Planning for Traffic Signals

An Online Continuing Education Course for Engineers

Course Number: T-3003

Credit: 3 Hours / 3 PDH / 3 CPD

PLANNING FOR TRAFFIC SIGNALS

This Traffic Signal Design course addresses basic procedures used in planning traffic signal installations. Included in this course is a discussion of warrants for traffic signal installation, traffic study guidelines, signal phasing selection, and flashing analysis.

TRAFFIC SIGNAL WARRANTS

A traffic signal should not be installed unless one or more of the 9 traffic signal warrants described in the 2009 Manual on Uniform Traffic Control devices (MUTCD) are satisfied. However, the satisfaction of a warrant is not in itself justification for installing a signal. A signal should only be installed after an engineering study has been completed and a finding made that a signal is the most appropriate form of intersection control. This study must include a comprehensive warrant analysis and should be "signed and sealed" by a registered traffic engineer (in those states that have such a designation) or a registered Professional Engineer (P.E.) with expertise in traffic signal operations.

Most warranted signals are justified under warrant 1, the Eight-Hour Vehicular Volume warrant.

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

This warrant requires that a certain volume of traffic exist on both the major street and the intersecting minor street for 8 hours of an "average" day. The same 8 hours must be used when comparing volumes from the major and minor street. The MUTCD defines an average day as "a day representing traffic volumes normally and repeatedly found at a location, typically a weekday where volumes are influenced by employment or a weekend day when volumes are influenced by entertainment or recreation". If this is a location that, for a significant portion of the year, is influenced by school traffic or tourist-related traffic then it is prudent to conduct the warrant study during periods when school is in session or the tourists are in town.

The volume of traffic required to satisfy warrant 1 varies depending on the number of travel lanes on the major and minor streets. The more approach lanes there are, the more traffic is required to satisfy this warrant. When two intersecting streets are roughly equivalent in size and traffic volume it can be difficult to decide which is the major street and which is the minor street. When this is the case, engineering judgment (based on such factors as the functional designation of the road and route continuity) must be exercised.

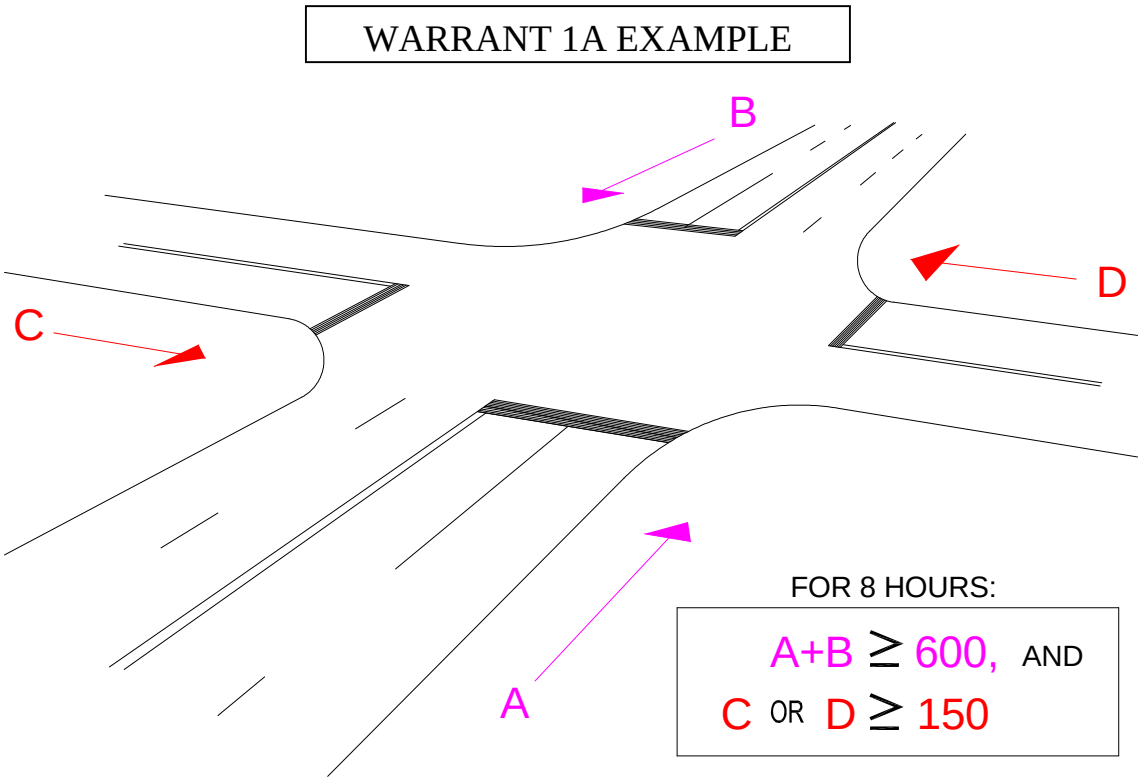
The volume of traffic on the major street required to satisfy warrant 1 is obtained by adding together the approaching volumes on the major street. The volume of traffic on the minor street required to satisfy warrant 1 is obtained by taking the highest minor street approaching volume. It should be kept in mind that the minor street approach having the highest volume may change depending on the time of day.

