1. INTRODUCTION

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Chapter 14, Multilane Highways, addresses capacity and level-of-service (LOS) analysis for uninterrupted-flow segments of surface multilane highways. In general, uninterrupted flow may exist on a multilane highway if there are 2 mi or more between traffic signals. Where signals are more closely spaced, the facility should be analyzed as an urban street.

Many multilane highways will have periodic signalized intersections, even if the average signal spacing is well over 2 mi. In such cases, the multilane highway segments that are more than 2 mi away from any signalized intersections are analyzed by using the methodology of this chapter. Isolated signalized intersections should be analyzed with the methodology of Chapter 18, Signalized Intersections.

LOS procedures are provided for both automobiles and bicycles. The automobile methodology is based on the results of NCHRP Project 3-33 (*1*), and bicycle LOS is based on research conducted for the Florida Department of Transportation (2). The same methodology for bicycle LOS is used for both multilane and two-lane highways; readers interested in details of the bicycle methodology should refer to Chapter 15, Two-Lane Highways.

TYPES OF MULTILANE HIGHWAYS

Multilane highways generally have four to six lanes (in both directions) and posted speed limits between 40 and 55 mi/h. In some states, speed limits of 60 or 65 mi/h are used on some multilane highways. These highways may be divided by one of various median types, may be undivided (with only a centerline separating the directions of flow), or may have a two-way left-turn lane (TWLTL). They are typically located in suburban areas, leading into central cities, or along high-volume rural corridors, connecting two cities or two activity centers that generate a substantial number of daily trips. Exhibit 14-1 illustrates common types of multilane highways.

Traffic volumes on multilane highways vary widely but often have demand in the range of 15,000 to 40,000 veh/day. In some cases, volumes as high as 100,000 veh/day have been observed when access across the median is restricted and when major crossings are grade-separated. Bicycles are typically permitted on multilane highways, and multilane highways often serve as primary routes for both commuter cyclists (on suburban highways) and recreational cyclists (on rural highways).

BASE CONDITIONS

Base conditions include good weather, good visibility, and no incidents or accidents. These conditions are always assumed to exist.

The base conditions under which the full capacity of a multilane highway segment is achieved include good weather, good visibility, no incidents or accidents, no work zone activity, and no pavement defects that would affect operations. This chapter's methodology assumes that these conditions exist. If any of these conditions do not exist, the speed, LOS, and capacity of the multilane highway segment can be expected to be worse than the predictions by this methodology.

Exhibit 14-1
Multilane Highways

(a) Divided suburban multilane highway

(b) Undivided suburban multilane highway

(c) Suburban multilane highway with TWLTL

(d) Undivided rural multilane highway

Base conditions include 0% heavy vehicles and a driver population composed of regular users of the highway.

The methodology provides adjustments for situations in which these conditions do not apply.

Base conditions include the following conditions; the methodology can be adjusted to address situations in which these conditions do not exist:

- No heavy vehicles, such as trucks, buses, and recreational vehicles (RVs), in the traffic stream; and
- A driver population composed primarily of regular users who are familiar with the facility.

Characteristics such as lane width, total lateral clearance (TLC), median type, and access-point density will have an impact on the free-flow speed (FFS) of the facility. Curves describing operations under base conditions, however, account for differing FFSs.

FLOW CHARACTERISTICS UNDER BASE CONDITIONS

More severe geometric characteristics and the existence of access points are two key differences that result in lower multilane highway speeds and capacities than those of freeways with similar cross sections.

Uninterrupted flow on multilane highways is in most ways similar to that on basic freeway segments (Chapter 11). Several factors are different, however. Because side frictions are present in varying degrees from uncontrolled driveways and intersections as well as from opposing flows on undivided cross sections, speeds on multilane highways tend to be lower than those on similar basic freeway segments. The basic geometry of multilane highways also tends to be more severe than that of basic freeway segments because of the lower speed expectations. Last, isolated signalized intersections can exist along multilane highways. The overall result is that speeds and capacities on multilane highways are lower than those on basic freeway segments with similar cross sections.

Exhibit 14-2 shows speed–flow characteristics of multilane highway segments for various FFSs. Equations describing these curves are shown in Exhibit 14-3.

Curves are shown for FFSs between 45 mi/h and 60 mi/h. Because FFSs can vary widely, it is recommended that the FFS of a multilane highway segment be estimated to the nearest 5 mi/h, as follows:

42.5 mi/h ≤ FFS < 47.5 mi/h: use FFS = 45 mi/h,

47.5 mi/h ≤ FFS < 52.5 mi/h: use FFS = 50 mi/h,

52.5 mi/h ≤ FFS < 57.5 mi/h: use FFS = 55 mi/h,

57.5 mi/h ≤ FFS < 62.5 mi/h: use FFS = 60 mi/h.

The FFS of a multilane highway segment should be rounded to the nearest 5 mi/h.

For multilane highway segments, speeds remain constant until they reach 1,400 pc/h/ln, after which speeds decline with further increases in flow rate.

Flow rates over 1,400 pc/h/ln result in speeds below the highway's FFS.

