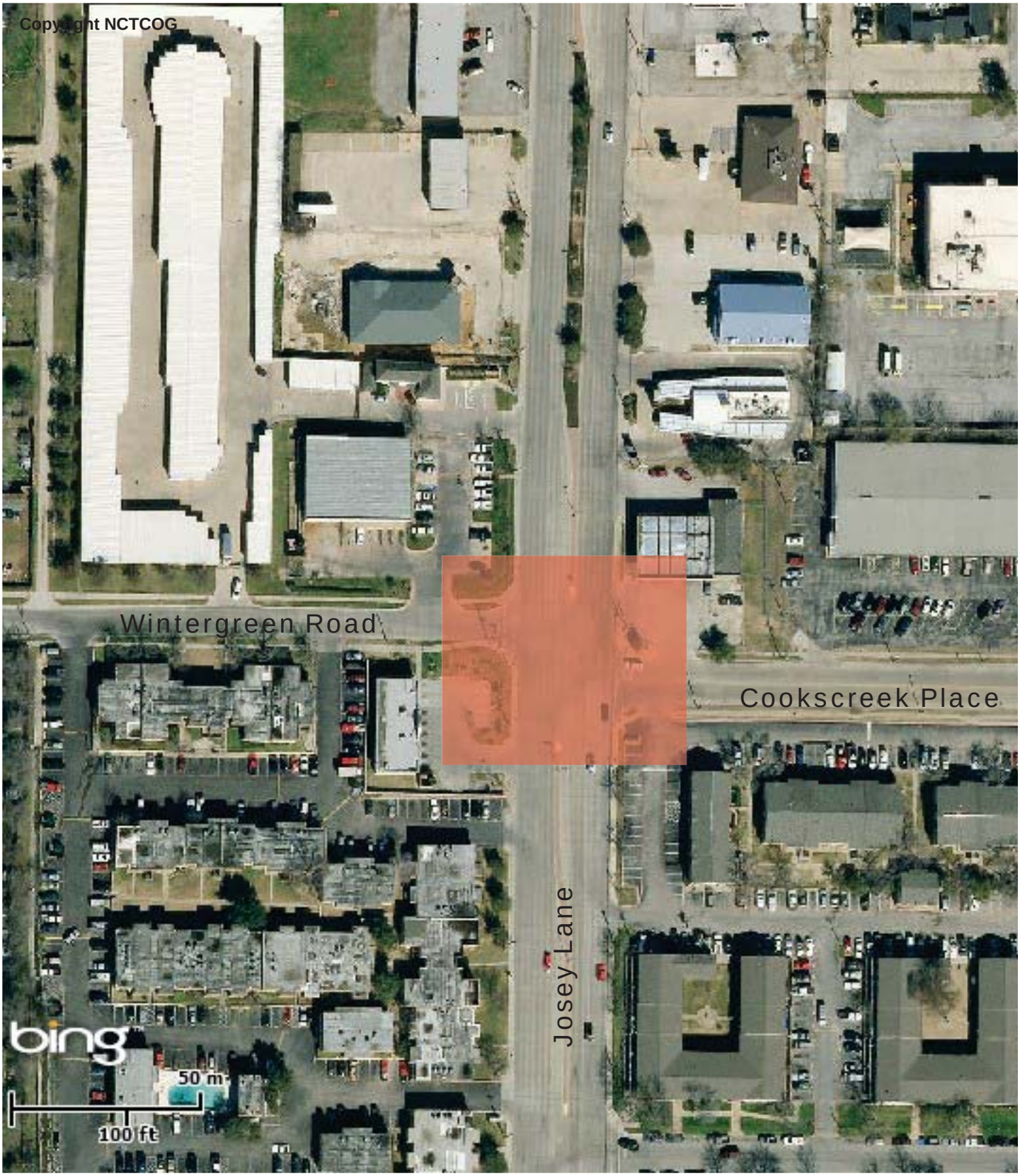

Figure 1. Intersection Location

DISCLAIMER
This data has been compiled for NCTCOG.
Various official and unofficial sources were used to gather this information. Every effort was made to ensure the accuracy of this data, however, no guarantee is given or implied as to the accuracy of said data.

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DATA COLLECTION

The primary data used in warranting the construction of traffic signals are traffic volumes. Secondary data that are typically included in the analysis of traffic signal needs are speed limits, pedestrian volumes, pedestrian crossing gaps, and traffic accidents. A summary of the traffic volume data used in the study along with additional data utilized in the signal warrant analysis are described in this section.

VEHICULAR TRAFFIC VOLUMES

Eleven hours of turning movement count data were collected at the study intersection on February 19, 2014. **Table 1** provides a summary of the approach volumes at the study intersection for the eleven hours which were counted.

Table 1. Vehicular Volumes

Time Period	Wintergreen Road	Cookscreek Place	Josey Lane	
	Eastbound Approach	Westbound Approach	Northbound Approach	Southbound Approach
7 AM - 8 AM	49	122	725	1161
8 AM - 9 AM	40	120	700	1307
9 AM - 10 AM	40	42	510	749
10 AM - 11 AM	44	30	488	592
11 AM - 12 PM	31	49	634	647
12 PM - 1 PM	47	40	779	770
1 PM - 2 PM	44	45	650	715
2 PM - 3 PM	37	55	786	793
3 PM - 4 PM	121	181	2287	1937
4 PM - 5 PM	63	78	1284	1013
5 PM - 6 PM	84	112	1780	1161

PEDESTRIAN TRAFFIC VOLUMES

In addition to traffic volumes, pedestrian crossing volumes were also collected. **Table 2** provides a summary of the pedestrian crossing volumes for each approach.

Table 2. Pedestrian Volumes

Time Period	Wintergreen Road	Cookscreek Place	Josey Lane	
	Eastbound Approach	Westbound Approach	Northbound Approach	Southbound Approach
7 AM - 8 AM	6	16	0	1
8 AM - 9 AM	0	6	0	1
9 AM - 10 AM	2	1	1	0
10 AM - 11 AM	2	5	0	1
11 AM - 12 PM	6	3	1	2
12 PM - 1 PM	6	9	0	5
1 PM - 2 PM	1	6	0	0
2 PM - 3 PM	0	4	1	0
3 PM - 4 PM	35	14	1	5
4 PM - 5 PM	17	8	4	6
5 PM - 6 PM	0	19	0	1

TRAFFIC ACCIDENT DATA

Traffic accident data was provided by the City of Farmers Branch. **Table 3** provides a summary of the dates, location, type, and brief description of the accidents based on the data provided.

Table 3. Traffic Accident Data

No.	Date	Type	Description	Location
1	4/12/2012	Vehicle to Vehicle	Right-Angle	Josey Ln 100' North of Cookscreek Place
2	7/30/2012	Vehicle to Vehicle	Right-Angle	Josey Ln at Cookscreek Place (at interesection)
3	10/27/2012	Vehicle to Vehicle	Sideswipe	Cookscreek Place at Josey Lane (at intersection)
4	11/6/2012	Vehicle to Vehicle	Right-Angle	Josey Ln at Cookscreek Place (at interesection)
5	3/25/2013	Vehicle to Vehicle	Right-Angle	Josey Ln at Cookscreek Place (at interesection)
6	6/10/2013	Vehicle to Bike	Right-Angle	Cookscreek Place at Josey Lane (on Cookscreek)
7	12/19/2013	Vehicle to Vehicle	Right-Angle	Josey Ln at Cookscreek Place (at interesection)
8	2/1/2014	Vehicle to Vehicle	Right-Angle	Josey Ln at Cookscreek Place (at interesection)

A right-angle crash may be corrected by improving sight distance or through the installation of a traffic signal.

