

# Are Raised Medians Safer Than Two-Way Left-Turn Lanes?

BY W. MARTIN BRETHERTON JR.

**J**immy Carter Boulevard is a major east-west arterial in Gwinnett County. The county road system has many north-south principal and major arterials. These include Peachtree Industrial Boulevard, Buford Highway, Interstate I-85, U.S. 29, Five Forks Trickum Road and U.S. 78. The problem with the road system is the lack of major arterials that operate east-west. These east-west arterials are Jimmy Carter Boulevard/Rockbridge Road, Indian Trail-Lilburn Road/Killian Hill Road, Beaver Ruin Road/Arcado Road, Pleasant Hill Road/Lester Road and the planned Ronald Reagan Parkway. The capacity of the north-south arterial roads are much greater than the east-west arterial.

Jimmy Carter Boulevard, before April 1987, was a five-lane roadway with four thru lanes and a two-way left-turn lane (TWLTL). The area of greatest traffic congestion occurs between Buford Highway on the West end and Singleton Road on the east end. I-85 bisects this section of roadway forming a "barrier" between land uses. The east side from Singleton Road to I-85 is mostly retail businesses while the west side from Buford Highway to I-85 is mostly industrial and commercial businesses with some retail. This corridor was experiencing many traffic accidents and was perceived to be a hazardous place to drive. The main reason was because average daily traffic volumes were averaging between 39,000 vehicles/day on the Buford Highway side to more than 50,000 vehicles/day on the Singleton Road side. The roadway is maintained by the Georgia Department of Transportation on the north as State Route 140, while the south end, from I-85 to Singleton Road is maintained by Gwinnett County. Figure 1 shows the project location and limits.

## The Existing Operation of the Two-Way Left-Turn Lanes

The operation of a two-way left-turn lane allows vehicles to make seven conflicting movements (See Figure 2). The conflicts involve 1) motorists trying to cross Jimmy Carter Boulevard from a driveway to a driveway or street to street; 2) making a left turn off Jimmy Carter Boulevard to a drive-

