METHODOLOGY FOR SELECTING URBAN MEDIAN TREATMENTS: A USER'S MANUAL

by

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Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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FOREWORD

This user's manual is a result of a study conducted by the Virginia Highway and Transportation Research Council at the request of the Virginia Department of Highways and Transportation. The study was initiated and conducted by Martin R. Parker, Jr. Because Mr. Parker left the Research Council before the end of the project, a draft of the manual was completed by William Galbraith and Mr. Parker made the final revisions and editing necessary for publication.

The companion report, "Development of Design Guidelines for Raised and Traversable Medians in Urban Areas," contains a complete record of the research conducted.

This project was performed under the general guidance and advice of the Research Task Force on Urban Median Design consisting of

R. E. Atherton, Chairman
R. L. Perry
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INTRODUCTION

Urban arterial streets must provide a high level of service for through traffic as well as access to abutting properties representing a variety of land uses. To an extent, the provision of traffic service and the accommodation of access needs are conflicting functions that require different median treatments and different access controls. The regulation of left-turn traffic through the utilization of alternate median controls is a primary method of providing a compromise.

Although several investigators have examined the merits of raised medians and traversable or continuous two-way, left-turn median lanes, guidelines for selecting the treatment best suited for medians under particular urban conditions have not been fully developed. The absence of guidelines has led to considerable differences in opinion among planners, designers, and traffic engineers, and often the design chosen has generated criticism from the motoring public, property owners, and businessmen.

The purpose of the study reported here was to develop guidelines that can be used to formulate a rational basis for selecting alternative median designs for nonlimited access urban highway projects. The specific objectives of the study were to —

1. examine the process currently used to select median treatments;

2. determine traffic operational, land use, and other characteristics that are best served by a raised median and the characteristics that favor a continuous two-way, left-turn median lane;

3. investigate the accident histories of various median treatments; and

4. provide guidelines that can be used to select the appropriate median treatment.

The state of the art in urban median treatments was determined by reviewing available literature and analyzing the results of a survey questionnaire sent to design engineers in major U. S. cities and state departments of transportation. The warrants presented here are based on field and accident data at 50 sites in Virginia for a three-year period. The remainder of this manual consists of —

1. a discussion of alternative median treatments;

2. guidelines for selecting alternative median treatments; and

3. example applications of the guidelines.

ALTERNATIVE MEDIAN TREATMENTS

The median treatments included in the study fall into two categories. The raised median prohibits crossings of the median except at openings selected by the designer. The traversable median provides a continuous, left-turn median lane but does not physically restrict the movement of traffic across the median. The advantages and disadvantages of each of these median treatments are discussed below.

Raised Medians

Shown in Figures 1 and 2 are typical raised median treatments. Each of the designs has a concrete curb and, for most projects, a combination of grass and concrete cover.

Raised medians usually render a high degree of traffic service by preventing left turns except at crossovers and providing left-turn storage lanes at crossovers leading to major intersecting streets and driveways. Raised medians also provide a refuge for pedestrians.

The minimum desirable width of a raised median is 14 feet; however, if there is a need to accommodate U-turning traffic or to shadow vehicles turning left from adjacent streets, a minimum width of 25 feet is necessary. Wide medians are seldom cost-effective in urban areas because of the cost of right-of-way.

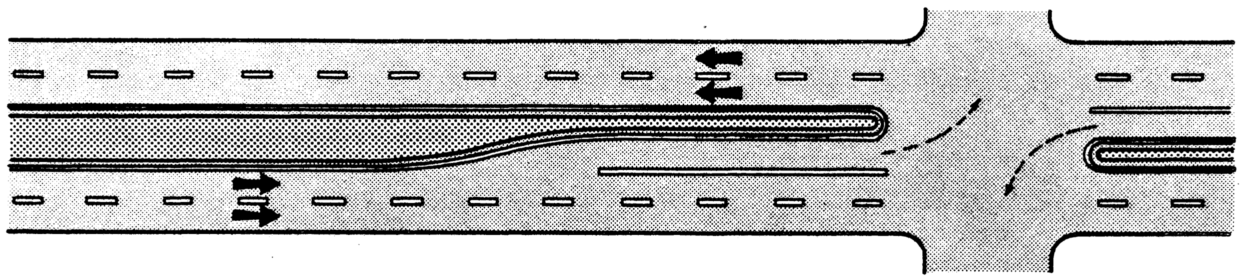

Figure 1. Raised median with concrete cover.(1)

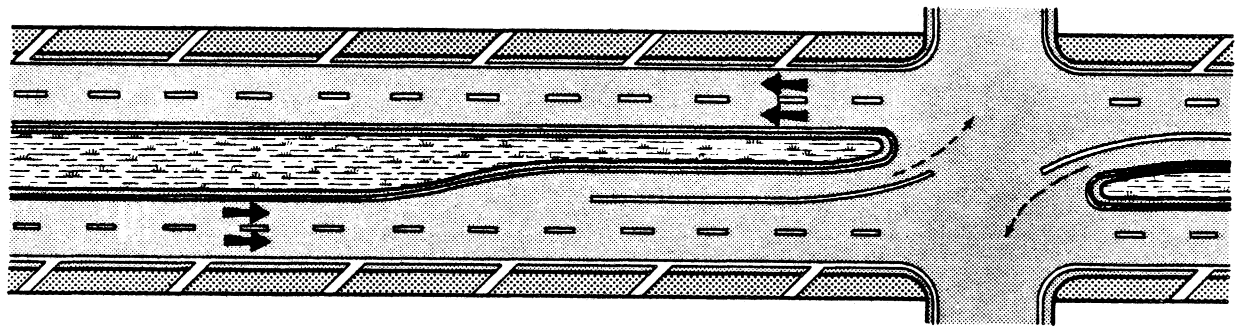

Figure 2. Raised median with grass cover.(1)
(Taken from 1971 edition of MUTCD.)

