Determination of Level of Service Volume Standards for Town Roads

The following methodology, look-up tables, and calculation procedure are provided hereinafter to determine the adopted level of service volume standards on Town thoroughfares given roadway characteristics including posted speed limit, lane width, shoulder width, median type, access density, sidewalk and bikelane coverage, intensity of signalized, two-way, all-way stop controlled intersections and/or traffic calming devices. An applicant for a new development or redevelopment may use this procedure to propose the necessary roadway improvements to meet the transportation concurrency requirements if roadway capacity deficiencies are determined to be an issue in the applicant's traffic study. The increase in service volume as estimated from this methodology due to the proposed roadway improvements could also be used to determine the proportionate fair share of the contribution from the applicant. Upon roadway improvements being committed, the adopted level of service standards established in the Comprehensive Plan may be amended, at the discretion of the Town Council, based on the methodology specified in this Section.

The volume standards are primarily established for peak hour directional traffic based on the volume-to-capacity ratio and maximum density designated at each level of service in the following table, and then converted to peak hour two-way as well as AADT using the *K* (conversion factor from AADT to peak hourly volume) and *D* (directional) factors. Note that the service volume standards greater than D would become F in some instances if intersection capacities have been reached. The calculation procedure can also be implemented using a worksheet program provided by the Town Engineering office.

Level of Service	**A**	**B**	**C**	**D**	**E**
Volume-to-capacity ratio	0.22	0.35	0.55	0.73	0.92
Max. density (vpmpl)	11	18	26	35	45
Peak-hour directional service volume (vph)	S_{avg} × max. density × no of lanes				
Peak-hour two-way service volume (vph)	Average peak-hour directional service volume divided by *D*				
AADT standards	Peak-hour two-way service volume divided by *K*				

(1) The average running speed, S_{avg}, is determined based on the free-flow speed and the effect of signal/stop controls/calming devices as follows:

$$S_{avg} = \left[\frac{1}{k \cdot FFS} + \frac{\sum_{i=1}^{4} n_i d_i}{3600} \right]^{-1} \text{ (mph)}$$

where FFS = Free-flow speed (mph);
k = FFS adjustment factor (=1 for LOS A through C; =0.97 for LOS D; =0.93 for LOS E)
n_i = number of signal/stop controls/calming devices per mile (i = 1, 2, 3, 4_for signal, two-way stop, all-way stop, and calming devices); and
d_i = average signal/stop control/calming device delay (sec/veh).

(2) The free-flow speed (*FFS*) is calculated by subtracting speed reductions due to lane-width/ shoulder, median, access density, and coverage of sidewalk/bikelane from the base free-flow speed (*BFFS*) in the following fashion:

$$FFS = BFFS - f_W - f_M - f_A - f_B \text{ (mph)}$$

where f_W = Lane-width adjustment factor;
f_M = Median type adjustment factor;
f_A = Access density adjustment factor; and
f_B = Sidewalk/bikelane adjustment factor.

In practice, *BFFS* is usually assumed as 5 mph over the posted speed limit (*PSL*), i.e., *BFFS* = *PSL*+5. The *K* and *D* factor is defaulted as 0.095 and 0.55 unless appropriate evidences from a local study or survey are employed to justify the use of different design values. The adjustment factors are described as follows:

a. Lane-width/shoulder width adjustment factor
f_W = tabulated speed reduction**PSL*/55

Lane Width (ft)	Shoulder Width (ft)			
	<2	≥2 - 4	≥4 - 6	≥6
9 - 10	6.4	4.8	3.5	2.2
≥10 - 11	5.3	3.7	2.4	1.1
≥11 - 12	4.7	3.0	1.7	0.4
≥12	4.2	2.6	1.3	0

(Source: tabulated speed reductions are taken from HCM 2000)

b. Median type adjustment factor (f_M)

Median Type	f_M
Undivided (2 lane road)	$1.6 + 0.9*(n\text{-}1)^*$
Undivided (4 lane road)	0.8
Two-way left-turn lane	0
Divided	0

Note:*n is number of left-turn access points per mile without exclusive turn lane or divided median. If the number of access points is greater than 3 per mile, n = 3.

c. Access density adjustment factor (f_A = 0.25*Access Density)

Access Density (per mile)	f_A
0	0
10	2.5
20	5
≥ 32	8

Note: Access density refers to no. of influencing driveways/on-street parking per mile on right-side of travel direction if roadway is divided; otherwise access points from both sides should be counted. (Source: HCM 2000)

d. Sidewalk/bikelane/shared-path adjustment factor (f_B)
$f_B = f_{B1} + f_{B2}$ or f_{B3} (assumed the existence of shared-use path is exclusive from

sidewalk/bikelane), where f_{B1}, f_{B2}, f_{B3} are adjustment factor for bikelane, sidewalk, and shared-use path, respectively.

Coverage of bikelane/sidewalk	f_{B1}	f_{B2}	f_{B3}
85% or more	0	0	0
50% - 85%	0.9	0.4	1.1
Less than 50%	1.7	0.7	2.0

(3) The average signal/stop control/calming device delay, d_1 through d_4, should be determined based on the most recently published HCM methodology as follows:

a. The signalized intersection delay can be determined as:

$$d_1 = PF \cdot \frac{C(1-\lambda)^2}{2(1-\lambda x)} + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{16x}{c}} \right) \text{ (sec)}$$

where PF=progression adjustment factor (default =1.0, poor=1.2, good=0.8);
C = cycle length (= 120 sec as default);
λ = effective green time to cycle ratio (= 0.41 as default);
x = volume-to-capacity ratio (= 0.22, 0.35, 0.55, 0.73, and 0.92 for LOS A, B, C, D, and E); and
c = capacity (= 1710·λ as default).

b. The intersection delay for two-way stop control can be determined as follows:

$$d_2 = \frac{3600}{c} + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{32x}{c}} \right) + 5 \text{ (sec)}$$

where c = capacity (vph) = $\frac{v_c e^{-v_c t_c / 3600}}{1 - e^{-v_c t_f / 3600}}$;
v_c = total conflicting volume (= 300 vph as default, since all-way stop control might be warranted if v_c exceeds 300 vph);
t_c = critical gap (= 4 sec as default); and
t_f = follow-up time (= 2.5 sec as default).

c. The intersection delay for all-way stop control can be determined as follows:

$$d_3 = h_d - t_m + 225 \cdot \left(x - 1 + \sqrt{(x-1)^2 + \frac{h_d x}{112.5}} \right) + 5 \text{ (sec)}$$

where h_d = departure headway (= 5.5 sec and 6.5 sec for one-lane and two-lane approach); and
t_m = move-up time (= 2 sec as default).

d. Delay due to traffic calming devices can be calculated based on the speed differential between *FFS* and the regulatory speed limit for the calming devices (denoted as s_c in mph). Assuming the driver decelerates from *FFS* to s_c (defaulted as 20 mph) at comfortable deceleration rate, a, of 11.2 ft/s^2 when approaching the calming device, passes through the device in 0.5 sec, and then accelerates to resume FFS at the same acceleration rate. The delay can then be calculated as:

$$d_4 = \frac{2.93(FFS - s_c)}{a} + 0.5 - \frac{0.73(FFS^2 - s_c^2)}{a \cdot FFS} \text{ (sec)}$$