

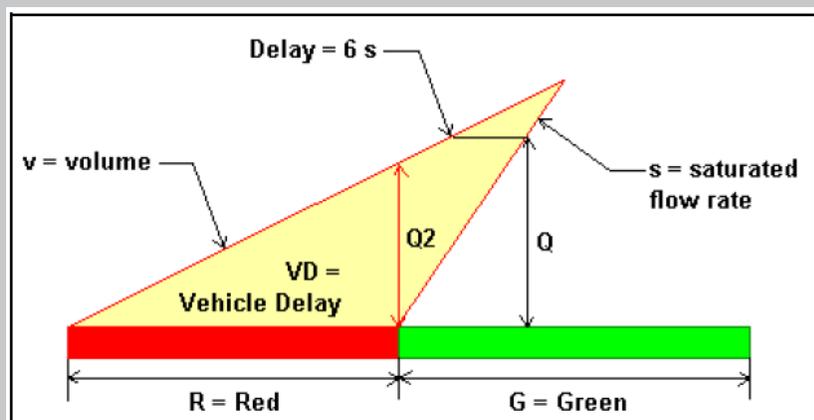
# Synchro Snippets

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We receive several questions related to the calculation of queues in Synchro and SimTraffic on our Support site. This edition of Synchro Snippets intends to shed some light on the various queue length methods applied within Synchro and SimTraffic.

First, let's examine how queues are determined in Synchro. Since Synchro is a macroscopic model, a series of equations based on traffic flow at the study intersection are used when calculating queue length. The volume-to-capacity ratio ( $v/c$ ) of the desired lane group is the key parameter used when determining which equation is used to calculate queue length. Within Synchro, the 50<sup>th</sup> and 95<sup>th</sup> percentile maximum queue lengths are calculated. Figure 14-19 from the Synchro 8 User Guide provides an arrival-departure graph for a typical cycle. Synchro calculates the value of  $Q$  (vehicles delayed by less than 6 seconds are not considered to be part of the queue). Other macro-level methods calculate  $Q_2$ . The queue length is calculated by integrating the arrival pattern of the arriving vehicles and determining the height of the shape for the 50<sup>th</sup> and 95<sup>th</sup> percentile volume levels.



## Queues Defined

The 50<sup>th</sup> percentile queue is the maximum back of queue based on the user input traffic flow.

The 95<sup>th</sup> percentile queue is the maximum back of queue based on the 95<sup>th</sup> percentile traffic volumes.

The equation used in calculating queue ( $Q$ ) is dependent on the congestion level at the intersection. If the  $v/c < 1.0$ , then equation one is used. For lane groups with  $v/c > 1.0$ , equation 2 is used. Equation 2 represents the maximum queue after two cycles, including unserved vehicles from the first cycle plus all arrivals on the second cycle.

$$(1) v/c < 1.0 \quad Q = \frac{V}{3600} * (R - 6) * \left[ 1 + \frac{1}{s/v - 1} \right] * \frac{L}{n * fLU} = \text{Queue Length (ft)}$$

$$(2) v/c > 1.0 \quad Q' = (v * (C - 6) + (v - s * g/C) * C/3600) = \text{Queue Length for Saturated Links (ft)}$$

$$(3) \quad v_{95} = v * PHFx * \left[ 1 + 1.64 * \frac{\sqrt{vc}}{C} \right] = 95^{\text{th}} \text{ Percentile Arrival Rate (vph)}$$



When calculating the 95th percentile queue, the volume is first determined based on Equation 3 and then based on the v/c ratio, equation 1 or 2 is selected. A detailed step-by-step example can be found on page 14-70 of the Synchro 8 User Guide.

Synchro also performs a series of checks to determine if flow at the study intersection is being metered by an upstream intersection. This can significantly affect queue results within saturated networks. If Synchro determines that Upstream Metering is occurring, the 95th percentile (no adjustment for the 50th percentile) is adjusted based on Equations 4 and 5.

(4)  $v/c = 1.0$ , the 95<sup>th</sup> queue will equal the 50<sup>th</sup> queue

(5)  $v/c = 0.95$ , the 95<sup>th</sup> queue will be limited to the 105% of the 50<sup>th</sup> percentile

### Key Footnotes Regarding Queuing

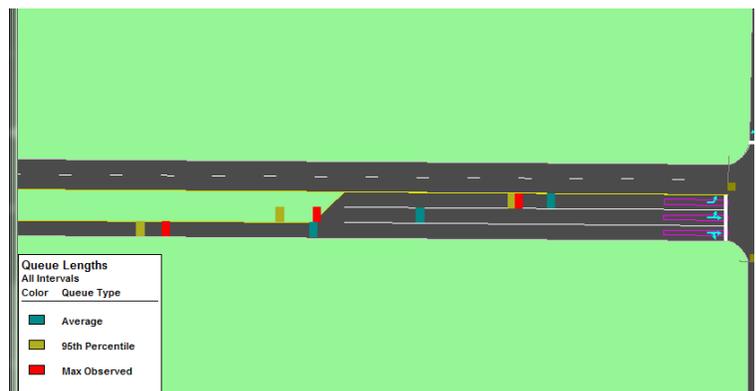
~ **Volume exceeds capacity, queue is theoretically infinite:** This is used with Intersection Queue Reports. See page 16-9.

# **95<sup>th</sup> percentile volume exceeds capacity:** This is used with Intersection Queue Reports. See page 16-9.

m **Upstream metering is in effect:** This is used with Intersection Queue Reports. See page 16-9.

The calculation of queue within SimTraffic is actually much simpler. SimTraffic is a microscopic simulation program that actually “observes” the queues based on traffic flow within the model. The model simulates individual vehicles as they traverse through the network. A vehicle is considered to be in a queue whenever it is traveling less than 10 feet per second and is either at the stop bar or behind other queued vehicles. At the completion of the simulation, SimTraffic reports the following maximums: the average queue (average of observed maximum queue at each 2 minute-interval) and the 95th percentile queue.

The 95th Percentile Queue is not necessarily an observed queue, but rather a calculated queue based on the standard deviation. Standard deviation is calculated by using the sum of squares for each 2 minute interval. The 95th Queue is equal to the Average Queue plus 1.65 standard deviations. The queues depicted in the graphic to the right provides a typical example of the relationship between the various queue results calculated within SimTraffic. Since the 95th Percentile queue is calculated, it is possible for it to be larger than the maximum queue. The traffic engineer should use their judgment in determining the most applicable queue value.



Queues calculated by Synchro and/or SimTraffic are reliable and provide the traffic engineer or planner with reasonable values based on the various attributes coded. It should be noted that when using SimTraffic, multiple runs should be completed and the results averaged. As v/c ratios begin to approach and exceed 1.0, a calibrated SimTraffic model should provide the most realistic queue results.