A disadvantage of raised medians where there is a large demand for mid-block left turns and crossovers are not provided is that motorists are required to use an indirect, circuitous route and U-turn at adjacent crossovers to reach their destinations. Also, the curb reduces the recovery area for motorists who run off the road.

Traversable Medians

The three basic types of traversable medians are (1) the continuous, two-way left-turn lane, (2) the alternating left-turn lane, and (3) continuous left-turn lanes. These median configurations are shown in Figures 3, 4, and 5. Traversable medians provide a high degree of traffic service and allow direct access to adjacent property from both directions of travel.

The continuous, two-way, left-turn median lane, shown in Figure 3, is perhaps the most widely used type of traversable median. The purpose of the median lane is to store left-turn

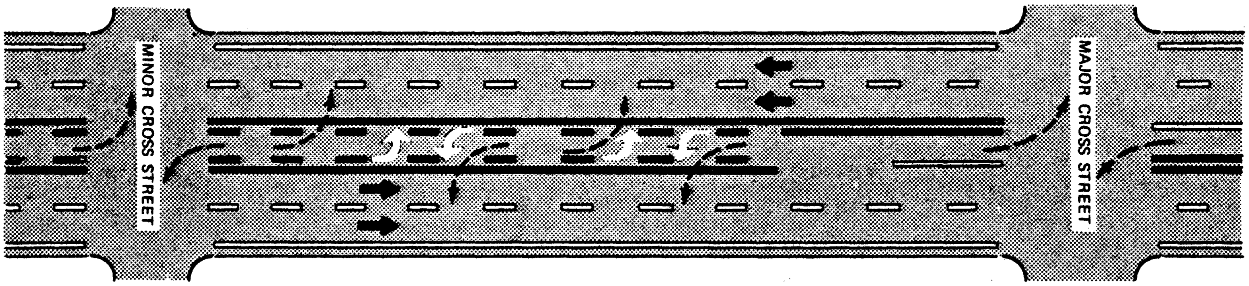

Figure 3. Continuous, two-way, left-turn median lane.(1)

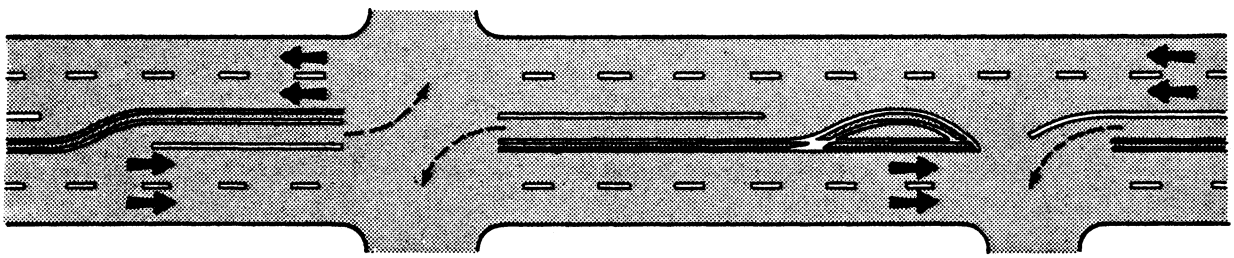

Figure 4. Alternating, left-turn median lane.(1)

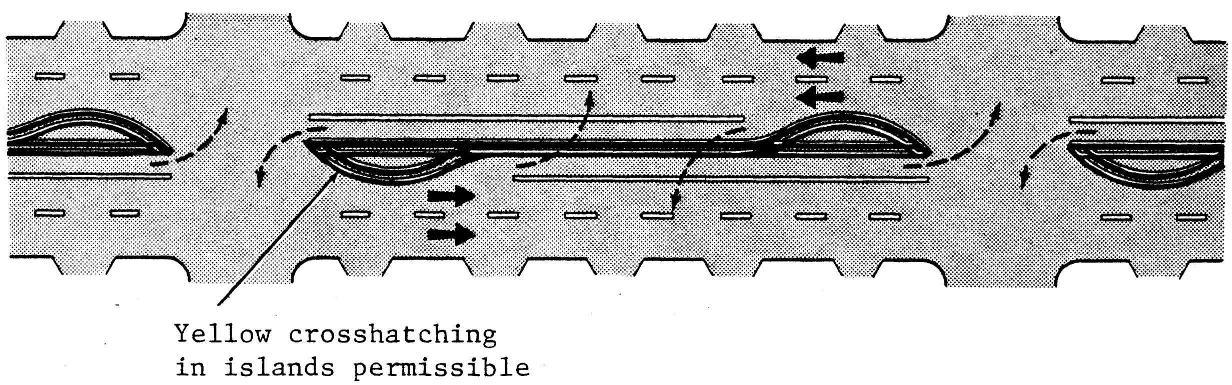

Figure 5. Continuous, left-turn median lanes.(1)
(Taken from 1971 edition of MUTCD.)

vehicles without impeding through traffic. The desirable width of the median lane is 12 feet and the typical maximum width is 14 feet. In cases where 11-foot lanes are being unitized for the through travel lanes, it is satisfactory to use an 11-foot median lane. A continuous, two-way, left-turn median lane can often be provided on existing right-of-way at a lower cost than a raised median. The median lane is also a flexible design that can be altered to meet changing access needs, and it can be used as an additional through lane, with appropriate markings and signalization, during peak hours. Concerns that two-way operation will promote head-on collisions do not appear to be supported by accident statistics and observations of traffic movement.

