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# 5I-5 Removing Turning Vehicles from Through Traffic Lanes

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## A. General

All driveway and intersection geometrics require that turns be made at very slow speeds and hence result in high speed differentials. The only means of limiting the speed differential is to provide an auxiliary lane for turning maneuvers. This is especially important on high volume and high speed roadways.

The several methods by which turning vehicles can be removed from through traffic lanes are:

- Install isolated left-turn bay
- Install a nontraversable median with left-turn bays
- Install right-turn deceleration bay
- Install right-turn lane
- Install a continuous two-way left-turn lane

## B. Crash rates

Minnesota conducted a crash study between 1991 and 1993 in urban areas comparing crash rates to the type of urban roadway. Table 1 shows the results of that study.

**Table 1:** Urban roadway types vs. crashes

<b>Roadway Type (All Urban Arterials)</b>	<b>Crash Rate (Crashes Per Million Vehicle-Miles)</b>
4-lane undivided	6.75
3-lane with center turn lane	4.96
4-lane with median	4.02
5-lane with center turn lane	4.01

Source: BRW, Inc. study for Minnesota Department of Transportation, August 1998.

## C. Three lanes with TWLTL

Three-lane roadway designs can be effectively used in situations where there are low to moderate levels of through traffic, yet concerns about conflict points and crashes caused by left-turning traffic. The upper limit for using a three lane design is about 17,000 vehicles per day of traffic. Three-lane designs are ideal where right-of-way width is limited due to existing land development or other constraints. Three lane roads can either be designed that way originally or can be created by widening an existing 2-lane route or by modifying an existing 4-lane undivided route.

## D. Five lanes with TWLTL

When the average daily traffic (ADT) on a street exceeds about 17,000 vehicles per day, 4-lane roadways with raised medians or 5-lane roadways with two-way left-turn lanes (TWLTL) are more appropriate designs. The limit for 5-lane roadway (with TWLTL) is approximately 24,000 ADT. TWLTL should not be used in situations where there are more than four total through lanes.

## E. Raised medians vs. two-way left turn lanes

1. Because they are the most restrictive access management treatment, building raised center medians along arterial are often very controversial among business and property owners. Two-way left-turn-lanes (TWLTL) are much less controversial among businesspersons and property owners. Business persons and property owners feel that installation of raised medians will have a large, negative impact on their customers, sales, and property values. Therefore, two-way left-turn lanes are often suggested as compromise solutions.
2. Arterial roadways with raised medians are statically safer and operate better than any other configuration involving access management. Research indicates that raised median roadways will always be at least 20 to 30% safer than undivided roadways in urban areas. When traffic volume on an arterial roadway is projected to exceed about 24,000 average annual daily traffic (AADT) during the next 20 years, including a raised median is prudent.
3. In general, TWLTL projects function well when traffic levels are moderate, when the percentage of vehicles turning as opposed to traveling through is high, and when the density of commercial driveways is low. Two-way left-turn lanes will function very well on most arterials where AADT is in the range of 10,000 to 24,000 AADT (5-lane TWLTL).
4. TWLTL projects can also work very well in places where the number of driveways per block or mile is high, but the land use is such that not many turning movements are generated per hour. An example would be an arterial through a predominately residential area.
5. Two-way left-turn lanes are also much less effective in situations where commercial driveway densities are high and these driveways are spaced close together. In such a situation, the number of conflict points is high and this will be reflected in crash experience. Research from many states indicates that raised median roadways are always safer than TWLTL roadways. If two-way left-turn lanes are considered, driveway density and driveway spacing must be managed very aggressively.