ANALYSES

The traffic data collected for this study were evaluated against the nine traffic signal warrants listed and described in the *Texas Manual on Uniform Traffic Control Devices* (TxMUTCD). The nine warrants are listed below:

- Warrant 1 – Eight-Hour Vehicular Volume
- Warrant 2 – Four-Hour Vehicular Volume
- Warrant 3 – Peak Hour
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing
- Warrant 6 – Coordinated Signal System
- Warrant 7 – Crash Experience
- Warrant 8 – Roadway Network
- Warrant 9 – Intersection Near a Grade Crossing

All nine warrants and their warranting criteria as described in the *TxMTUCD* have been included in the Appendix.

BBCPI utilized the *HCS 2010* software, developed and supported by *McTrans*, to conduct the analyses. The computer output for the warrants evaluated in this study have been included in the Appendix.

SIGHT DISTANCE

The geometry of the intersection and the observed sight distances from Cookscreek Place and Wintergreen Road are not idea. Sight distance guidelines and criteria have been developed and published in the 2004 by the Association of American State Highway and Transportation Officials (AASHTO). The following criteria from AASHTO were applied to the intersection sight distance conditions at this location.

- Terrain Type Level
- Eye Height 3.5’
- Vehicle Height 3.5’
- Speed Limit 35 mph

This location dictates the need to evaluate three different sight distances circumstances as outlined by AASHTO. Below is a summary of those three circumstances.

- Case B1: Left-turn from minor road
- Case B2: Right-turn from minor road
- Case F: Left-turn from major road

Table 4 provides a summary of the sight distance analysis while **Figure 2** approximately illustrates the required sight distance triangles for Case B1. Provided in the Appendix are photos from Wintergreen Road and Cooksreek Place looking north and south along Josey Lane.

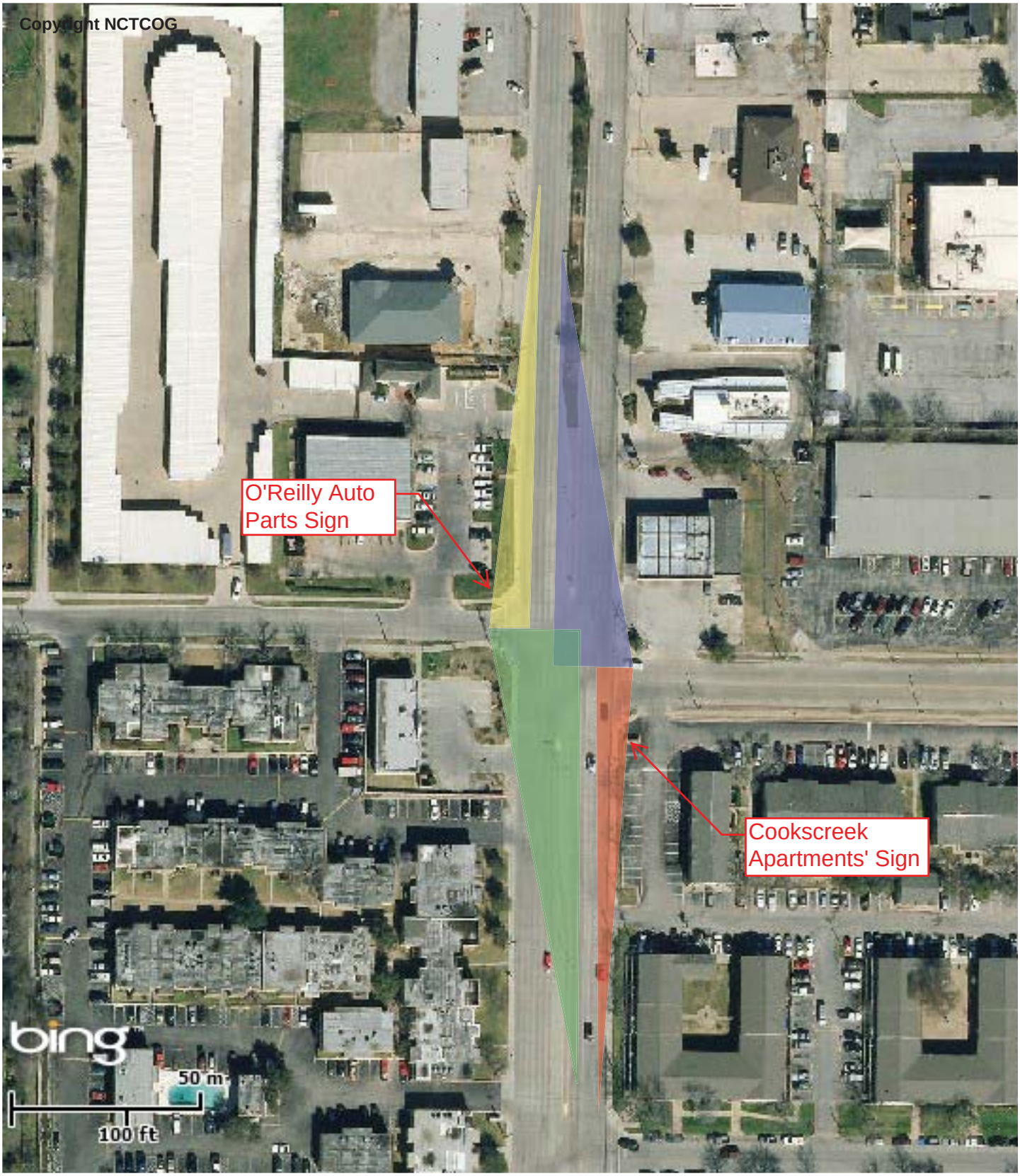

Figure 2. Sight Distance Triangles

Note: Sight distance triangles are approximate and based on a required sight distance of 390'. Distances have not been field verified. This figure is for illustration purposes only.

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Table 4. Sight Distance Analysis

Vehicular Movement	Available Sight Distance	Required Sight Distance	Requirement Satisfied?
Case B1: Left-turn from Side-Street			
Northbound (Looking Right) Southbound (Looking Left)	Not Measured	390' 390'	-
Case B2: Right-turn from Side-Street			
Southbound (Looking Left)	Not Measured	335'	-
Case F: Left-turn from Josey Lane			
Southbound (Looking South)	Not Measured	285'	-

WARRANT ANALYSIS

Table 5 provides a summary of the analysis results for the nine warrants as described in the *TxMUTCD*.

Table 5. Warrant Analysis Summary

Warrant	Satisfied?
Warrant 1 – Eight-Hour Vehicular Volume	No
Warrant 2 – Four-Hour Vehicular Volume	No
Warrant 3 – Peak Hour	No
Warrant 4 – Pedestrian Volume	No
Warrant 5 – School Crossing	N/A
Warrant 6 – Coordinated Signal System	Not Studied
Warrant 7 – Crash Experience	**Yes**
Warrant 8 – Roadway Network	N/A
Warrant 9 – Intersection Near a Grade Crossing	N/A

The *TxMUTCD* indicates that the satisfaction of a warrant or warrants is not in itself justification for a signal. It suggests that an engineering study be conducted to determine if traffic signals will improve the overall safety and/or operation of the intersection. If these requirements are not met, a traffic signal should neither be placed into operation nor continued in operation (if already installed).

