Guidelines for Preparation of Traffic Management Studies

City of Aiken, South Carolina

10/05

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I. Developing the Scope of a Traffic Management Study

Traffic Management Ordinance Requirements

The City of Aiken Traffic Management Ordinance specifies the general scope of traffic impact studies which may be required for new or expanded developments in Section 11-3.

> Sec. 11-3. Criteria for Determining When a Traffic Management Study Is Required
>
> 1) No study will be required on a road with a Level of Service A.
> 2) A study will be required for the following:
>   a) any proposed project that would generate traffic on a road providing access to the site with a Level of Service B where such project, if new, will generate 3000 or more net new vehicle trips per day or, if an expansion or change in use of an existing project, shall add 3000 or more net new vehicle trips per day; or
>   b) any proposed project that would generate traffic on a road providing access to the site with a Level of Service C where such project, if new, will generate 2000 or more net new vehicle trips per day or, if an expansion or change in use of an existing project, shall add 2000 or more net new vehicle trips per day; and
>   c) any proposed project that would generate traffic on a road providing access to the site with a Level of Service D where such project, if new, will generate 1000 or more net new vehicle trips per day or, if an expansion or change in use of an existing project, shall add 1000 or more net new vehicle trips per day.
> 3) Notwithstanding the foregoing, a study shall not be required in connection with any request for approval involving property that is developed and for which no redevelopment is proposed as determined by the Planning Director.

The following table sets forth when a Traffic Management Study is required.

Is a Traffic Management Study Required?

Level of Service	< 1000 New Trips Per Day	1000 to 2000 New Trips Per Day	2000 to 3000 New Trips Per Day	>= 3000 New Trips Per Day
A	No	No	No	No
B	No	No	No	Yes
C	No	No	Yes	Yes
D	No	Yes	Yes	Yes
E	Yes	Yes	Yes	Yes
F	Yes	Yes	Yes	Yes

The following is taken from Sec 11-4 of the Traffic management ordinance and it explains the criteria for establishing the study area.

Study Area

The study area shall include all proposed access points, all signalized intersections and all non-signalized intersections having side-street average daily traffic counts of 4000 vehicles per day or more within ¼ mile of the property lines on all streets adjoining the site. If the estimated trip generation for the project is over 5000 trips per day, then the study area shall include all proposed access points, all signalized intersections, and all non-signalized intersections having side street average daily traffic counts of 4000 vehicles per day or more within ½ mile of the property lines on all adjoining streets. The potential traffic from any approved project shall be considered in the study as determined by the Planning Director.

The criteria are summarized below:

	< 5000 Trips Per Day	> 5000 Trips Per Day
All Proposed Access Points	Yes	Yes
All Signalized Intersections within ¼ mile	Yes	Yes
All signalized intersections more than ¼ mile but within ½ mile of site	No	Yes
All non-signalized intersections within 1/4 mile of the site with at least 4000 ADT	Yes	Yes
All non-signalized intersections more than ¼ mile but within ½ mile of the site with at least 4000 ADT	No	Yes

Pre-project Scoping Meeting

Before beginning a traffic impact study, it is necessary to discuss with the Planning Department staff the scope for the study and establish guidelines for the report. For smaller projects, this discussion may be done by telephone, through e-mail correspondence, or regular mail. In either case, the City will provide a checklist indicating the required report content. A sample is included as Figure 1.

Figure 1

Checklist for Traffic Management Study
City of Aiken, South Carolina

Name of Project____

Address (attach location map)____

Type of Proposed Development____

Existing Land Use____

ITE Development Code(s)____

Estimated Daily Trip Generation (provide calculations)_______________________

Required study area dimension ¼ mile or ½ mile radius?_____________________

List all intersections for study within study area______________________________
____
____
____
____

List time periods for study____

List scenarios for study (existing, full development, phasing, future years)___________
____

List committed projects to be included in study_______________________________
____

List recent traffic studies available for use_________________________________

Provide proposed trip distribution method___________________________________
____
____

Provide proposed trip assignment method____________________________________

Traffic safety analysis required (list intersections or corridors)_____________________
____
____

Other items required as part of the study____________________________________

II. Collection of Traffic Data

Available Traffic Data

Traffic counts may be available from the City of Aiken, the Aiken County Planning Department, and the South Carolina Department of Transportation (SCDOT). Any of these organizations may have average daily traffic counts, intersection turning movement counts, and traffic study reports containing pertinent data and estimates.

The City of Aiken maintains a map indicating the Level of Service of major streets in the City. The City also maintains a library of traffic studies that have been conducted. Aiken County maintains the local data for the area-wide transportation plan, the Augusta Regional Transportation Study, also known as ARTS. SCDOT conducts annual traffic counts in the area as part of the on-going transportation planning process. This data is available from the Traffic Engineering Division of SCDOT at the main office in Columbia. In addition, the District Traffic Engineer for SCDOT conducts traffic studies in the Aiken area. Data from these studies may be available at the office of the District Traffic Engineer in Columbia. A summary of these data sources is listed below.

Agency	Office	Phone	Data
City of Aiken	Planning Dept.	803-642-7608	LOS Map, studies
Aiken County	Planning Dept.	803-642-1520	ARTS Data
SCDOT	Traffic Eng. Division	803-737-1455	ADT counts Traffic safety
SCDOT	District Office	803-737-6600	Turning Movement Counts

Use of Available Data

Generally, any available daily traffic counts may be used in developing historical trends for use in forecasting traffic growth trends. Turning movement counts may used if less than two years old. Requests for use of any existing data will require the prior approval of the Planning Director. The City of Aiken will provide any available turning movement counts within five (5) working days of request. Recently completed traffic management studies for other projects may be used as a source of data upon the approval of the Planning Director. Generally, any studies less than two years old may be eligible for use.