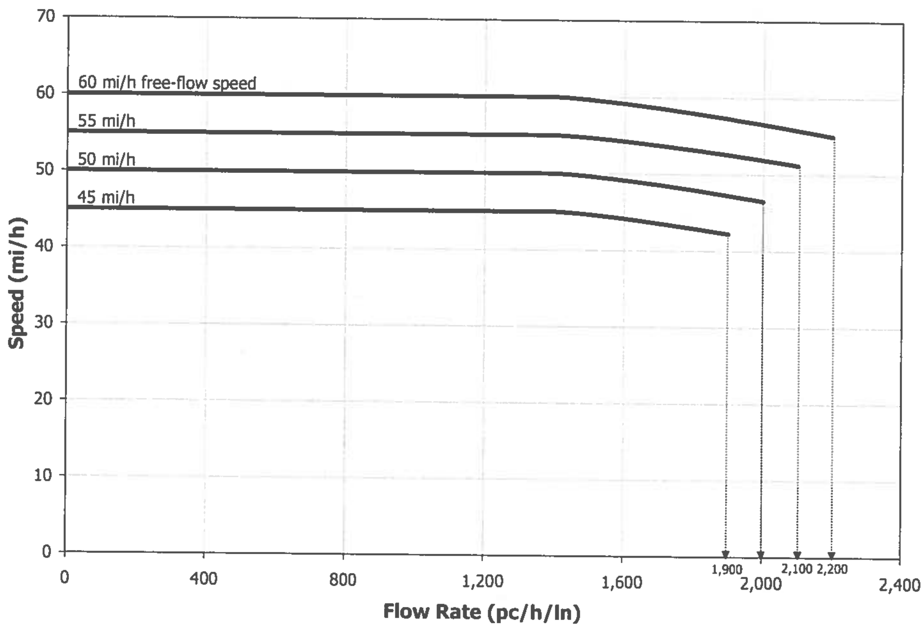

Exhibit 14-2
Speed–Flow Curves for Multilane Highways Under Base Conditions

Note: Maximum densities for LOS E occur at a *v/c* ratio of 1.00. These are 40, 41, 43, and 45 pc/mi/ln for FFSs of 60, 55, 50, and 45 mi/h, respectively.

Exhibit 14-3
Equations Describing Speed–Flow Curves in Exhibit 14-2

FFS (mi/h)	For $v_p \le 1{,}400$ pc/h/ln, S (mi/h)	For $v_p > 1{,}400$ pc/h/ln, S (mi/h)
60	60	$60 - \left[5.00 \times \left(\frac{v_p - 1400}{800}\right)^{1.31}\right]$
55	55	$55 - \left[3.78 \times \left(\frac{v_p - 1400}{700}\right)^{1.31}\right]$
50	50	$50 - \left[3.49 \times \left(\frac{v_p - 1400}{600}\right)^{1.31}\right]$
45	45	$45 - \left[2.78 \times \left(\frac{v_p - 1400}{500}\right)^{1.31}\right]$

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CAPACITY OF MULTILANE HIGHWAY SEGMENTS

Multilane highways with higher FFSs will also have higher base capacities. As most highways do not operate under base conditions, observed capacities will usually be lower than the base capacity.

Capacities represent an average flow rate across all lanes. Individual lanes could have higher stable flows.

The capacity of a multilane highway segment under base conditions varies with the FFS. For 60-mi/h FFS, the capacity is 2,200 pc/h/ln. For lesser FFSs, capacity diminishes. For 55-mi/h FFS, the capacity is 2,100 pc/h/ln; for 50-mi/h FFS, 2,000 pc/h/ln; and for 45-mi/h FFS, 1,900 pc/h/ln.

These values represent national norms. Capacity varies stochastically, and any given location could have a larger or smaller value. In addition, capacity refers to the average flow rate across all lanes. Thus, a two-lane (in one direction) multilane highway segment with a 60-mi/h FFS would have an expected capacity of 2 × 2,200 = 4,400 pc/h. This flow would not be uniformly distributed in the two lanes. Thus, one lane could have stable flows in excess of 2,200 pc/h/ln.

LOS FOR MULTILANE HIGHWAY SEGMENTS

Automobile Mode

Automobile LOS is defined by density.

Automobile LOS for multilane highway segments are defined in Exhibit 14-4. Because speeds are constant through a broad range of flow rates, LOS are defined on the basis of density, which is a measure of the proximity of vehicles to each other in the traffic stream.

Exhibit 14-4
Automobile LOS for Multilane Highway Segments

LOS	FFS (mi/h)	Density (pc/mi/ln)
A	All	>0–11
B	All	>11–18
C	All	>18–26
D	All	>26–35
E	60	>35–40
	55	>35–41
	50	>35–43
	45	>35–45
F	Demand Exceeds Capacity	
	60	>40
	55	>41
	50	>43
	45	>45

LOS thresholds for multilane highways are the same as those on freeways for LOS A–D. However, multilane highway capacity (the LOS E–F boundary) occurs at lower densities.

For LOS A through D, the criteria are the same as those for basic freeway segments. This classification is appropriate, since both represent multilane uninterrupted flow. The boundary between LOS E and F, however, represents capacity. For multilane highways, capacity occurs at varying densities, depending on the FFS. The density at capacity ranges from 40 pc/mi/ln for 60-mi/h FFS to 45 pc/mi/ln for 45-mi/h FFS.

LOS F is determined when the demand flow rate exceeds capacity. When this occurs, the methodology does not produce a density estimate. Thus, although density in such cases will be above the thresholds shown, specific values cannot be determined.

Exhibit 14-5 shows LOS thresholds in relation to the base speed–flow curves.