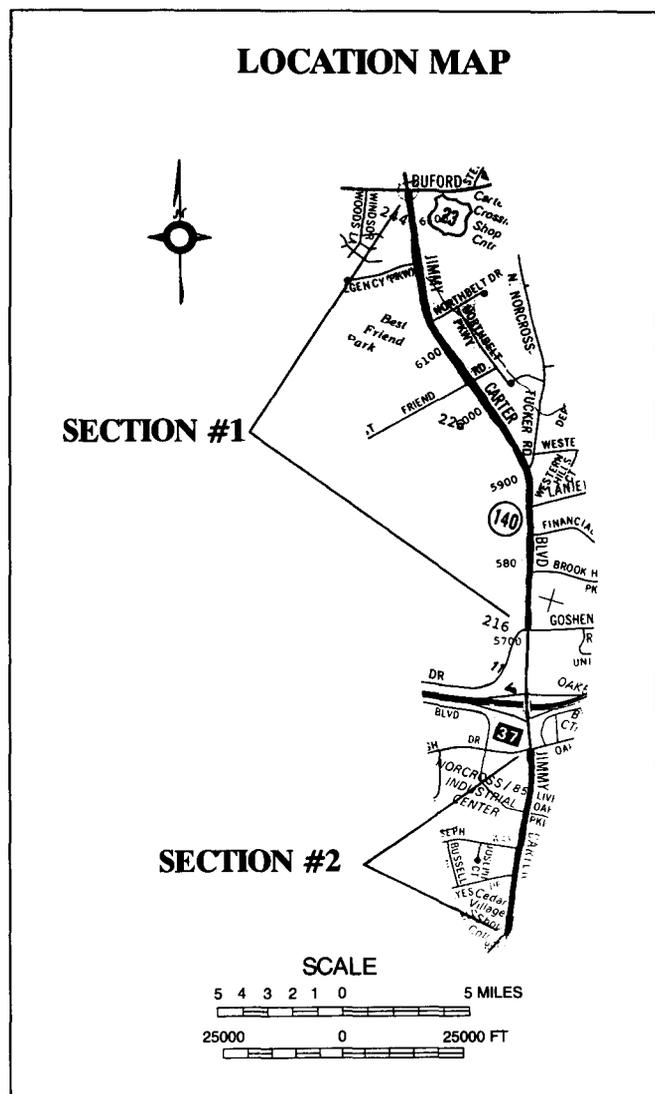


Figure 1. Location Map

way or side street; 3) using the left-turn lane to pass stopped vehicles in the main thru lanes; 4) allowing uncontrolled U-turns across two thru lanes; 5) making a left turn from a side street or driveway onto Jimmy Carter Boulevard; 6) accelerating in TWLTL to merge right; and 7) head-on accidents in the TWLTL. All of these conflicts are potential traffic accidents. These conflicts are highlighted by the very high traffic volumes on Jimmy Carter Boulevard, which minimize natural gaps in traffic. Another operational problem is the potential safety hazard of pedestrians trying to cross the street, as there is no refuge area in a five-lane roadway. The final problem on Jimmy Carter Boulevard was the lack of capacity for the corridor. All the turning movement conflicts, closely spaced traffic signals and near misses were causing very low operating speeds, which severely limited the capacity of the roadway.

It was decided by the Gwinnett County Board of Commissioners, under the recommendation of the Gwinnett

County Department of Transportation and the Georgia Department of Transportation, to install a raised median in place of the two-way left-turn lane. The new roadway would be six thru lanes with a 10 foot (ft) concrete median (4 ft wide) dividing the three thru lanes in each direction.

The county and state expected the conflict accidents involving the usage of the two-way left-turn lanes to be reduced. The expected reductions included mid-block angle intersection type accidents, side swipe opposite accidents, head-on type accidents and possibly some rear-end accidents. The county expected an increase in struck object accidents and angle intersection accidents at intersections. The theory for the reductions and increases was based on how a two-way left-turn lane and raised median section operate. To get a better understanding of these operational services and their effects on safety, the county looked at the operational advantages and disadvantages of two-way left-turn lanes and raised medians.

### **Operational Effects of Two-Way Left-Turn Lanes**

Listed below are the advantages and disadvantages of designing and operating a median with a two-way left-turn lane.<sup>1</sup>

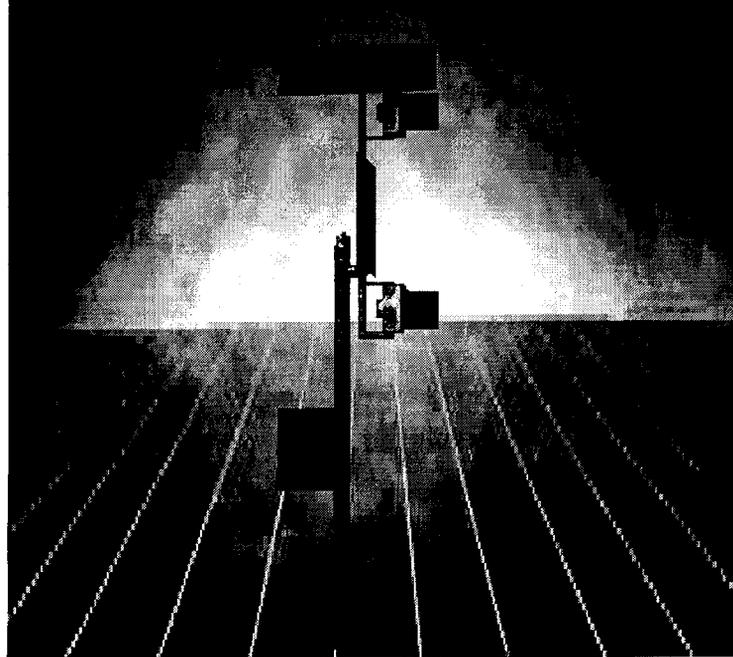
#### *Advantages*

1. Remove left-turning vehicles from thru traffic while still providing maximum left-turn access to side streets and driveways.
2. Encourage new strip development.
3. Reduce delay for left-turning vehicles.
4. Enhance operational flexibility for emergency vehicles and others.
5. Operate safer when less than 60 commercial driveways per mile are permitted to be constructed.
6. Are operationally safer than roadways with no turn lanes in the median.

#### *Disadvantages*

1. Conflicting vehicle maneuvers at driveways.
2. Poor operation of roadway if stopping sight distance is less than the AASHTO minimum design.
3. No refuge area for pedestrians.

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4. Operate poorly under high volume of thru traffic.
5. Should not be used when access is required on only one side of the street.
6. Visibility problems with painted median, especially with snow and rain or when pavement markings begin to outlive their design life.
7. A safety problem when they are used as a passing lane.
8. High maintenance cost of keeping the striping and raised pavement markers in proper operating condition.
9. Must continually instruct public of proper use and operation.