If an intersection has a heavy left turn movement on the major street that constitutes the predominant flow at the intersection then, for warrant calculations, this left turn movement can be treated as the minor street while the opposing thru movement is treated as the major street.

At locations serving sizeable new developments (such as a regional shopping center) a traffic signal could be needed immediately upon opening the facility. To avoid a potentially unsafe situation, expected hourly traffic volumes at opening of the facility should be projected and signal warrants should be evaluated using these projected volumes. If a signal is installed based on projected traffic volumes then, once the facility is open, a signal warrant study using actual volumes should be conducted within one year. If warrants are not met, the signal should be removed or placed into flashing operation.

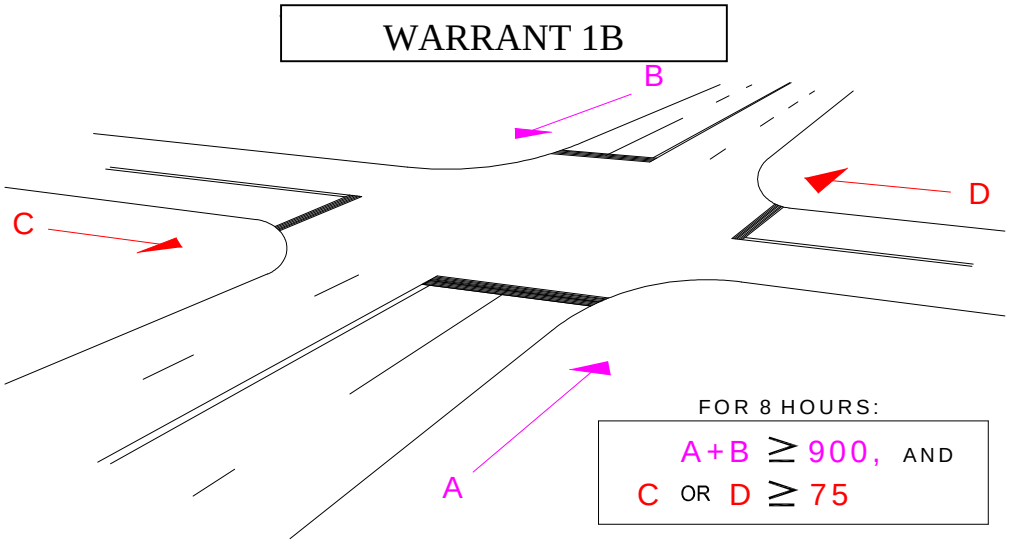
In order to satisfy warrant 1 – condition A (often referred to as warrant 1A), the Minimum Vehicular Volume warrant, traffic volumes on both the major and minor streets must be relatively high.

For example, at the intersection of a 2 lane major street and a 1 lane minor street, warrant 1A requires that the major street have at least 600 vehicles per hour and the minor street have at least 150 vehicles per hour, and that these volumes occur for at least 8 hours.



Warrant 1 – condition B (often referred to as warrant 1B), the Interruption of Continuous Traffic warrant, is satisfied when traffic volumes on the major street are so heavy that traffic on the minor street suffers excessive delay or hazard in crossing the major street. In comparison to warrant 1A, the required volumes for warrant 1B are higher on the major street, but lower on the minor street.

For example, at the intersection of a 2 lane major street and a 1 lane minor street, warrant 1B requires that the major street have at least 900 vehicles per hour and the minor street have at least 75 vehicles per hour, and that these volumes occur for at least 8 hours.



The 900 value is 50% greater than the 600 value required by warrant 1A whereas the 75 value is half that required by warrant 1A.