One major advantage of the traversable median is the potential use of the median lane as a temporary through lane when travel lanes are closed for maintenance work.

A reported disadvantage of the two-way, left-turn lane is that it does not provide appropriate channelization at major intersections. Also, it has been suggested that some drivers do not appear to understand the meaning of the pavement markings.

The alternating left-turn lane shown in Figure 4 is another type of traversable median that provides storage for left-turning vehicles. In this case, left turns are permitted for only one direction at a time; thus direct access to some properties may not be permitted. Alternating left-turn lanes are best suited to areas that have well-defined and heavily-used access points with few driveways between the major intersections. The desirable width of the median lane is 12 feet. Similar to other traversable medians, the alternating left-turn lane is a flexible design that can be altered to accommodate changing access needs. Accidents and delay to through traffic caused by left-turning vehicles have been reported to be significantly decreased by this median treatment as compared to undivided highways.

The continuous, left-turn median lanes, shown in Figure 5, are similar in concept to the two-way, left-turn lane shown in Figure 3, except that separate left-turn lanes are provided for each direction of travel. Painted islands are utilized at major intersections to prohibit left turns and through movements at the far side of the intersection. This treatment provides a high degree of traffic service and access needs; however, a major disadvantage is that a 24-foot median width is required. Due to the additional right-of-way required for this design and the additional construction costs, this treatment usually is not cost-effective.

GUIDELINES FOR SELECTING MEDIAN TREATMENT

The general methodology depicted in Figure 6 assists in the selection of either a raised or traversable median treatment for four-lane, nonlimited access highways in urban areas. The six elements shown in the figure are discussed below. In addition, the Appendix gives instructions for using a computer program to estimate accident and delay characteristics for the median treatments.

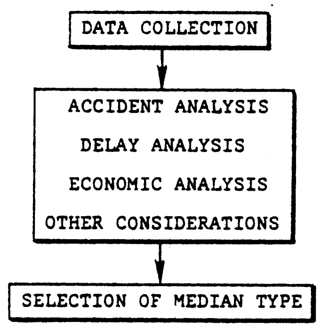

Figure 6. Median selection process.

Data Collection

For each section of roadway under consideration, data must be collected for each of the items shown in Table 1. Where different median treatments are being considered for separate sections of a project, the data must be assembled for each section separately. These data are used to calculate the measures shown in Table 2, which are necessary for the accident and delay analysis and when the designer wants to conduct an economic analysis of the alternatives.

Table 1

Data Required for Median Analysis

- Section length (miles)
- Number of traffic signals
- Average daily traffic (ADT)

- Design hourly volumes (assume 10% of ADT if no other data are available)
- Number of intersecting public streets (a four-way intersection would be counted as two streets, whereas a T intersection has only one street)
- Number of driveways (includes all intersections except public streets)
- City or area population
- Number of median openings (applies only to raised median)

Note: **The following items are needed only when an economic analysis is conducted.**

- **Cost of each alternative median treatment**
- **Average daily left-turn volume (total for section)**

Table 2

Independent Variables for Regression Analysis

Variable	Symbol
Signals per mile	Sig
Average daily traffic	ADT
Design hourly volume	DHV
Driveways per mile	Dr.
Area population	Pop.
Streets per mile	St.
Median openings per mile	Open

Accident Analysis

The accident analysis is used to estimate the annual number of accidents per mile for the study site for both raised and traversable median treatments. The equations used, as shown in Table 3, are based on field studies and accident data for 50 locations in Virginia. It is suggested that the estimates be made for the current year as well as the design year. In some cases, it is also desirable to use one other year, say 10 years from the current year, to determine if the future median design remains constant over the 20-year period.

All other things being equal, the median treatment with the lowest predicted accidents per mile is the preferable alternative.

Table 3

Regression Equations for Predicting Annual Number of Accidents Per Mile

- AI_r = Annual accidents per mile for raised median

  $= 8.040\ Sig + 0.00155\ ADT - 0.0228\ Dr - 0.00000926\ Pop. - 12.718.$ ($R^2 = 0.73.$)*

- AI_t = Annual accidents per mile for traversable median

  $= 5.432\ Sig + 0.00173\ ADT + 2.157\ St + 0.0000058\ Pop. - 28.797.$ ($R^2 = 0.71.$)*

Delay Analysis

It has not been shown that the median type, whether raised or traversable, influences the overall travel time for through traffic. The median type does, however, influence the time motorists are stopped while waiting to turn left from the median. Therefore, the delay analysis considers only mid-block, left-turn delays. Based on the data collected during the field studies, the regression equations, shown in Table 4, for predicting mid-block, left-turn delay (seconds per vehicle turning left) for each median treatment were developed.

All other things being equal, the median treatment with the lowest predicted mid-block, left-turn delay is preferable.

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*R^2 is the explained variance, i.e., 73% of the variance in the accidents per mile is explained by the independent variables, e.g., number of signalized intersections, ADT, etc.