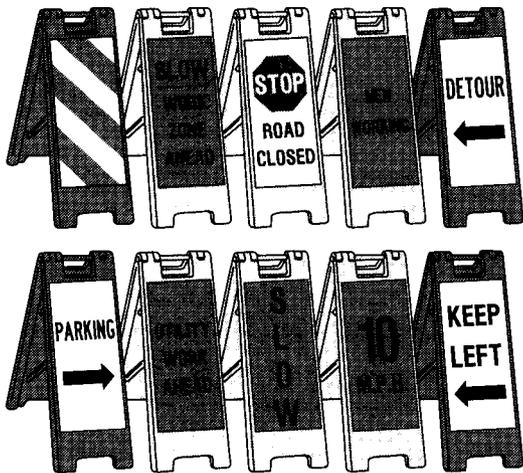
### Operational Effects of Raised Medians

Listed below are the advantages and disadvantages of designing and operating a median with a raised median design.<sup>1</sup>

#### Advantages:

1. Discourage new strip development.
2. Allow better control of land use by local government.
3. Reduce number of conflicting vehicle maneuvers at driveways.
4. Safer on major arterials with high (greater than 60) number of driveways per mile.
5. Increase traffic flow.
6. Desirable for large pedestrian volumes, provide refuge area.
7. Permit circuitous flow of traffic in a grid pattern.
8. Allow greater operating speeds on through roads.

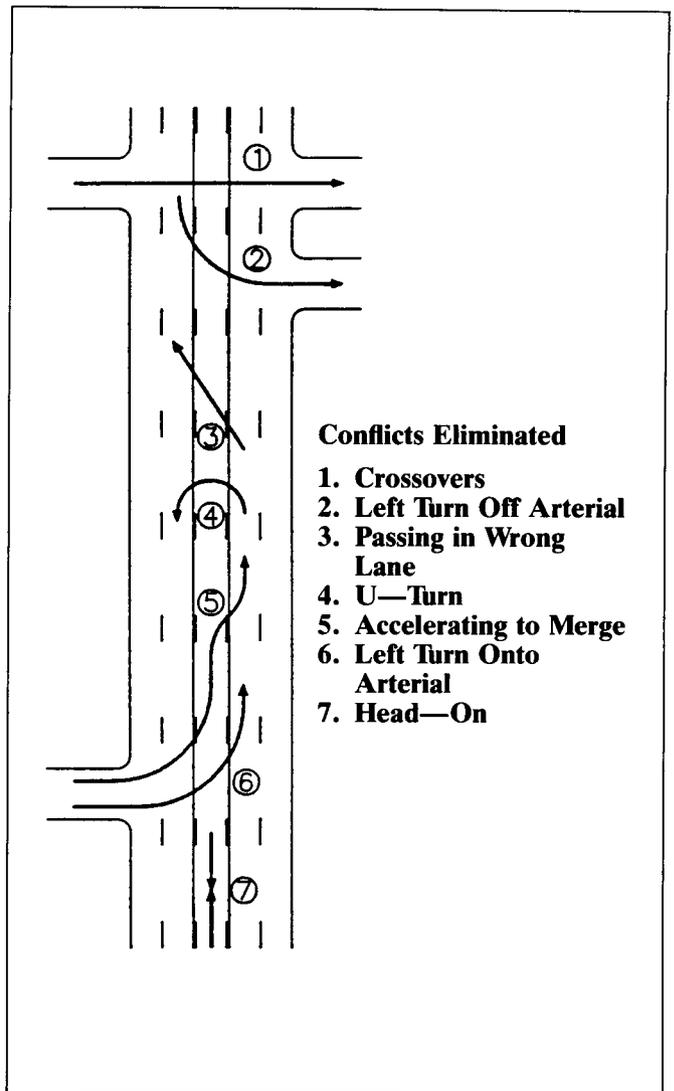
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5. Accelerating to Merge
6. Left Turn Onto Arterial
7. Head—On

Figure 2. Midblock conflicts eliminated by raised medians

9. Safer than TWLTLs in four-lane sections.
10. Safer than TWLTLs in six-lane sections, but depends on number of signals per mile, driveways per mile, average daily traffic, and street approaches per mile.
11. Encourages access roads and parallel street development.
12. Reduce accidents in mid-block areas (See Figure 1).
13. Reduces total driveway maneuvers on the major roadway.
14. Low maintenance cost of raised median, depending on final design.