The results of the analyses conclude that the traffic conditions, as analyzed, at this intersection **satisfy** the requirements for consideration of traffic signalization based on the **crash experience alone**.

FINDINGS AND RECOMMENDATIONS

Based on the analysis approach none of the volume warrants were satisfied. The only warrant satisfied was Warrant 7, Crash Experience. Eight accidents have been reported at or near the intersection since April 4, 2012. It could be assumed that additional crashes have occurred at this intersection but they have not been reported.

At this time, it is not recommended to install a traffic signal based only on Warrant 7, Crash Experience. The geometry at this intersection would dictate inefficient signal operations. For example, the northbound and southbound left-turn movements conflict with one another and therefore could not operate simultaneously. Protected only left-turns operating in a lead-lag configuration would be required therefore reducing the northbound and southbound efficiency. Additionally, due to the offset nature of Cookscreek Place and Wintergreen Road these minor streets would need to operate as split phase. This split phase requirement would further reduce the efficiency of signal operations. A signal at this location would need to be coordinated with other signals along the Josey Lane corridor which would mostly likely reduce signal progression along Josey Lane. Further detailed analysis would be required to confirm operational impacts.

The following recommendations are provided for consideration at this intersection in order to improve safety and operations. The goals of these recommendations are to reduce potential conflict points at or near the intersection, improve sight distances from Cookscreek Place and Wintergreen Drive, and improve traffic operations.

- Approach Cookscreek Apartments about relocating the apartment's sign at the southeast corner of the intersection to improve sight distance from Cookscreek Place
- Restripe and sign the westbound approach of Cookscreek Place to Josey Lane to provide an exclusive left-turn lane along with a shared through and right-turn lane
- Extend the southernmost median on Josey Lane north to reduce the possibility of left-turns from Posco Beer and Wine (currently prohibited by signage)
- Convert the Posco Beer and Wine driveway on Josey Lane to a right-in-right-out driveway to eliminate left-turns out of the driveway (currently prohibited by signage)
- Approach Posco Beer and Wine about providing an additional access point to the property from Wintergreen Road (Requires coordination with City of Carrollton)
- Convert the southernmost Shell Gas Station driveway on Josey Lane to a right-in-right-out driveway to eliminate left-turns out of the driveway (currently prohibited by signage)
- Approach Cookscreek Apartments about closing the driveway closest to Josey Lane on Cookscreek Place
- Approach O'Reilly Auto Parts about the relocation of the store's sign to improve sight distance from Wintergreen Road

If these improvements are implemented and crashes as well as delay on the minor streets still persist, it is recommended to consider the installation of a traffic signal at this intersection.

CLOSING

We have appreciated the opportunity to assist you in the preparation of a traffic signal warrant study for the Josey Lane at Cookscreek Place/Wintergreen Road in City of Farmers Branch. Please do not hesitate to contact our office should you have any questions or comments concerning this report.

APPENDIX

File Name: C:\TMC\C&P2191.ppd
Start Date: 2/19/2014
Start Time: 7:00:00 AM
Site Code: 00002191
Comment 1: Farmers Branch
Comment 2: Josey & Wintergreen/Cookscreek
Comment 3: 2-19-14
Comment 4: Vehiclur Volumes

	Josey Southbound				Cookscreek Westbound				Josey Northbound				Wintergreen Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
07:00 AM	1	214	9	0	10	0	9	0	2	120	4	0	6	0	4	0
07:15 AM	4	255	8	0	15	0	27	0	8	145	8	0	11	0	4	0
07:30 AM	1	311	5	1	17	0	16	0	19	216	6	0	9	1	2	0
07:45 AM	2	336	14	0	15	0	13	0	11	183	3	0	7	0	5	0
08:00 AM	4	322	6	1	14	0	10	0	8	215	3	0	4	0	7	0
08:15 AM	6	364	11	0	13	1	8	0	15	126	4	1	6	1	6	0
08:30 AM	8	290	5	2	13	0	30	0	19	140	4	0	2	2	3	0
08:45 AM	0	281	7	0	13	3	15	0	10	154	1	0	5	0	4	0
09:00 AM	9	213	4	0	3	2	8	0	3	120	5	0	6	0	3	0
09:15 AM	0	188	5	1	5	0	4	0	3	120	2	0	7	0	6	0
09:30 AM	4	168	5	0	2	0	7	0	5	114	7	0	6	0	3	0
09:45 AM	5	140	6	1	9	0	2	0	2	125	4	0	6	1	2	0
10:00 AM	4	163	5	2	3	0	5	0	3	103	3	1	6	0	4	0
10:15 AM	2	136	4	4	2	0	4	0	1	105	3	0	6	0	5	0
10:30 AM	0	131	2	2	4	0	5	0	3	115	1	0	4	0	7	0
10:45 AM	5	127	2	3	4	0	3	0	5	144	1	0	8	0	4	0
11:00 AM	0	128	9	5	6	0	4	0	2	136	4	1	5	0	5	0
11:15 AM	3	125	8	5	8	1	6	0	3	144	2	0	2	1	3	0
11:30 AM	6	163	9	4	7	0	4	0	5	156	5	0	6	0	4	0
11:45 AM	5	167	5	5	7	1	5	0	4	167	5	0	3	0	2	0
12:00 PM	5	184	11	8	7	0	5	0	5	205	8	0	8	0	3	0
12:15 PM	4	174	9	10	3	0	3	0	3	169	12	1	11	0	3	0
12:30 PM	4	175	7	2	8	0	4	0	2	189	2	1	6	1	8	0
12:45 PM	2	166	4	5	2	0	8	0	4	174	4	0	2	0	5	0
01:00 PM	4	159	9	5	4	0	5	0	4	168	4	0	5	0	5	0
01:15 PM	1	172	11	5	7	0	9	0	3	155	5	1	6	0	6	0
01:30 PM	8	155	12	4	4	0	5	0	6	150	4	0	10	0	2	0
01:45 PM	6	160	4	0	7	0	4	0	4	144	2	0	7	0	3	0
02:00 PM	2	158	6	13	1	0	5	0	8	181	4	0	6	0	3	0
02:15 PM	5	172	12	2	7	0	6	0	7	182	4	0	8	0	1	0
02:30 PM	5	203	4	2	4	0	7	0	9	188	7	1	4	0	6	0
02:45 PM	4	191	11	3	11	0	14	0	10	178	5	2	5	0	4	0
03:00 PM	4	189	12	2	14	0	6	0	36	212	7	1	13	0	6	0
03:15 PM	6	160	17	6	13	0	14	0	12	234	7	1	6	0	4	0
03:30 PM	5	210	13	7	19	2	11	0	13	223	5	0	8	0	2	0
03:45 PM	10	255	24	4	18	0	6	0	14	237	1	0	13	0	6	0
04:00 PM	9	202	8	2	5	0	9	0	9	236	8	0	13	0	4	0
04:15 PM	10	234	17	1	14	0	5	0	5	270	3	0	8	0	7	0
04:30 PM	10	258	18	3	14	0	3	0	15	360	8	1	11	0	3	0
04:45 PM	7	219	15	0	18	0	10	0	17	340	11	1	13	0	4	0
05:00 PM	15	248	15	3	15	0	5	0	14	391	8	0	16	0	4	0
05:15 PM	14	285	18	1	18	0	5	0	17	438	6	1	15	0	3	0
05:30 PM	11	259	10	3	26	0	11	0	15	422	12	1	21	0	7	0
05:45 PM	9	248	15	7	18	0	14	0	18	423	13	1	14	0	4	0