Table 4

Regression Equations for Predicting Mid-Block, Left-Turn Delay

- LTD_r = Mid-block, left-turn delay (seconds per vehicle) for raised median

  $$= -1.362\ \text{Sig} + 0.0184\ \text{DHV} - 0.205\ \text{Open} - 0.0000332\ \text{Pop.} + 2.937. \quad R^2 = 0.73.$$

- LTD_t = Mid-block, left-turn delay (seconds per vehicle) for traversable median

  $$= -0.525\ \text{Sig} + 0.0198\ \text{DHV} - 0.0676\ \text{Dr} - 0.0000214\ \text{Pop.} + 0.920. \quad R^2 = 0.75.$$

Economic Analysis

For many highway projects an economic analysis is conducted to aid the decision makers in selecting among project alternatives. Alternative median treatments may be, among other design alternatives, selected for economic analysis.

For every project, the costs of right-of-way, utilities, and construction should be estimated for each alternative. In lieu of specific cost items for an individual project, the following typical costs are suggested for use in the economic evaluation.

Raised Median = $600,000/Mile

Traversable Median = $500,000/Mile

Accident and delay savings should be among the benefits considered in the analysis.

No specific method for conducting an economic analysis is suggested as a result of this research. In fact, the decision of whether an economic analysis should be conducted is an option left to the designers or traffic engineer. The major emphasis of this guide is to provide an estimate of the accident and delay characteristics of several median alternatives, thus enabling the designers to select the treatment offering the best safety estimates. If the designer wishes to conduct an economic analysis to further determine which treatment is justified, current Departmental practices should be followed.

Other Considerations

If, after calculations of accident statistics and operational delay have been made there is no clear determination or choice of median type, then neither treatment is assumed to have advantages over the other, and either type may be selected for design. Nevertheless, there are several factors that should be considered before the final decision is made. The following guidelines are suggested.

1. If the stopping sight distance is less than the safe distance as computed by AASHTO standards anywhere on the project, a traversable median should never be used on the section, unless the sight distance can be increased above acceptable limits.

2. Raised medians should not be used on roadway sections where the operating speed exceeds 45 mph.

3. Generally, raised medians are desirable under the following conditions:

   (a) Access points are limited to major intersections where crossovers can be provided.

   (b) The number of streets per mile is greater than 12.

   (c) Large volumes of pedestrians frequently cross the roadway throughout the section and cannot be confined to crosswalks.

   (d) A grid pattern of intersecting streets permits circuitous flow of traffic without disrupting traffic in residential communities.

4. Generally, traversable medians are desirable under the following conditions:

   (a) The number of streets per mile is less than 12.

   (b) The number of driveways per mile is greater than 50.

   (c) A reversable lane for carrying peak-period traffic is needed in the near future.

5. Generally, the alternating left-turn lanes, as shown in Figure 4, should be used when access is not needed on one side of the road.

6. Generally, continuous median lanes, as shown in Figure 5, offer no safety or operational advantages over other median treatments and should not be selected for implementation due to their right-of-way and construction costs.

Selection of Median Type

The accident and delay evaluations, along with the other considerations outlined in the previous sections, are intended to aid the designer or traffic engineer in the selection of a median treatment. Examples of the selection process are given in the next section.

EXAMPLE APPLICATIONS OF THE GUIDELINES

For the purpose of illustrating the methodology, three examples are provided below. The input data as well as the results of the analysis are provided for each example. An interpretation of the analysis data and the conclusions are also presented.

Example 1

A 1.402-mile, two-lane, urban arterial street carrying 12,040 vehicles per day (1,204 during the peak period) is scheduled for widening. There are 3 signalized intersections, 4 streets, and 86 driveways on the highway. It has been estimated that 13 openings will be required if a raised median is utilized. The population of the area is 127,109 persons; however, in the design year the population is expected to be 138,000 persons. Traffic volumes are expected to be 21,100 vehicles per day (2,110 in the peak period) by the design year. Also, it is anticipated that 2 new signals will be installed on existing public streets along with 11 new driveways. No new streets are anticipated.

Program MEDEQU, shown in the Appendix, was utilized to provide estimates of the safety and operational characteristics for raised and traversable median design alternatives.

The results of the accident and delay analyses are given in Table 5. Based on the accident results, a traversable median should be selected; however, the mid-block, left-turn delay statistics slightly favor a raised median. The pedestrian volume in the area is very low and circuitous routing of traffic on existing streets is not possible.

Table 5

Estimated Accident and Delay Impacts for Example 1

Annual Number of Accidents Per Mile

Condition	Raised	Traversable
Existing	20.57	9.07
Design (20 Years)	45.83	32.45

Mid-Block Left-Turn Delay, Seconds Per Vehicle

Condition	Raised	Traversable
Existing	16.06	16.77
Design (20 Years)	30.42	33.19

The safety impact of providing a traversable median on this roadway section is an important factor in this case. For example, if the traversable median were constructed today, the annual number of accidents on the 1.402-mile section is estimated to be 13 (1.402 mile x 9.07 accidents per mile = 12.72 ≈ 13). By comparison, if a raised median were constructed, the annual number of accidents expected is 29, which is more than twice the number of accidents anticipated with a traversable median. Moreover, in the design year it is estimated that the traversable median will have 30% fewer accidents than the raised section (45 accidents on the traversable section compared to 64 accidents on the raised section, a savings of 19 accidents annually). Over the 20-year design period 360 fewer accidents are expected on the traversable section.