#### Disadvantages:

1. Reduce operational flexibility for emergency vehicles and others.
2. Increase left-turn volume at major intersections and median openings.
3. Increase travel time for vehicles desiring to turn left where median openings not provided.
4. May reduce capacity at signalized intersections.
5. Possible increase of accidents at intersections and median openings.
6. Possible increase in object struck type accidents.

## Safety Effects of Raised Median Project

### Description of Project

The operational review of installing a raised median on Jimmy Carter Boulevard involved looking at two variables: land use and type of raised median.

The first part of the analysis looked at land use by section of roadway. The heavy retail business area is on Jimmy Carter Boulevard from I-85 to Singleton Road (east end). The other section of Jimmy Carter, from I-85 to Buford Highway (west end), has a mixture of commercial and industrial development, with some retail.

The second part of the analysis reviewed the type of raised median. The project built two different types of medians because of the planned staging for the construction of the median. On the first day of construction in April 1987, the contractor installed a 3-ft high temporary New Jersey type barrier, the length of the two projects. The final raised median was 10 inches (in) high, with the first 5 in having a vertical face and the second 5 in being slanted at 45 degrees. The raised median was 4 ft wide, except at intersections where it narrowed to 2 ft adjacent to left-turn lanes.

This study reviews the effect of different heights for medians. The first accident analysis compared the pre-construction period of the TWLTL operation to the temporary construction period with a 3-ft high raised median section (New Jersey barrier). The study then compared the pre-construction period of the TWLTL operation to the 10-in high permanent raised median sections.

Construction began on Jimmy Carter Boulevard (SR-140) from I-85 to Buford Highway on April 17, 1987, and the project was completed on Aug. 21, 1988. This section of the project took 16 months to complete and had a project length of 1.63 miles.

### Description of Accident Analysis Procedures

The intersections at Buford Highway and Singleton Road and all accidents at the two I-85 interchange ramps were not included in the analysis to prevent a biased analysis. The

computer database could not differentiate the approaches to the end intersections; since the end intersections had approaches not affected by the raised median project, these end intersections were not analyzed. The analysis only used complete months of accident data in the before and after conditions, thus skipping all transitional accidents. Figure 1 shows the project limits for each section of analysis.

All accident frequency and rate changes were analyzed for statistical significance. The Poisson Distribution and Comparison of Means Test was used to test for statistical significant change at 95 percent level of confidence. This gave three statistical answers: yes, significant at level of confidence of 95 percent for both Poisson tests; no, not significant at level of 95 for both Poisson tests; or uncertain at 95 percent level of confidence (yes, for Poisson Distribution, but no for Poisson's Comparison Mean Test).

The analysis of the 3-ft high New Jersey barrier section is called the "during" construction analysis. Only

the results of the "during" study will be provided in this report.

Because of space limitations, detailed analysis is only available from the author. The permanent 10-in high raised median is called the "after" construction analysis. The computerized accident database started on Jan. 1, 1986, and was complete through Dec. 31, 1993. This limits the before and after periods for analysis, because of the short "before" period.

Fatal accidents along these corridors were not analyzed. The county only experienced one fatal accident before the project and one occurred after the project. This is not statistically significant data to analyze. This project's inception was motivated more by the number of accidents and traffic congestion than fatal accidents.

### Review of Raised Median Project

The accident data shows that retrofitting a two-way left-turn lane with a 10-in concrete raised median is benefi-



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cial. However, the benefits are not as wide sweeping as the 3-ft high temporary New Jersey raised median. Both projects, regardless of land use, showed accident rate reductions with this project. Both projects had increases in the total number of injuries along Jimmy Carter Boulevard, though the increases are not statistically significant. However, the injury rate in Section 1 had a small decrease.

When analyzing these two projects, the significance of the rate analysis is quite different. The median project from Singleton Road to Oakbrook Parkway (Section 2) had statistically significant accident reductions for angle-type and total accidents (Table 1). This supports one of the reasons for building this project: making the road safer. Considering traffic is moving along this section of road at a higher average speed (less congestion) and the road is operating as a safer arterial, this supports the decision to build this project.