File Name: C:\TMC\C&P2191.ppd
Start Date: 2/19/2014
Start Time: 7:00:00 AM
Site Code: 00002191
Comment 1: Farmers Branch
Comment 2: Josey & Wintergreen/Cookscreek
Comment 3: 2-19-14
Comment 4: Pedestrians Volumes

	Josey Southbound				Cookscreek Westbound				Josey Northbound				Wintergreen Eastbound			
Start Time	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn	Right	Thru	Left	U-Turn
07:00 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	3
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
07:45 AM	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	1
08:00 AM	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
08:15 AM	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:45 AM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
09:00 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
09:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
09:30 AM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
09:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10:00 AM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
10:15 AM	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
10:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10:45 AM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
11:00 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
11:15 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
11:30 AM	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
11:45 AM	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	4
12:00 PM	0	0	0	3	0	0	0	4	0	0	0	0	0	0	0	3
12:15 PM	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	2
12:30 PM	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
12:45 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
01:00 PM	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
01:15 PM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
01:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:45 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
02:15 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
02:30 PM	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
02:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
03:00 PM	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0
03:15 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
03:30 PM	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
03:45 PM	0	0	0	5	0	0	0	11	0	0	0	0	0	0	0	33
04:00 PM	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	13
04:15 PM	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	1
04:45 PM	0	0	0	3	0	0	0	2	0	0	0	1	0	0	0	3
05:00 PM	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0
05:15 PM	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0
05:30 PM	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
05:45 PM	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**

02 **The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:**

Warrant 1, Eight-Hour Vehicular Volume
Warrant 2, Four-Hour Vehicular Volume
Warrant 3, Peak Hour
Warrant 4, Pedestrian Volume
Warrant 5, School Crossing
Warrant 6, Coordinated Signal System
Warrant 7, Crash Experience
Warrant 8, Roadway Network
Warrant 9, Intersection Near a Grade Crossing

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

Support:

04 Sections 8C.09 and 8C.10 contain information regarding the use of traffic control signals instead of gates and/or flashing-light signals at highway-rail grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

05 *A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.*

06 *A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.*

07 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*

08 *The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in Paragraph 2.*

09 *Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.*

10 *Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.*

11 *At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.*

12 *For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.*

Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume.

14 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

15 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

16 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

17 Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions, pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.
G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

18 The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of Paragraph 17:

A. Vehicle-hours of stopped time delay determined separately for each approach.
B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.
C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.
D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.
E. Queue length on stop-controlled approaches.

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

01 The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

02 The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

03 It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Standard:

04 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

05 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

06 *The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.*

Standard:

07 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume

[b] Used for combination of Conditions A and B after adequate trial of other remedial measures

[c] May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Option:

08 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

01 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour

Support:

01 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

02 **This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.**

03 **The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:**

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and

2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and

3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Option:

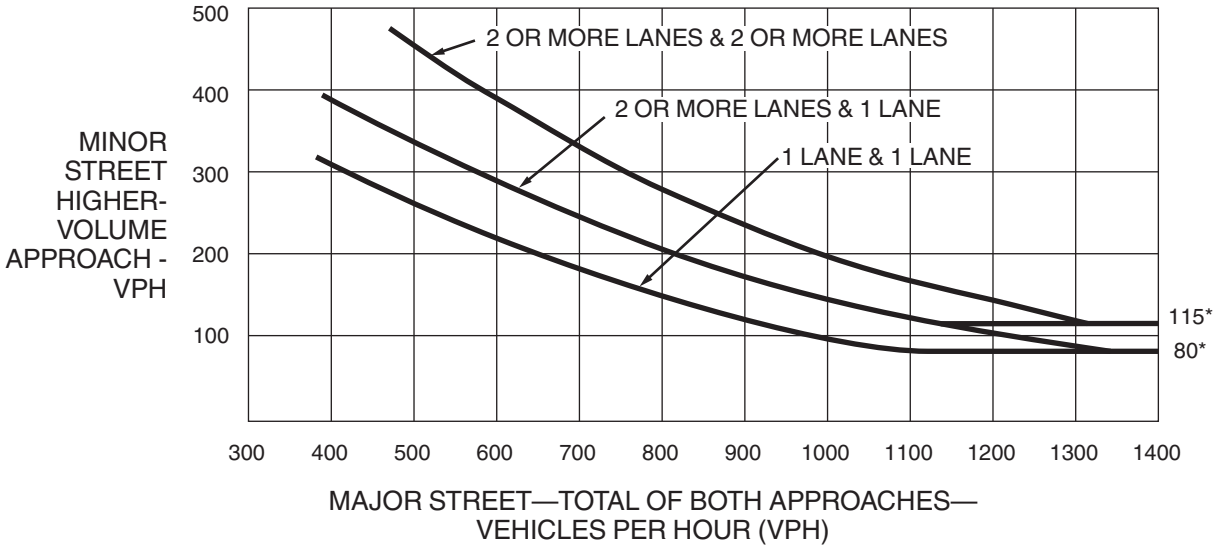
04 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second category of the Standard.

05 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

Guidance:

06 *If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.*

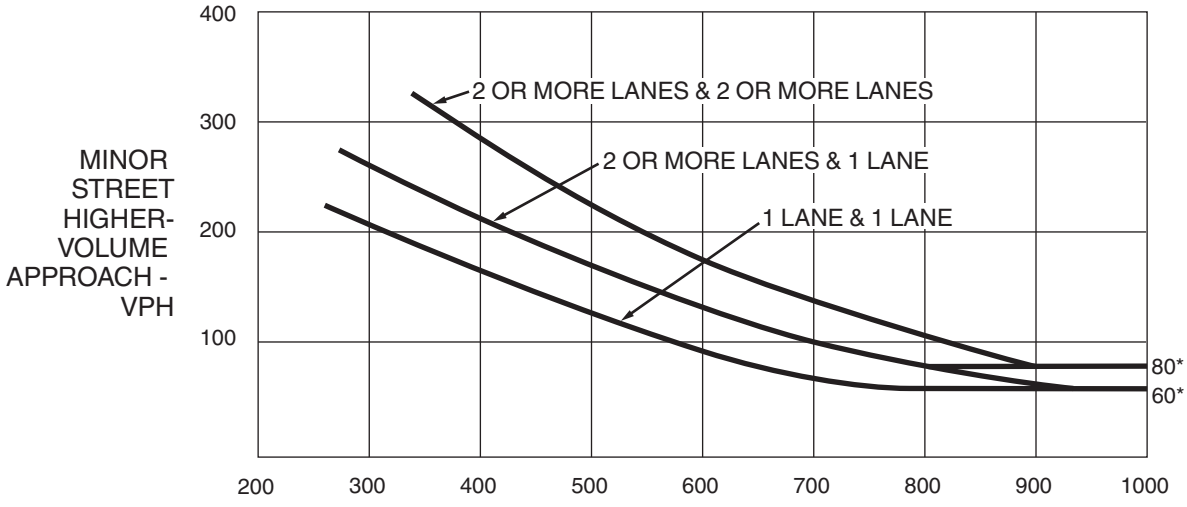
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*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.