**Table 2:** Representative crash rates per million vehicle miles traveled (MVMT)

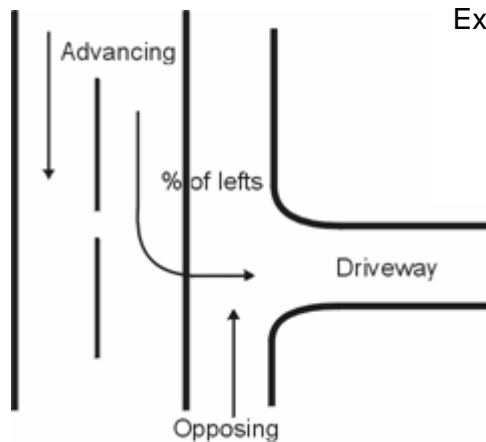
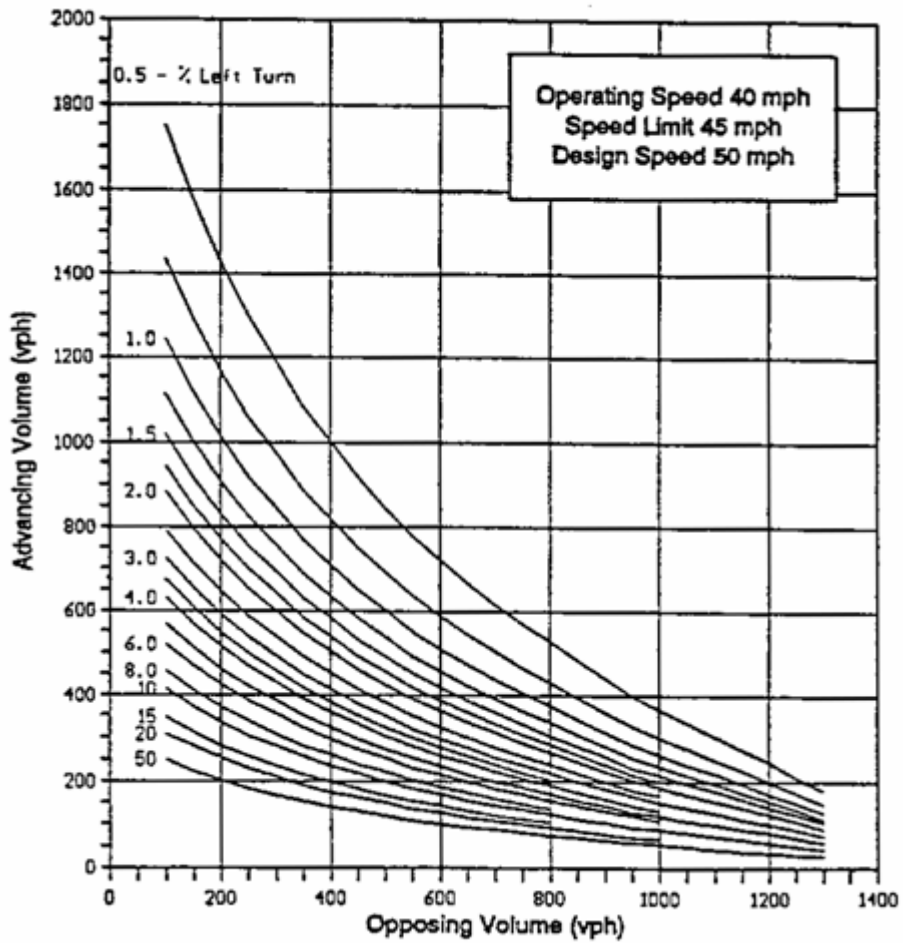
Access Points Per Mile	Undivided (Painted Centerline) Crash Rate (Per MVMT)	TWLTL Crash Rate (Per MVMT)	Raised Median Crash Rate (Per MVMT)	Rate Reduction Raised Median Versus TWLTL
Less than 20	3.8	3.4	2.9	-0.5 (15%)
20 to 40	7.3	5.9	5.1	-0.8 (14%)
40 to 60	9.4	7.4	6.5	-0.9 (12%)
Over 60	10.6	9.2	8.2	-1.0 (11%)

Source: National Cooperative Highway Research Program Report

**F. Left turn lanes (urban/ suburban areas) warrants**

Left turn lanes allow turning vehicles to clear the through traffic lane with an acceptable speed differential, queue storage is provided without interference with through traffic, rear-end and side-swipe collisions are greatly reduced, and the capacity is increased and delay decreased. To use Figures 1 and 2, mark the advancing volume with percentages left of the advancing volume on the figure. Move straight down to determine the opposing volume. If the opposing volume in the figure is equal to or less than the actual opposing volume then a left turn lane is warranted.