The safety benefits of the median project from Buford Highway to Crescent Drive are not nearly as beneficial from an accident reduction perspective. The only significant reduction was with rear-end accidents, and this was not an anticipated benefit of the project (Table 1). The biggest surprise was the relatively small reduction in angle-type accidents. This section of road experiences much greater demand for U-turns than the Singleton project (Section 2). The project along this section of road did reduce accidents by 9 percent, though this is not statistically significant.

Most of the accident reductions by type of accident behaved as theorized. The angle-type accident rates had a reduction of 13 percent and 45 percent. The side swipe-opposite and head-on accidents also decreased as expected. The road had an increase in "object struck accidents," as expected. The biggest surprise was in the very large (25 percent and 39 percent) and significant reduction in rear-end accidents rates. The study had projected a small accident opportunity for thru motorists to be cut off by turning vehicles from and to Jimmy Carter Boulevard. This category analysis proposes the theory that there was a very serious rear-end accident problem with the two-way left-turn lane opera-

**Table 1. Section 1: Buford Hwy to Crescent Dr., Section 2: Singleton Rd to Oakbrook Pkwy**

<i>Permanent Raised Median (10") Installation</i>						
<i>Accident Frequency Analysis</i>						
<i>Type of Accident</i>	<i>Section 1</i>			<i>Section 2</i>		
	<i>Before</i>	<i>After</i>	<i>%Change</i>	<i>Before</i>	<i>After</i>	<i>%Change</i>
Angle	71	72	+1, N	106	65	-39, Y
Rear End	105	93	-11, N	104	70	-33, Y
Side Swipe-Same	13	25	-92, Y	23	26	+13, Y
Side Swipe-Opposite	3	1	-67, N	3	1	-67, N
Head-On	5	2	-60, N	2	1	-50, N
Object	0	19	+00, Y	0	8	+00, Y
Other	1	1	0, N	1	1	0, N
Total Accidents	198	213	+8, N	239	172	-28, Y
Total Injuries	68	73	+16, N	37	50	+35, U

<i>Accident Rate Analysis</i>						
<i>Type of Accident</i>	<i>Section 1</i>			<i>Section 2</i>		
	<i>Before</i>	<i>After</i>	<i>%Change</i>	<i>Before</i>	<i>After</i>	<i>%Change</i>
Angle	2.45	2.12	+13, N	4.61	2.55	-45, Y
Rear End	3.62	2.73	-25, Y	4.52	2.75	-39, Y
Side Swipe-Same	0.45	0.73	+62, U	1.00	1.02	-2, Y
Side Swipe-Opposite	0.10	0.03	-70, N	0.13	0.04	-69, N
Head-On	0.17	0.06	-65, N	0.09	0.04	-56, N
Object	0.00	0.56	+00, Y	0.00	0.04	+00, Y
Other	0.03	0.03	0, N	0.04	0.04	0, N
Total Accidents	6.82	6.26	-9, N	10.39	6.75	-35, Y
Total Injuries	2.34	2.32	-1, N	1.61	1.97	+22, N

\*%Change Statistically Significant at 95% Level of Confidence Using Poissons Distribution and Comparison of Means Test: Yes, No or Uncertain

\*\*Note: Accident and Injury Rates are Per One Million Annual Vehicle Miles

tion. This must have involved many vehicles using the lane as a thru lane or cutting off thru vehicles as they tried to merge back into traffic. As expected, the object and side swipe-same type accidents increased for both projects.

## Conclusions and Recommendations

The conclusion of this study is that retrofitting the raised median barrier reduces accidents. As was documented in another paper on medians,<sup>1</sup> two-way left-turn lanes do not function safely or efficiently when traffic volume exceeds 24,000 vehicles per day. Jimmy Carter Boulevard had more than 40,000 vehicles a day along the analyzed corridor.

Should additional projects for retrofitting the TWLTLs be considered, it is the conclusion of this analysis to recommend retrofitting a raised median, based on operating the road more safely and more efficiently. Consideration

should be given to looking at alternative raised median designs to minimize object struck type accidents, while minimizing the opportunity to illegally cross the median. It is very interesting that the before/during analysis found that utilizing the temporary 3-ft New Jersey barrier reduced accidents by 32 percent for both sections of road. The 10-in median only reduced accidents in both sections by 12 percent. The results suggest that land use type, traffic volume and median designs are significant variables in the optimum design. However, better consideration should be given to the crossing ability of emergency vehicles, while still eliminating motorists' opportunity to illegally cross the raised median.