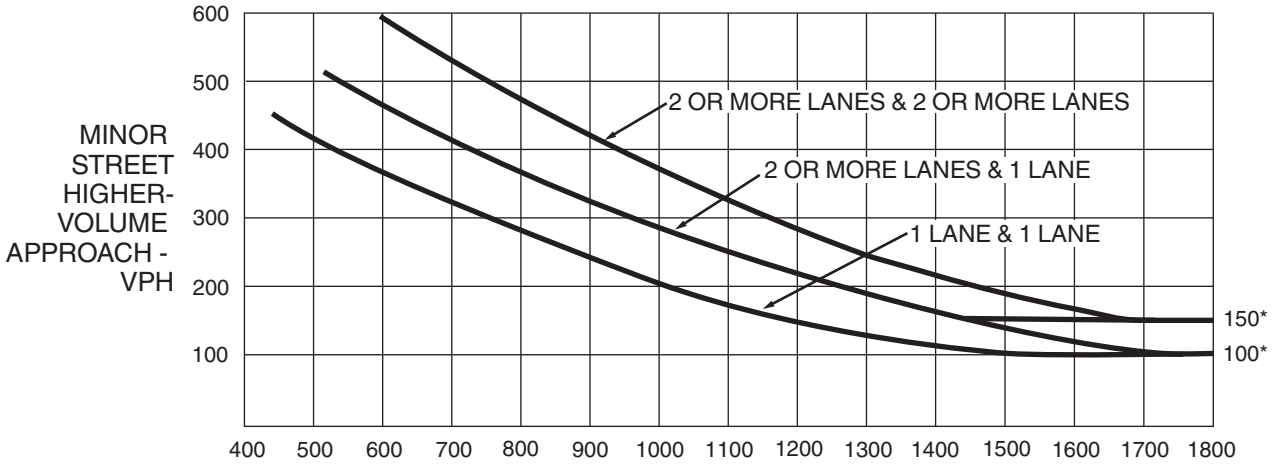
Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

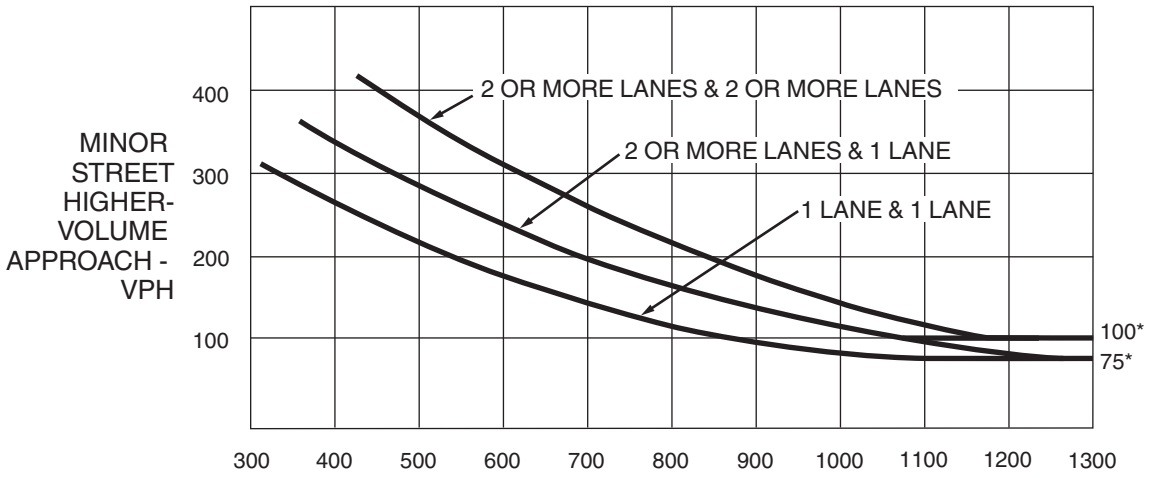
Figure 4C-3. Warrant 3, Peak Hour



*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.

Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

01 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

02 **The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:**

- **A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or**
- **B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2, and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

Standard:

04 **The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

05 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E.**

Guidance:

06 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

- *A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.*
- *B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.*
- *C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.*

Option:

07 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

08 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

Section 4C.06 Warrant 5, School Crossing

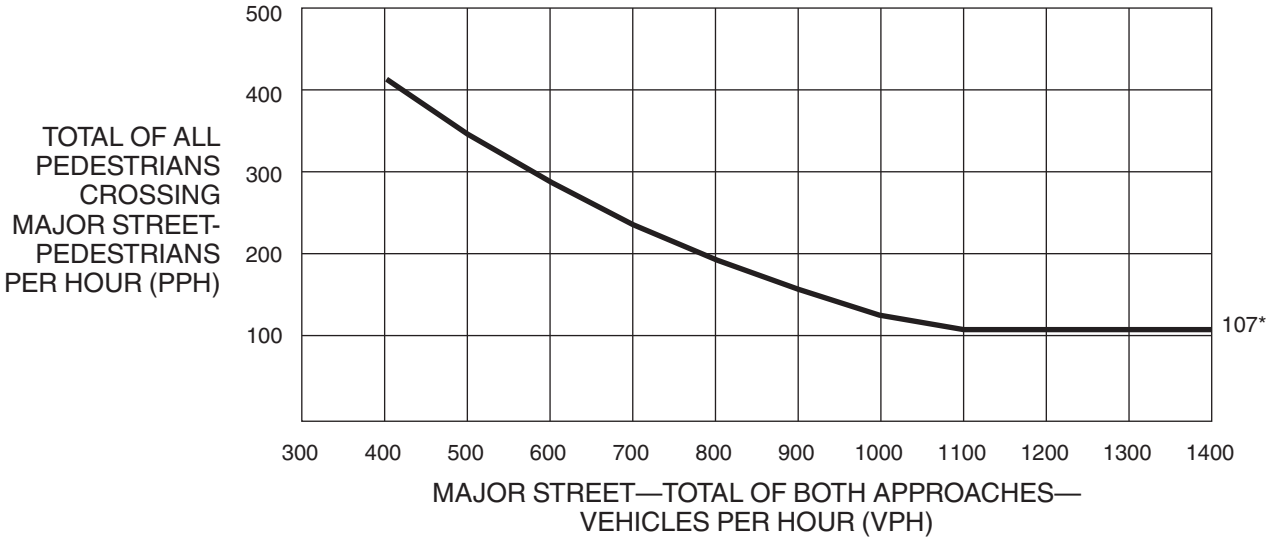
Support:

01 The School Crossing signal warrant is intended for application where the fact that school children cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word “school children” includes elementary through high school students.