Consideration of all factors clearly suggests that a two-way, left-turn traversable median design should be selected for the project. A summary of the analysis is shown in Table 6.

Table 6

Summary of Results for Example 1

Existing roadway: Two-lane, two-way arterial street

Project length : 1.402 miles

Estimated annual number of accidents for:

	Raised Median	Traversable Section
Current Year	29	13
Design Year (20 years)	64	45
Total accidents over the design period	940	580

Estimated mid-block, left-turn delay, seconds per vehicle:

	Raised Median	Traversable Section
Current Year	16.06	16.77
Design Year (20 years)	30.42	33.19

Other considerations:

1. Stopping sight distance — Greater than 1,000 ft. will be provided.
2. Suggested posted speed limit — 45 mph
3. Access points — Cannot limit access to major intersections due to numerous driveways
4. Circuitous routing — Existing streets do not provide circuitous traffic flow
5. Estimated pedestrian crossing volume — Less than 100 crossings per day.
6. Distribution of access points — Access is required at numerous points on both sides of the road
7. Right-of-way availability — R/W width should not exceed 70-ft. to avoid acquisition of business units.
8. Other factors — None

Table 6 (continued)

Recommendation:

The estimates of the accidents expected on the project clearly indicate that a traversable median section offers significant benefits over a raised median section. Consideration of the physical features of the site and vehicle and pedestrian volumes provides supporting evidence that a continuous two-way, left-turn median lane with four 11-foot lanes (total of 5 lanes) be selected for this project.

Example 2

A 0.786-mile section of a three-lane suburban roadway is being considered for improvement. The existing conditions are given in Table 7.

Table 7

Existing Roadway Conditions for Example 2

Item	Number	Number Per Mile
Signalized intersections	1	1.27
Public streets	3	3.82
Driveways	84	106.87
Proposed median openings	8	10.18
Average daily traffic		9,860
Area population		118,000
Design hourly volume (peak-hour volume)		986

The designers have been informed that considerable commercial development has been planned in the area during the next 20 years. Because of the growth potential the designer obtained estimates of roadway conditions for both a 10-year and a 20-year (design year) period. Input from the transportation planner, district traffic engineer, central office traffic safety engineer, and the assistant resident engineer were used to obtain the estimated conditions projected in Table 8.

The data shown in Tables 7 and 8 were used in program MEDEQU to provide estimates of the annual number of accidents and mid-block delay for existing conditions and the 10- and 20-year periods. The results of the analysis are shown in Table 9.

Table 8

Estimated Roadway Conditions for Example 2

Item	Number		Number Per Mile	
	10 Years	20 Years	10 Years	20 Years
Signalized intersections	1	2	1.27	2.55
Public streets	5	7	6.36	8.91
Driveways	95	95	120.87	120.87
Proposed median openings	8	8	10.18	10.18
Average daily traffic			17,230	24,600
Area population			126,000	134,000
Design hourly volume			1,723	2,460

Table 9

Estimated Accident and Delay Impacts for Example 2

Annual Number of Accidents Per Mile

Condition	Raised	Traversable
Existing	9.25	2.71
10 year	20.28	20.90
Design (20 year)	41.92	46.05

Left-Turn Delay, Seconds

Condition	Raised	Traversable
Existing	13.35	10.03
10 year	26.64	23.50
Design (20 year)	Unable to Est*	Unable to Est*

*It is not possible to estimate values for this condition because the estimated result is out of the range of known values. Program MEDEQU provides this check without user input.

The results of the accident analysis indicate that:

1. For the current year, a traversable section has significantly fewer accidents per mile per year than the raised section (2.71 compared to 9.25).

2. The area development anticipated and the projected traffic volumes suggest that ten years from now there will be little difference in accidents per mile between a raised and a traversable section (20.28 compared to 20.90 accidents per mile).

3. Twenty years from now (the design year) a raised section will have significantly fewer accidents per mile than the traversable section (41.92 compared to 46.05 accidents).*

The analysis clearly indicates that as site and volume conditions change, the choice of a median treatment changes.

This example provides an interesting but practical problem that must be faced when interpreting the results and selecting a specific median treatment. Before a median type is selected, the remaining analysis, as outlined in Example 1, Table 6, must be completed. It should be evident that factors such as stopping sight distance access point distribution, circuitous routing, etc., are also important factors for consideration in the choice of a median treatment.

In this case, the minimum stopping sight distance for a 45 mph anticipated operating speed could not be provided at a feasible cost. Because of the accident benefits anticipated in the design year and the sight distance problem, a raised median section was chosen for the project.

Example 3

A 2.477-mile section of a four-lane undivided roadway located in an urban fringe area has been selected for reconstruction. A review of the existing physical and operational characteristics of the site indicates that the project should be divided into three

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*It is suggested that a 10% difference in accidents be used as a guide in determining if the difference is important enough to support the selection of one treatment over the other.

sections. The first section is 0.544 mile in length and ties into an existing four-lane highway with a raised median. Section two is 0.681 mile in length and has considerable commercial development on the west side of the roadway and residential development on the east side. Pedestrian volumes in excess of 500 per hour have been observed at three major sections; however, a large number of pedestrians do not cross at crosswalks. The third section is 1.252 miles long and encompasses an area of predominantly residential streets. The existing roadway conditions are shown in Table 10. An example of using these input data for program MEDEQU are shown on pages A-5 through A-7 and the results are given on page A-9.