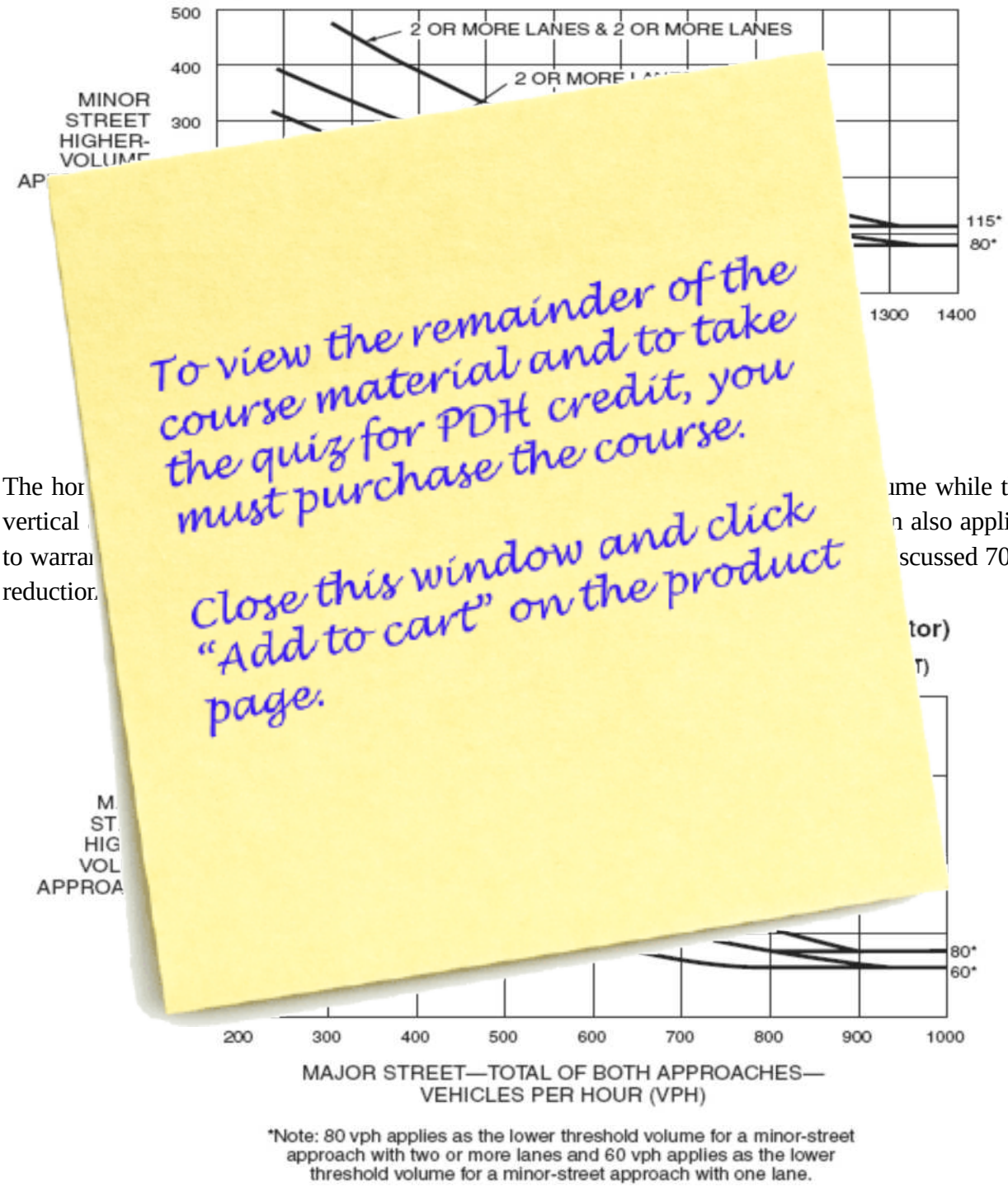
In examining the volumes required to meet warrants 1A and 1B an interesting phenomenon is noted. An intersection which satisfies one of these warrants may no longer satisfy the warrant if the number of lanes is increased. Consequently, a viable alternative to installing a signal may be the addition of travel lanes. The MUTCD echo's this sentiment by stating that "It is desirable to have at least two lanes for moving traffic on each approach to a signalized location".

When neither warrant 1A nor warrant 1B is satisfied, yet the numbers are such that both of these warrants are almost satisfied, a combination warrant (which can be referred to as warrant 1A-B) may apply. This warrant is satisfied when 80% of both warrant 1A and warrant 1B is met. However, the MUTCD cautions that adequate trial of other intersection control measures (such as a four way stop) should be carried-out before installing a signal under this warrant.

The values required to meet warrant 1 are reduced to 70% of their normal value if one of two conditions exist. The first condition is that the 85th percentile speed on the major street exceeds 40 mph. The MUTCD recognizes that, other things being equal, intersecting traffic on high-speed facilities requires a higher level of control. The second condition for applying the 70% reduction is that the intersection lies within an isolated community of less than 10,000 people. The reason for this condition is not made clear by the MUTCD. One possible explanation is that drivers in smaller communities are less accustomed than their urban counterparts in dealing with unsignalized intersections having high traffic volumes.

Warrant 2, the Four Hour Vehicular Volume warrant, is satisfied when, for any four hours of an average day, plotted points on the graph fall above the appropriate line.

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



*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.