County of Roanoke Virginia

Traffic Signal Warrants

Determining the Need for Traffic Signals and the Engineering Data Required

January 2003

Prior to the selection and use of traffic signal control at a location, the first question that must be addressed is whether or not traffic signalization is needed, or warranted. It is the responsibility of the Virginia Department of Transportation (VDOT) and the County of Roanoke to determine whether a location can best be served by the use of traffic signals. The decision should be based on a comprehensive investigation of traffic conditions and location characteristics. An explanation of the comprehensive investigation and the associated engineering data required for such a study is included herein.

Engineering Data Required

The comprehensive investigation of traffic conditions and location characteristics requires the following:

1) Traffic volumes (vehicular and pedestrian)

2) Approach travel speeds (posted and/or 85^{th}-percentile)

3) Physical condition diagrams (intersection geometrics, channelization, grades, sight-distance restrictions, pavement markings, etc.). This should include information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities.

4) Accident history and collision diagrams (showing crash experiences by type, location, direction of movement, etc.)

5) Gap studies (vehicular traffic on the major street), and

6) Delay studies (vehicle-hours of stopped time and pedestrian delay time)

Traffic Signals: Pros and Cons

It is important to remember that installing and utilizing traffic control signals has associated pros and cons. Traffic control signals that are properly located, operated, and maintained may have one or more of the following advantages:

- Signals may provide for the orderly movement of traffic by assigning right-of-way to conflicting movements of traffic;

- Signals may increase the traffic-handling capacity of an intersection by permitting conflicting streams of traffic to share the same intersection;

- Signals may reduce the frequency of certain types of accidents, especially right-angle (broadside) collisions;
- Signals may provide for continuous movement and progression of traffic through coordination with surrounding traffic signals;
- Signals may interrupt heavy traffic to allow both vehicular and pedestrian traffic to cross.

Traffic control signals that are not correctly placed or installed may have one or more of the following disadvantages:

- Signals may increase delay – both overall intersection delay and/or specific movement delay;
- Signals may encourage the use of alternate and/or less adequate routes by drivers wishing to avoid the signal;
- Signals may promote increased volumes of traffic on the minor street by drivers wishing to use the signal;
- Signals may cause an increase in the frequency of certain types of accidents, especially rear-end collisions.

In order to ensure that the advantages outweigh the disadvantages of installing a traffic signal, and to provide some consistency in the application of traffic signals, a series of warrants has been developed by the Federal Highway Administration, FHWA.

Traffic Signal Warrants

These eight warrants, taken from the FHWA's Manual on Uniform Traffic Control Devices, MUTCD 2000, define ***minimum*** conditions under which signal installations may be justified. The Manual suggests that traffic control signals should not be installed unless one or more of the eight signal warrants are met. However, satisfaction of a warrant or warrants is not in itself justification for a signal. Every situation is unique and warrant guidelines must be supplemented by the effects of specific site conditions and the application of good engineering judgment by VDOT and the County of Roanoke.

Installation of a traffic signal should improve the overall safety and/or operation of an intersection and should be considered only when deemed necessary by careful traffic analysis and after less restrictive solutions have been attempted.

Failure to meet any of the warranting criteria indicates that a traffic signal should not be installed, as there should be a better way of addressing the problems or needs at that specific location. Furthermore, if an existing traffic signal no longer meets any of the warrants, it should be removed. A summary of the traffic signal warrants are as follows:

1) **Warrant 1 -- Eight-Hour Vehicular Volume:** Traffic volumes on intersecting streets exceed specified values (see Table 4C-1, Part 4, MUTCD 2000) for each of any 8 hours of an average day ("average" day is defined as a weekday representing traffic volumes normally and repeatedly found at the location).

2) **Warrant 2 -- Four-Hour Vehicular Volume:** Traffic volumes on intersecting streets exceed specified values (see Figure 4C-1 or 4C-2, Part 4, MUTCD 2000) for each of any 4 hours of an average day.

3) **Warrant 3 -- Peak Hour:** The minor street traffic suffers undue delay (see Figure 4C-3 or 4C-4, Part 4, MUTCD 2000) when entering or crossing the major street for a minimum of 1 hour of an average day. This warrant is usually applied at locations that include office complexes, manufacturing plants, industrial complexes, or other facilities that attract or discharge large numbers of vehicles over a short time.

4) **Warrant 4 -- Pedestrian Volume:** Vehicular volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. A signal is warranted if the pedestrian volume at the location during an average day is: 100 or more for each of any 4 hours, or 190 or more during any 1 hour; and there are less than 60 adequate gaps per hour in the traffic stream for the pedestrian to cross. (The criterion for this warrant may be reduced by as much as 50% if the average crossing speed of the pedestrians at this location is less than 4 $^{ft}/_{sec}$).

5) **Warrant 5 -- School Crossing:** The number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period and there are a minimum of 20 students during the highest crossing hour.

6) **Warrant 6 -- Coordinated Signal System:** Traffic signalization is necessary to maintain proper grouping or platooning of vehicles and effectively regulate group speed.

7) **Warrant 7 -- Crash Experience:** The number of reported accidents potentially preventable by a traffic signal exceeds 5 per year. Additionally, a signal may be warranted if volume requirements of warrants 1 or 4 are 80% satisfied and less restrictive solutions have been attempted.

8) **Warrant 8 -- Roadway Network:** This warrant encourages concentration and organization of the traffic flow on a major street network. A signal may be warranted if the common intersection of 2 or more major routes 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-yr projected traffic volumes that meet one or more of Warrants 1, 2, and 3 criteria during an average weekday. It may also be warranted if 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 on a nonnormal business day (Saturday or Sunday).

Please consult *Part 4 Highway Traffic Signals*, **MUTCD 2000**, for a more detailed explanation of the 8 Warrants.

Getting a Traffic Signal Installed

If you believe that your particular intersection may meet the aforementioned warrants and you would like VDOT or Roanoke County staff to investigate the matter, please contact us at:

Mail: Traffic Engineer
County of Roanoke
Department of Community Development
P.O. Box 29800
Roanoke, VA 24018-0798

Phone: (540) 772-2080

Email: engineering@roanokecountyva.gov

However, a traffic signal may not be the best solution to the problems encountered at your particular intersection. Please continue reading to see what alternatives may be available to you.

Alternatives to Traffic Control Signals

Since traffic signals are considered to be one of the most restrictive of the traditional traffic control devices, they should be used only where the less restrictive signs and markings do not provide the necessary level of control. In areas that traffic signals are not warranted, nor the most effective means of managing traffic,

consideration shall be given to alternatives to traffic control signals. The alternatives may include, but are not limited to, the following:

- Installing signs along the major street to warn road users approaching the intersection;
- Relocating the stop line(s) and making other changes to improve the sight distance at the intersection;
- Installing measures designed to reduce speeds on the approaches;
- Installing a flashing beacon at the intersection to supplement STOP sign control;
- Installing flashing beacons on warning signs in advance of a STOP sign controlled intersection on major- and/or minor-street approaches;
- Adding one or more lanes on a minor-street approach to reduce the number of vehicles per lane on the approach;
- Revising the geometrics at the intersection to channelize vehicular movements and reduce the time required for a vehicle to complete a movement, which could also assist pedestrians;
- Installing roadway lighting if a disproportionate number of crashes occur at night;
- Restricting one or more turning movements, perhaps on a time-of-day basis, if alternate routes are available;
- If the warrant is satisfied, installing multiway STOP sign control;
- Installing a roundabout; and
- Employing other alternatives, depending on conditions at the intersection.