It is the consensus of the design team that moderate to low growth can be expected in the project corridor. Thus only the 20-year design estimates were made. The projected roadway conditions for the design year are shown in Table 11.

Table 10

Existing Roadway Conditions for Example 3

Item	Section Number		
	1	2	3
Length, miles	0.544*	0.681	1.252
Signalized intersections	2	3	5
Public streets	12	10	15
Driveways	51	67	121
Proposed median openings	6	7	13
Average daily traffic	15,220	16,870	17,900
Area population	22,716	22,716	22,716
Design hourly volume (Peak-hour volume)	1,522	1,687	1,790

*Section lengths of 0.35 mile or less should not be used because the roadway conditions are greatly affected by short sections which produce erroneous results.

Table 11

Projected Roadway Conditions for Example 3

Item	Section Number		
	1	2	3
Length, miles	0.544	0.681	1.252
Signalized intersections	3	5	5
Public streets	12	10	15
Driveways	58	68	121
Proposed median openings	6	7	13
Average daily traffic	22,700	23,100	23,800
Area population	53,100	53,100	53,100
Design hourly volume	2,270	2,310	2,380

Utilizing program MEDEQU and the input values from Tables 10 and 11, estimates of the safety and delay impacts were computed and the results are shown in Table 12.

Based on the annual number of accidents per mile, a raised median treatment should be selected for sections 1 and 3. The raised median treatment has safety benefits on these sections under existing as well as design conditions. A raised median is also desirable for existing conditions on section 2; however, the design year estimates are not significantly different, $79.33 \approx 82.39$.

Based on consideration of the safety, delay, and other site-specific data, a raised median treatment was selected for the three sections.

Table 12

Estimated Accident and Delay Impacts for Example 3

Annual Number of Accidents Per Mile

	Existing Conditions		Design Conditions	
Section Number	Raised	Traversable	Raised	Traversable
1	38.11	64.97	63.93	87.73
2	46.43	55.88	79.33	82.39
3	44.69	49.55	53.56	59.58

	Left-Turn Delay, Seconds		Left-Turn Delay, Seconds	
Section Number	Raised	Traversable	Raised	Traversable
1	22.91	22.30	33.16	34.62
2	25.11	24.87	31.57	34.92
3	27.56	27.25	Unable to Est	Unable to Est

REFERENCE

1. U. S. Department of Transportation, Federal Highway Administration, Manual on Uniform Traffic Control Devices for Streets and Highways, Washington, D. C.

APPENDIX

PROGRAM — MEDEQU

URBAN MEDIAN DESIGN

Keypunching Guide

This program contains a set of equations which compute accidents per mile and left-turn delays for several sections of a median design project. A listing of the program is presented in Table A-1.

The first data card contains the project information: route, county, district, project number, and the total number of sections to be processed. Table A-2 shows the input variables, their type, format, and card column numbers.

Each remaining card corresponds to a project section and contains these equation variables: section numbers, signals per mile, ADT, streets per mile, driveways per mile, area population, DHV, and median openings per mile.

Data are to be punched from the formatting sheet, Figure A-1. The only variables on the formatting sheet which are to be punched are enclosed in boxes. Column numbers are below the first box of each variable and decimals appear where they should be punched. Please note that section number, ADT, population, and DHV do not have an input decimal point. Also, other sections would be continued on the following sheets.

Figure A-3 gives the output for the sample cards of Figure A-2. Notice that the project labels (route, county, and district) are left-justified. All other variables should be right-justified when punched. In this example, three roadway sections are being considered.

Table A-1

Listing of Program MEDEQU

```
C**********************************************************************
C
C  PROGRAM FOR USE IN MEDIAN TYPE SELECTION
C
C
C  INPUT:
C                                                            COLUMNS
C     CARD1:     ROUTE                                        1-6
C                COUNTY                                      10-29
C                DISTRICT                                    35-49
C                PROJECT NUMBER                              55-73
C                NUMBER OF SECTIONS (<= 100)                 78-80
C
C                                                           COLUMNS
C  REMAINING
C     CARDS:     SECTION NUMBER                               1-6
C                SIG, NUMBER OF SIGNALS PER MILE              7-13
C                ADT, AVERAGE DAILY TRAFFIC                  14-19
C                STREET, STREETS PER MILE                    20-26
C                DRIVE,  DRIVEWAYS PER MILE                  28-34
C                POP, CITY POPULATION                        35-42
C                  DHV,  HOURLY VOLUME                       43-48
C                OPEN,   MEDIAN OPENINGS PER MILE            49-55
C
C
C  OUTPUT FOR EACH MEDIAN TYPE
C     1.  ACCIDENTS PER MILE
C     2. LEFT TURN DELAY (SECONDS)
C
C**********************************************************************
C
      DIMENSION  SIG(100), ADT(100), STREET(100), DRIVE(100), POP(10(
     1  DHV(100), OPEN(100), XIND1(100), XIND2(100), XIND3(100),
     2                                  DEL1(100), DEL2(100),DEL3(1
      DIMENSION A(2), B(5), C(4), D(5)
C**********************************************************************
C  INITIALIZE VARIABLES:
C
      DATA XIND1,XIND2,XIND3,                      DEL1,DEL2,DEL3/600*0.(
C
C**********************************************************************
C  READ IDENTIFICATION CARD
      READ(5,1000) A(1), A(2), (B(I),I=1,5) ,(C(I),I=1,4),(D(I),I=1,5
 1000 FORMAT(A4,A2,3X,5A4,5X,3A4,A3,5X,4A4,A3,4X,I3)
C  READ SECTION PARAMETERS
      DO 10  I=1, N
   10 READ(5,2000) SIG(I), ADT(I), STREET(I), DRIVE(I), POP(I),  DHV(
     1OPEN(I)
 2000 FORMAT(6X,E7.2,F6.0,E7.2,1X,E7.2,F8.0,F6.0,E7.2)
```