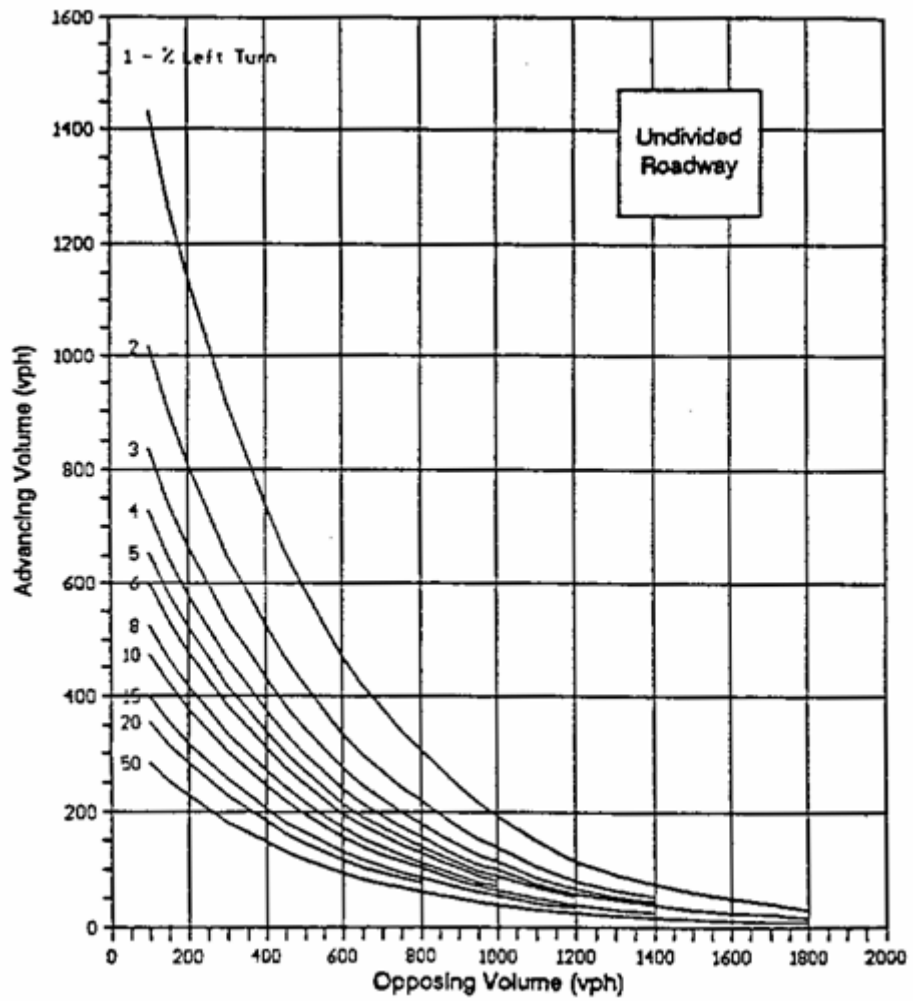
**Figure 1:** Left-turn lane at unsignalized driveway/intersection - two-lane roadway



Example: Advancing Volume - 800 vph  
% Left Turn - .75%  
Opposing Volume - 400 vph  
Actual Opposing Volume 450 vph  
Left Turn Warranted.