Standard:

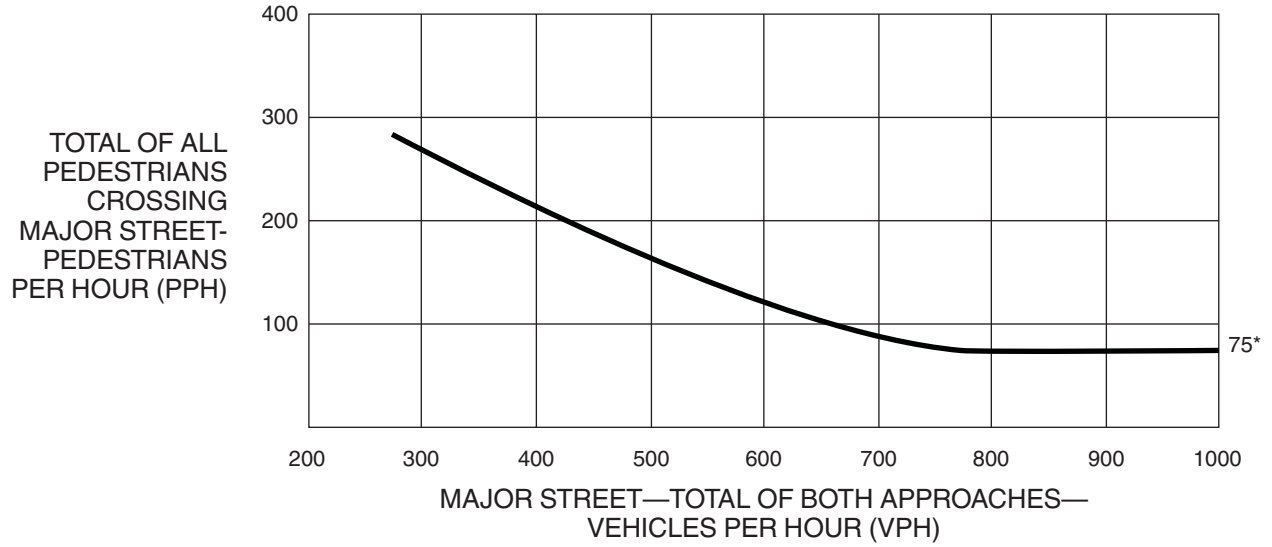
02 **The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of school children at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the school children are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 school children during the highest crossing hour.**

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



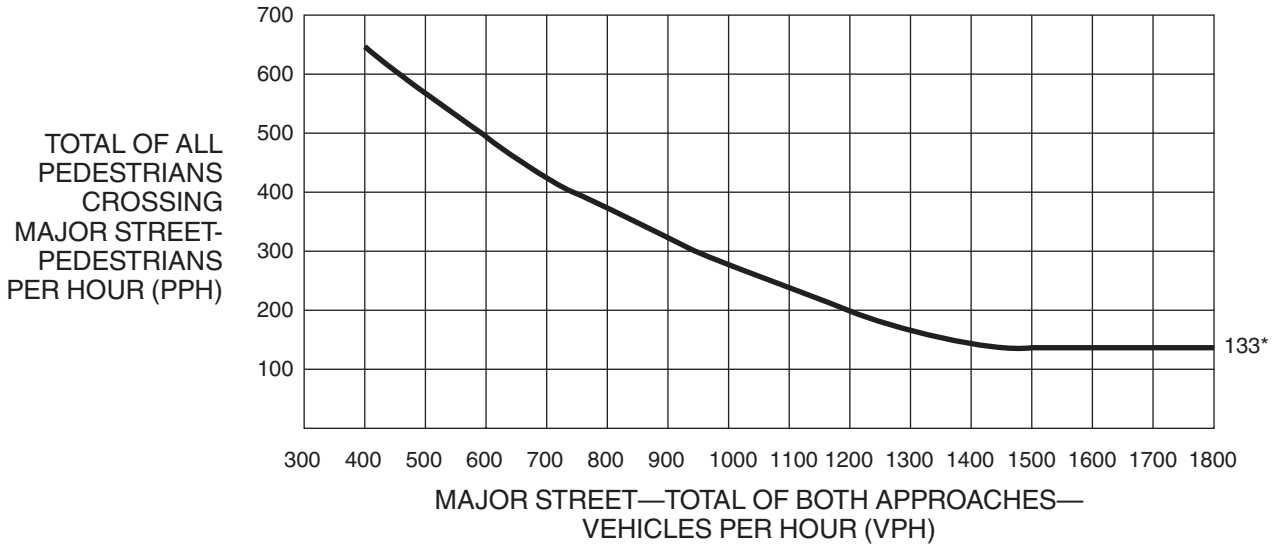
*Note: 107 pph applies as the lower threshold volume.

Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)



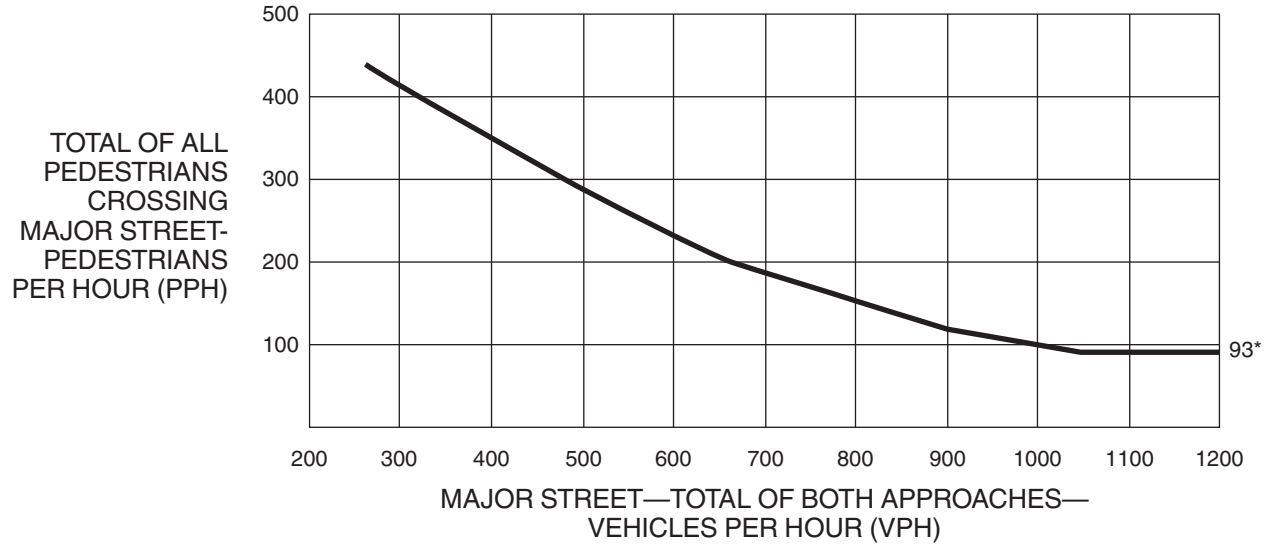
*Note: 75 pph applies as the lower threshold volume.

Figure 4C-7. Warrant 4, Pedestrian Peak Hour



*Note: 133 pph applies as the lower threshold volume.

Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)



*Note: 93 pph applies as the lower threshold volume.

03 **Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.**

04 **The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

Guidance:

05 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.