## Limitations with Analysis and Data

There was a problem with traffic volume (ADT) counts from the

Georgia DOT along Jimmy Carter Boulevard from I-85 to Buford Highway for the years 1986 to 1989. We had to use our turning movement counts to adjust their traffic volume counts because of the Georgia Department of Transportation's mechanical and statistical problems with their two-count stations on this section of road. This may have caused the rate analysis to be biased against the benefits of the median. Traffic on Jimmy Carter Boulevard has risen dramatically since the project completion.

The annual vehicle mileage for Section 1 (Buford Highway to Crescent Drive) had a 17 percent increase in traffic volume, and Section 2 (Singleton Road to Oakbrook Parkway) had a 10 percent increase in traffic volume. Both these increases seem very low when the study considers that vehicle registrations in Gwinnett County have increased from 262,000 vehicles in 1986 to about 311,000 vehicles in 1989, the time period of analysis for this project. The increase (19 percent) in traffic along a major arterial should be at least this high. The 1994 traffic volume on Jimmy Carter Boulevard is more than 69,000 vehicles a day for Section 1 and 76,000 vehicles a day in Section 2. These are very dramatic traffic volume increases since 1986.

The most important limitation of this analysis is lack of data detailing traffic volume approaching Jimmy Carter Boulevard from side streets and driveways. As the number of conflicts increase, the potential for accidents increase, and although there is no data to support the claim, potential traffic conflicts increased dramatically. However, the median prevented many of these left-turn conflicts or they were handled more safely at controlled intersections.

Another problem involves the comparison of the permanent raised median installation with the existing five-lane section. The permanent improvement has six thru lanes compared to the four thru lanes for the existing roadway. A partial consideration to this limitation involves the analysis of the temporary raised median (3 ft). During most of this construction period, there were only four thru lanes. This project had the greater reduction

in accidents compared to the permanent raised median, even though the "before" and "during" period had an equivalent number of thru lanes.

## Other Retrofit Project in Georgia

The Georgia Department of Transportation sent Gwinnett a copy of the study results from a similar project on Memorial Drive (SR-10) in DeKalb County. Memorial Drive was a seven-lane roadway with similar problems to Jimmy Carter Boulevard: accidents, congestion and motorist's perceptions as a "dangerous" corridor.

The Department of Transportation installed a median in place of the TWLTL based on the Jimmy Carter Boulevard safety results. The results of the project were better than the Jimmy Carter Boulevard project. The concrete median was 10 ft wide with a 6-in (mountable) raised median. Accidents were reduced by 37 percent and injuries by 42 percent. The "before" traffic volume was 43,000, and the "after" traffic volume was 50,400. The biggest benefit of this project was the fatality analysis. From Jan 1, 1979, to July 27, 1987, this road experienced 15 fatalities, many involved MARTA buses and pedestrians. Two years after this project, there has not been a fatality on this 4.3 mile section. Georgia DOT estimates that in the past two years since the median was installed, they have saved 600 accidents and 300 injuries.

## Other Opinions

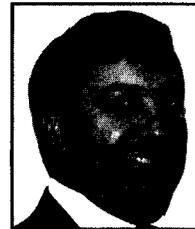
Medians are not liked by many practicing traffic engineers across the country.<sup>3</sup> After much discussion with many traffic engineers, there is a good hypothesis regarding why some states prefer raised medians while others to prefer two-way left-turn lanes.

The major difference between states seems to be the way traffic operates in the TWLTL. Some states educate and enforce the proper use of the TWLTL. Thus, traffic does not use the lane as an accel and decel lane. States such as Georgia that allow this operation find TWLTLs do not work well when traffic gets heavier than 24,000 vehicles a day. States such as Arizona and Michigan are reported to have

good operation in TWLTL, and not surprisingly are strong supporters of TWLTLs.

## References

1. W. Martin Bretherton, et al., "One Suburban County's Policy for Selecting Median Treatments for Arterials," *1990 ITE Compendium of Technical Papers*: 197-201.
2. "Before/After Evaluation for New Median Construction, Memorial Drive in DeKalb County," Georgia Department of Transportation, Office of Traffic and Safety (November 3, 1992): Unpublished.
3. Dibyendu Mukherjee, et al., "Choosing Between a Median and a TWLTL for Suburban Arterials," *ITE Journal* (July 1993): 25. ■



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