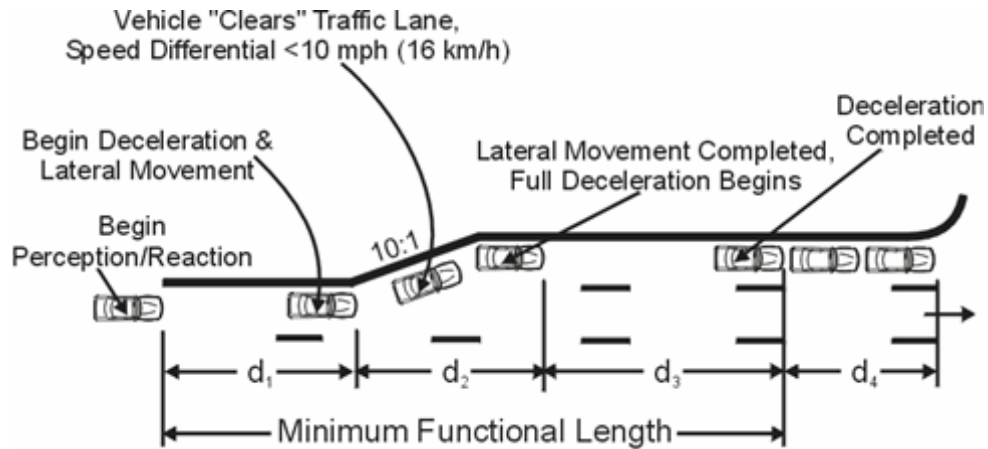
**ITE Warrants for Left-Turn Bays on 2-Lane Roadways**

**Figure 2:** Guidelines for left-turn lane at unsignalized intersection - four-lane roadway, undivided roadway



**ITE Committee 4A-2 Guidelines for Left-Turn Lanes at Unsignalized Approaches on Multi-Lane Undivided Roadways**

### G. Left turn lane length with raised medians



No crossing traffic (driveway or intersection) should be within the functional length or storage length.

$d_1$  = distance traveled during perception - reaction time (2.5 sec.)

$d_2$  = distance traveled while driver decelerates and maneuvers laterally ( $4.5 \text{ fps}^2$ )

$d_3$  = distance traveled during full deceleration and coming to a stop or to a speed at which the turn can be comfortably executed ( $9.0 \text{ fps}^2$ )

$d_4$  = storage length

**Table 3:** Minimum functional length

MPH	L(ft)
30	280 ft
35	348 ft
40	422 ft
45	505 ft

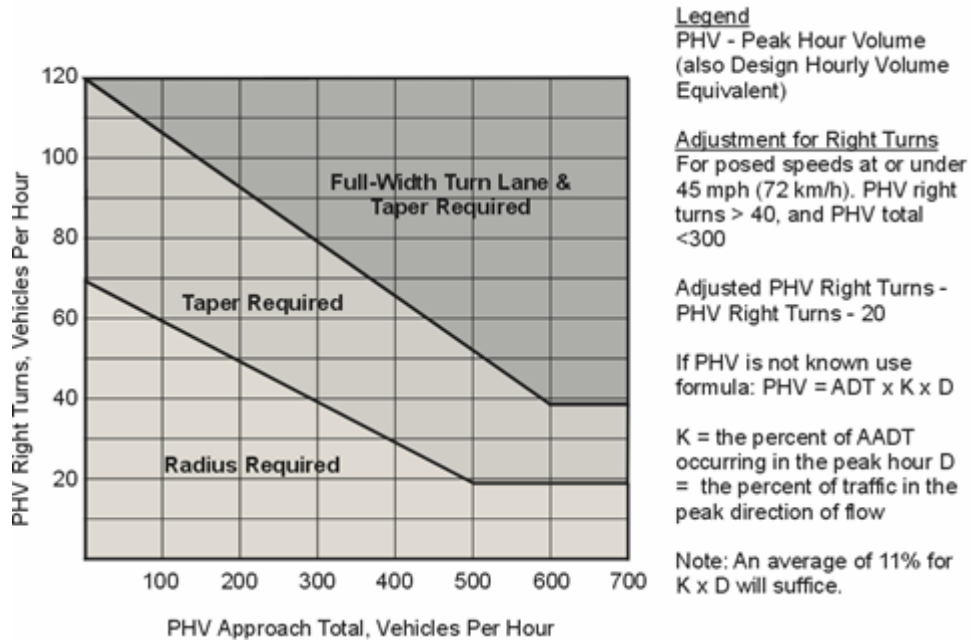
Source: Florida Department of Transportation 1995