B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

01 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:**

A. 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.

B. 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.

Guidance:

03 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.*

Section 4C.08 Warrant 7, Crash Experience

Support:

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:**

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and

B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and

C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

01 Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:**

- **A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or**
- **B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).**

03 **A major route as used in this signal warrant shall have at least one of the following characteristics:**

- **A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.**
- **B. It includes rural or suburban highways outside, entering, or traversing a city.**
- **C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.**
- **D. It connects areas of principal traffic generation.**
- **E. It has surface street freeway or expressway ramp terminals.**

Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

Support:

01 The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Guidance:

02 *This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:*

- *A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or*
- *B. Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.*

Standard:

03 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:**

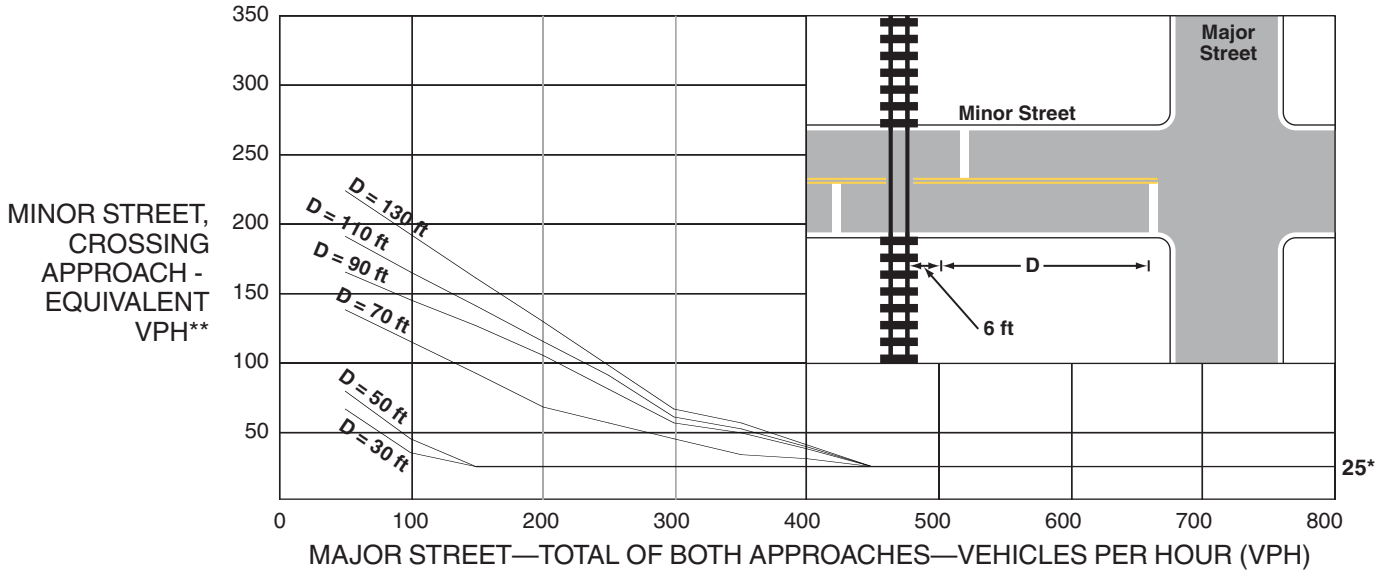
- **A. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and**
- **B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.**

Guidance:

04 *The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:*

- *A. Figure 4C-9 should be used if there is only one lane approaching the intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the intersection at the track crossing location.*

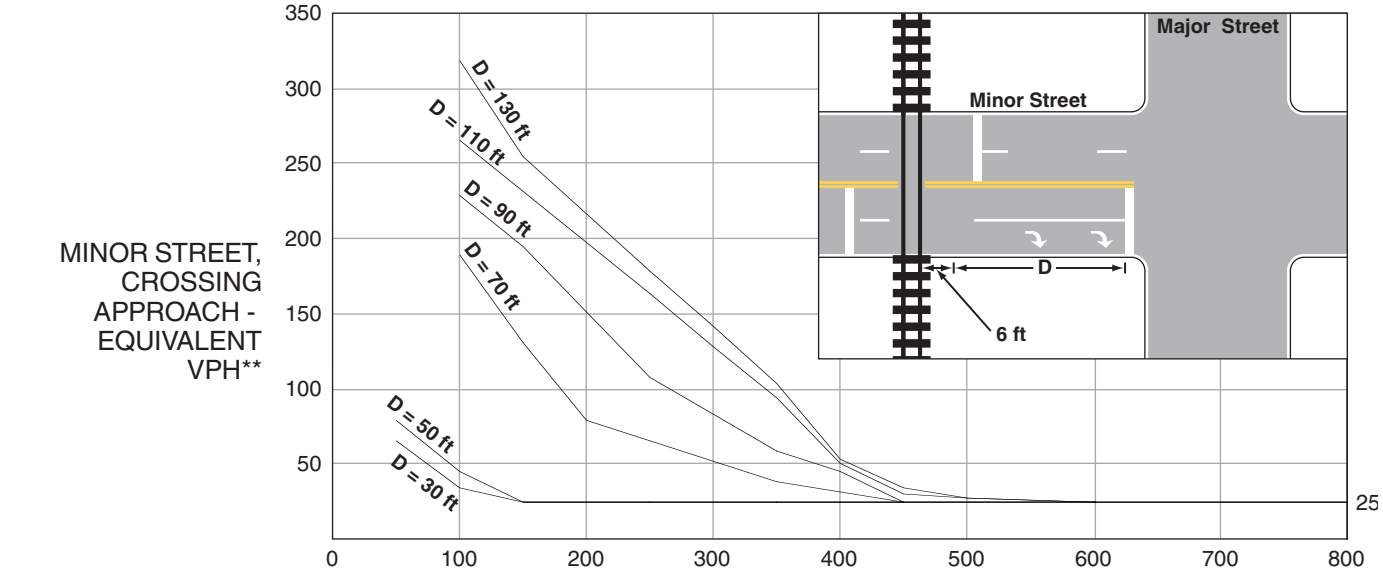
Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

B. After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D = 90 feet.

C. If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option:

05 The minor-street approach volume may be multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

06 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-2 for the appropriate number of occurrences of rail traffic per day.

07 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-3 for the appropriate percentage of high-occupancy buses.

08 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-4 for the appropriate distance and percentage of tractor-trailer trucks.

Standard:

09 **If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, then:**

A. The traffic control signal shall have actuation on the minor street;

B. Preemption control shall be provided in accordance with Sections 4D.27, 8C.09, and 8C.10; and

C. The grade crossing shall have flashing-light signals (see Chapter 8C).

Guidance:

10 *If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, the grade crossing should have automatic gates (see Chapter 8C).*

Table 4C-2. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Table 4C-3. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

* A high-occupancy bus is defined as a bus occupied by at least 20 people.

Table 4C-4. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

Warrants Summary

Information			
Analyst	Cameron L. Williams PE	Intersection	Josey Lane at Cookscreek Place
Agency/Co	BBCPI	Jurisdiction	City of Farmers Branch
Date Performed	3/11/2014	Units	U.S. Customary
Project ID	BC14022	Time Period Analyzed	
East/West Street	Cookscreek Place	North/South Street	Josey Lane
File Name	Josey at Cookscreek (3-2).xhy	Major Street	North-South

Project Description *BC14022*

General				Roadway Network	
Major Street Speed (mph)	35	☐	Population < 10,000	Two Major Routes	☐
Nearest Signal (ft)	1000	☐	Coordinated Signal System	Weekend Count	☐
Crashes (per year)	5	☐	Adequate Trials of Alternatives	5-yr Growth Factor	0

Geometry and Traffic	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N	0	1	0	1	1	0	1	3	0	1	3	0
Lane usage		LTR		L	TR		L	TR		L	TR	
Vehicle Volume Averages (vph)	15	0	28	29	0	35	20	726	31	45	754	19
Peds (ped/h) / Gaps (gaps/h)	--	6 / 0	--	--	7 / 0	--	--	0 / 0	--	--	1 / 0	--
Delay (s/veh) / (veh-hr)	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--