Table A-1. (Continued)

```
C***********************************************************************
C  CALCULATE OUTPUT
C
C
C  ACCIDENTS PER MILE
      DO 20  I=1, N
      XIND1(I)=8.04*SIG(I) + 0.00155*ADT(I) - 0.0228*DRIVE(I) -
     1         9.26E-06*POP(I) - 12.718
      XIND2(I)=5.432*SIG(I) + 0.00173*ADT(I) + 2.157*STREET(I) -
     1         5.8E-06*POP(I) - 28.797
```

LEVEL 21 MAIN DATE = 82041 10/27/59

```
C DELAY
      DEL1(I) =-1.362*SIG(I) + 0.0184*  DHV(I) - 0.205*OPEN(I) -
     1          3.32E-05*POP(I) + 2.937
      DEL2(I) =-0.525*SIG(I) + 0.0198*  DHV(I) - 0.0676*DRIVE(I) -
     1          2.14E-05*POP(I) + 0.919
   20 CONTINUE
C***********************************************************************
C  PRINT VARIABLES
      WRITE(6,3000) A(1), A(2), (B(I),I=1,5),(C(I),I=1,4),(D(I),I=1,5)
 3000 FORMAT(1H ,19X,'***  URBAN MEDIAN DESIGN  ***',//,1H ,'ROUTE- ',
     1A4,A2,3X,'COUNTY- ',5A4,3X,'DISTRICT- ',3A4,A3,/,1H ,18X,'PROJECT
     2NUMBER- ',4A4,A3,/////,1H ,8X,'NUMBER OF ACCIDENTS PER MILE',/)
      WRITE(6,4000)
 4000 FORMAT (1H,1X,'SECTION',5X,'RAISED',7X,'TRAVERSABLE',/
     1,1H,1X,'NUMBER',/,1H,1X,'-------',5X,'------',7X,
     2'-----------')
      DO 30  J=1, N
   30 WRITE (6,5000) J,XIND1(J),XIND2(J)
 5000 FORMAT (1H,3X,I3,3X,F10.2,4X,F10.2,/)
      WRITE(6,7000)
 7000 FORMAT(1H ,/////,1H ,8X,'LEFT TURN DELAY, SECONDS',/)
      WRITE(6,4000)
      DO 50  I=1, N
      IF (DEL1(I).LE.35.0.OR.DEL2(I).LE.35.0) GO TO 50
   35 WRITE (6,8000)I
 8000 FORMAT (1H,3X,I3,3X,'UNABLE TO EST',3X,'UNABLE TO EST')
      GO TO 60
   50 WRITE (6,5000) I,DEL1(I),DEL2(I)
   60 CONTINUE
      STOP
      END
```

Table A-2

Input Data for MEDEQU

	Variable	Type	Format	Columns
Card 1	Route	Character	A4, A2	1-6
	County	Character	5A4	10-29
	District	Character	3A4, A3	35-49
	Project Number	Character	4A4, A2	55-73
	Number of Sections	Integer	I3	78-80
Remaining Cards	Section Number	Integer	Not Read	1-6
	Signals/Mile	Decimal	E7.2	7-13
	ADT	Decimal	F6.0	14-19
	Streets/Mi.	Decimal	E7.2	20-26
	Driverways/Mi.	Decimal	E7.2	28-34
	Population	Decimal	F8.0	35-42
	DHV	Decimal	F6.0	43-48
	Openings/Mi.	Decimal	E7.2	49-55

ROUTE 130 CITY-COUNTY AMHERST

DISTRICT LYNCHBURG

PROJECT NUMBER 0007-061-101-C-502

TOTAL NUMBER OF SECTIONS 3.

SECTION NO. 1.

TERMINI

FROM: Rte. 29

TO: Rte. 645

DESCRIPTION OF SECTION:

✓ EXISTING CONDITION (1981)

________ DESIGN YEAR PROJECTION

________ OTHER, DESCRIBE ________

SECTION LENGTH (MILES) 0.544

ITEM	NUMBER	NUMBER PER MILE
SIGNALS	2	3.68
ADT		15220.
STREETS	12	22.06
DRIVEWAYS	51	93.75
POPULATION		22716.
DHV		1522.
MEDIAN OPENINGS	6	11.03

Figure A-1. Urban median design.

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ROUTE 130 CITY- COUNTY AMHERST

DISTRICT LYNCHBURG

PROJECT NUMBER 0007-061-101- C-502

TOTAL NUMBER OF SECTIONS 3.

SECTION NO. 2.

TERMINI

FROM: Rte. 645

TO: Rte. 611

DESCRIPTION OF SECTION:

✓ EXISTING CONDITION (1981)

________ DESIGN YEAR PROJECTION

________ OTHER, DESCRIBE ________

SECTION LENGTH (MILES) 0.681

ITEM	NUMBER	NUMBER PER MILE
SIGNALS	3	4.41
ADT		16870.
STREETS	10	14.68
DRIVEWAYS	67	98.38
POPULATION		22716.
DHV		1687.
MEDIAN OPENINGS	7	10.28

Figure A-1. (Continued)

ROUTE 130 CITY- COUNTY AMHERST

DISTRICT LYNCHBURG

PROJECT NUMBER 0007-061-101-C-502

TOTAL NUMBER OF SECTIONS 3.