- $d_3$  and  $d_4$  for unsignalized intersections is normally 150 feet. A minimum storage length for  $d_4$  should be two vehicles.
- $d_4$  for signalized intersection is a function of turning volume, cycle length and percent trucks.
- Add approximately 80 feet plus  $d_4$  to the above volumes to obtain minimum distance between centerline of driveway/intersections.

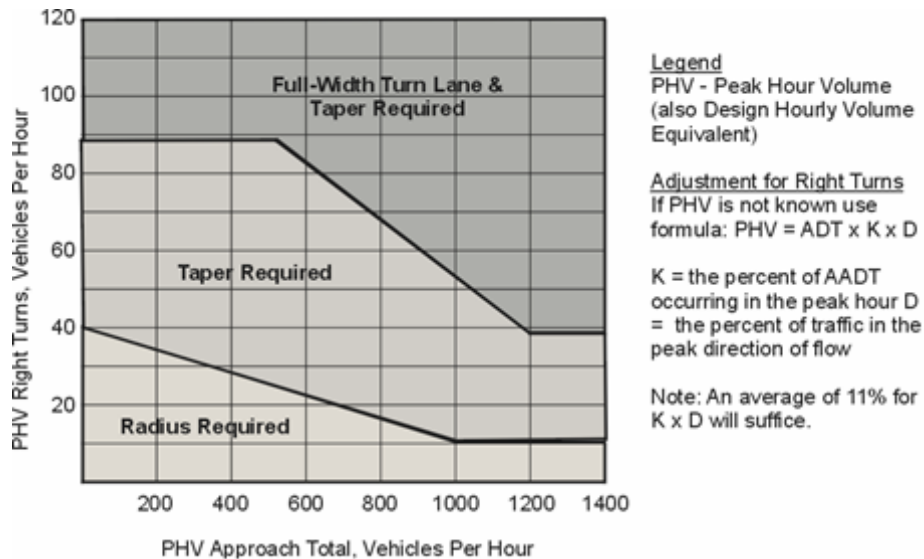
## H. Right turn lanes (urban/suburban areas)

1. Warrants for right turn lanes (unsignalized)

**Figure 3:** Guidelines for right turn treatments 2-lane highway



**Figure 4:** Guidelines for right turn treatments 4-lane highway



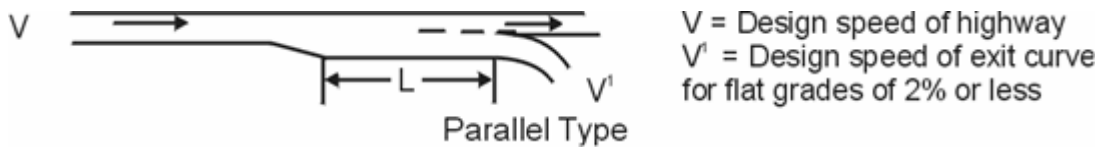
**I. Rural left turn and right turn lane warrants**

See Iowa Department of Transportation’s Design Manual, Chapter 6.

**J. Right turn lane deceleration length (unsignalized)**

**Table 4:** Right turn lane deceleration length

Highway Design Speed, V (mph)	Deceleration Legth, L (ft) for Design Speed of Exit Curve, (mph)			
	Stop Condition	15	20	25
30	235	185	160	140
40	315	295	265	235
50	435	405	385	355
60	530	500	490	460
65	570	540	530	490
70	615	590	570	550



V = Design speed of highway  
 V' = Design speed of exit curve  
 for flat grades of 2% or less