Warrant 1: Eight-Hour Vehicular Volume	☐
1 A. Minimum Vehicular Volumes (Both major approaches --and-- higher minor approach) --or--	☐
1 B. Interruption of Continuous Traffic (Both major approaches --and-- higher minor approach) --or--	☐
1 80% Vehicular --and-- Interruption Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 2: Four-Hour Vehicular Volume	☐
2 A. Four-Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 3: Peak Hour	☐
3 A. Peak-Hour Conditions (Minor delay --and-- minor volume --and-- total volume) --or--	☐
3 B. Peak- Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 4: Pedestrian Volume	☐
4 A. Four Hour Volumes --or--	☐
4 B. One-Hour Volumes	☐
Warrant 5: School Crossing	☐
5. Student Volumes --and--	☐
5. Gaps Same Period	☐
Warrant 6: Coordinated Signal System	☐
6. Degree of Platooning (Predominant direction or both directions)	☐
Warrant 7: Crash Experience	☐
7 A. Adequate trials of alternatives, observance and enforcement failed --and--	☐
7 B. Reported crashes susceptible to correction by signal (12-month period) --and--	☑

7 C. 80% Volumes for Warrants 1A, 1B --or-- 4 are satisfied	☐
Warrant 8: Roadway Network	☐
8 A. Weekday Volume (Peak hour total --and-- projected warrants 1, 2 or 3) --or--	☐
8 B. Weekend Volume (Five hours total)	☐
Warrant 9: Grade Crossing	☐
9 A. Grade Crossing within 140 ft --and--	☐
9 B. Peak-Hour Vehicular Volumes	☐

Warrants Volume

Information

Analyst	Cameron L. Williams PE	Intersection	Josey Lane at Cookscreek Place
Agency/Co	BBCPI	Jurisdiction	City of Farmers Branch
Date Performed	3/11/2014	Units	U.S. Customary
Project ID	BC14022	Time Period Analyzed	
East/West Street	Cookscreek Place	North/South Street	Josey Lane
File Name	Josey at Cookscreek (3-2).xhy	Major Street	North-South

Project Description *BC14022*

Warrant 1

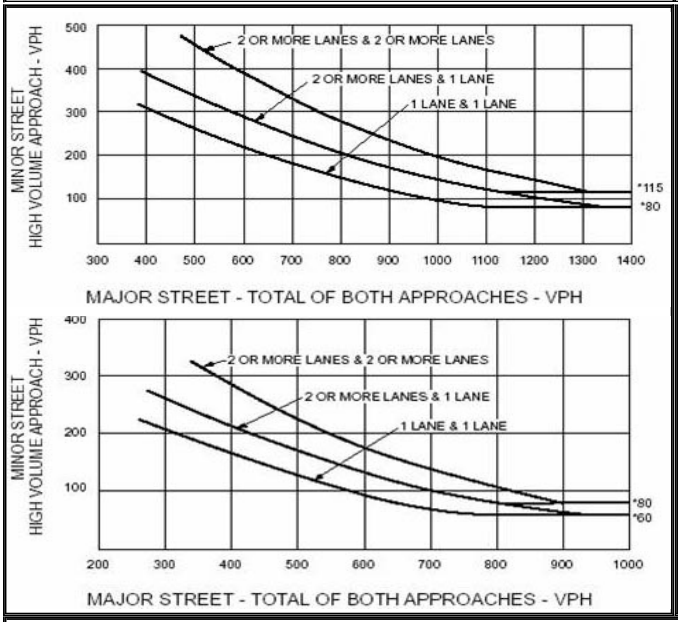
Condition A - Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approach (one direction only)		
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	100%[a]	80%[b]	70%[c]
1	1	500	400	350	150	120	105
2 or more	1	600	480	420	150	120	105
2 or more	2 or more	600	480	420	200	160	140
1	2 or more	500	400	350	200	160	140

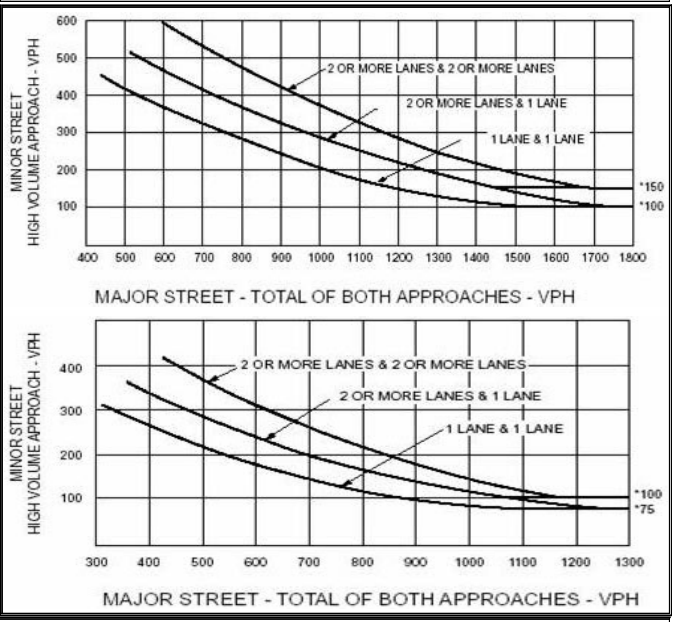
Condition B - Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approach (one direction only)		
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	100%[a]	80%[b]	70%[c]
1	1	750	600	525	75	60	53
2 or more	1	900	720	630	75	60	53
2 or more	2 or more	900	720	630	100	80	70
1	2 or more	750	600	525	100	80	70

Warrant 2



Warrant 3



Volume Summary

Major Street Lanes 2+ **Minor Street Lanes** 2+ **Speed** 35 **Population** 10000+

Hours	Major Volume	Minor Volume	Total Volume	1A (100%)	1A (80%)	1B (100%)	1B (80%)	2 (100%)	3A (100%)	3B (100%)
07-08	1886	122	2057	No	No	Yes	Yes	Yes	No	No
08-09	2007	120	2167	No	No	Yes	Yes	Yes	No	No
09-10	1259	42	1341	No	No	No	No	No	No	No
10-11	1080	44	1154	No	No	No	No	No	No	No
11-12	1281	49	1361	No	No	No	No	No	No	No
12-13	1549	47	1636	No	No	No	No	No	No	No
13-14	1365	45	1454	No	No	No	No	No	No	No
14-15	1579	55	1671	No	No	No	No	No	No	No
15-16	1927	103	2088	No	No	Yes	Yes	No	No	No
16-17	2297	78	2438	No	No	No	No	No	No	No
17-18	2941	112	3137	No	No	Yes	Yes	No	No	No
18-19	0	0	0	No	No	No	No	No	No	No
Totals	19171	817	20504	0	0	4	4	2	0	0

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Wintergreen Road at Josey Lane – Looking South from Stop Bar

Wintergreen Road at Josey Lane – Looking North from Stop Bar

Wintergreen Road at Josey Lane – Looking North from behind Stop Bar

Wintergreen Road at Josey Lane – Looking South from behind Stop Bar

Cookscreek Place at Josey Lane – Looking South from Stop Bar

Cookscreek Place at Josey Lane – Looking North from Stop Bar