SECTION NO. 3.

TERMINI

FROM: Rte. 611

TO: Rte. 22

DESCRIPTION OF SECTION:

✓ EXISTING CONDITION (1981)

______ DESIGN YEAR PROJECTION

______ OTHER, DESCRIBE ______

SECTION LENGTH (MILES) 1.252

ITEM	NUMBER	NUMBER PER MILE
SIGNALS	5	3.99
ADT		17900.
STREETS	15	11.98
DRIVEWAYS	121	96.65
POPULATION		22716.
DHV		1790.
MEDIAN OPENINGS	13	10.38

Figure A-1. (Continued)

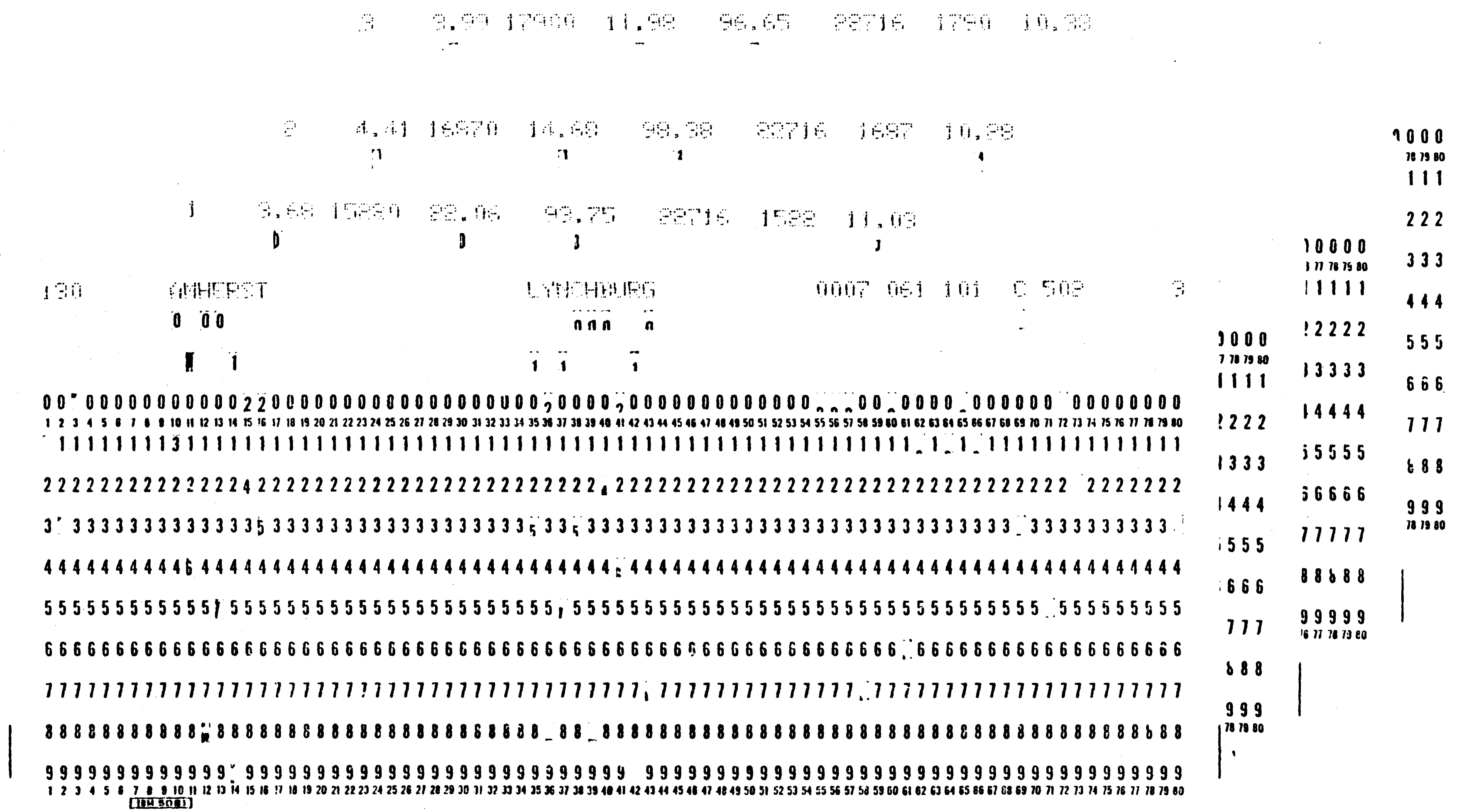

Figure A-2. Sample punched cards.

*** URBAN MEDIAN DESIGN ***

ROUTE- 130 COUNTY- AMHERST DISTRICT- LYNCHBURG

PROJECT NUMBER- 0007 061 101 C 502

NUMBER OF ACCIDENTS PER MILE

SECTION NUMBER	RAISED	TRAVERSABLE
1	38.11	64.97
2	46.43	55.88
3	44.69	49.55

LEFT TURN DELAY, SECONDS

SECTION NUMBER	RAISED	TRAVERSABLE
1	22.91	22.30
2	25.11	24.87
3	27.56	27.25

Figure A-3. Sample output from MEDEQU.