Collection of Turning Movement Counts

Traffic turning movement counts will be made at the required intersections to cover the necessary hours of the study. For most studies, the hours of study will require the morning and afternoon peak hours on typical weekdays. For some studies, especially where there may be a desire to attempt to establish the need for a traffic signal, additional hours will be required. In these cases, counts should be made to cover the busiest eight hours of a typical weekday. It is normally best to exclude Mondays and Fridays, as these days are generally different from the average. Care must be taken to avoid peak seasonal events and to avoid days in which public school is not in session. For projects which include improvements to schools or sites adjacent to schools, it will be necessary to include peak hour counts for the school take-in and dismissal times. Establishment of times for turning movement counts will be made in the scoping session with the Planning Department staff.

III. Prediction of Traffic Volume Growth

Traffic volume growth may be predicted using a number of methods but the two primary ones are (1) the use of the ARTS long-range plan and (2) manual methods. The ARTS plan may be used to establish average daily traffic volumes for streets within a study area for a future year as predicted by the ARTS model. This data can be used to develop a factor to apply to existing traffic counts to predict future-year traffic volumes.

Manual extrapolation of existing data using growth factors may be available from the City, or the consultant may need to develop them. Growth factors may be estimated from historical data and can be representative of a number of algebraic trends. Among these are the straight-line, exponential, and decaying-rate exponential trends. For a good discussion of these trend methods, see the Trip Forecasting Manual published by the Florida Department of Transportation. Generally, manual extrapolation of turning movement counts will not be accepted for periods of time exceeding five (5) years.

IV. Trip Generation Estimation

Trip generation may be estimated using the Institute of Transportation Engineers (ITE) Trip Generation, 7th edition, 2004. An accompanying publication, the Trip Generation Handbook, 2nd Edition, provides additional information on how to use Trip Generation, 7th edition, 2004 and how to apply adjustments such as pass-by trips.

Generally, the City of Aiken accepts the methodology provided in Trip Generation, 7th edition, 2004 and the Trip Generation Handbook. In some cases, trip generation data may not be available from ITE for certain land uses. In these cases the applicant's consultant will be required to develop estimated trip generation data for use in the study after consultation with the City of Aiken staff.

The Trip Generation, 7th edition, 2004 provides estimated trip generation data for various land use categories, known as land use codes in the Manual. Average rates for weekdays, weekends, and morning and afternoon peak hours are given for most land use codes. In addition, many of the land use codes provide equations that may be used to determine estimated traffic generation. An example of the data for a land use, Code 210, single-family residential, is given on the following page (Figure 2). As seen in this example, there are average rates as well as an equation given for this particular land use. The Trip Generation Handbook gives information that recommends when to use the average rate data and when to use the equations. A summary decision chart from the Handbook as shown in Figure 3 takes into account the size of the development and the statistics indicating the reliability of the data in Trip Generation, 7th edition, 2004. For example, for a single-family residential development, the average daily trip generation rate given is 9.57 trips per dwelling unit. The equation given is $Ln(T) = 0.92 \times Ln(X) + 2.71$. If a proposed single-family residential project has 300 dwelling units, then the equation would give the following estimate of daily trips:

$$Ln(T) = 0.92 \times Ln(300) + 2.71$$

Figure 2

Single-Family Detached Housing
(210)

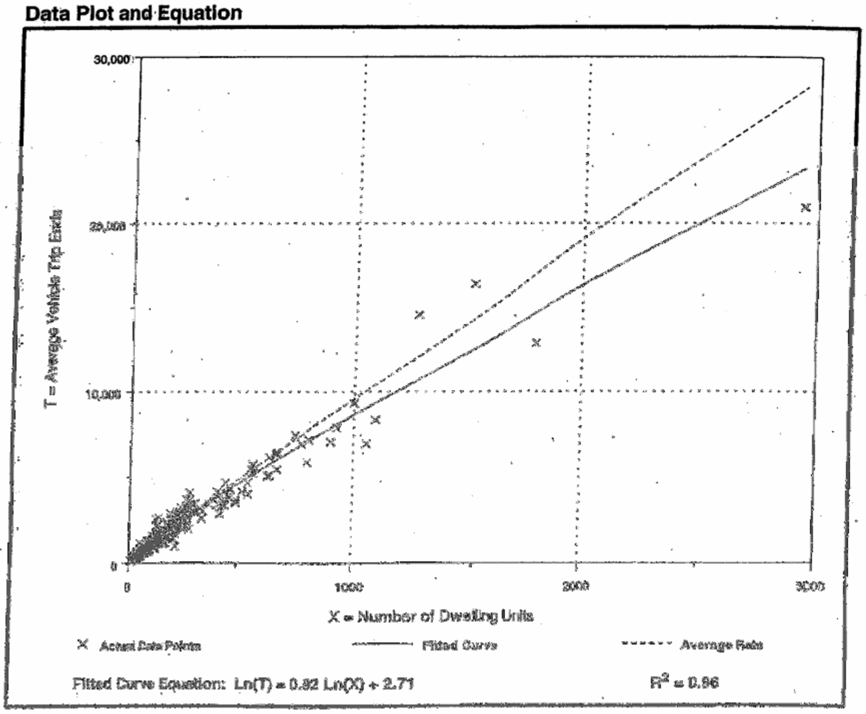
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 350
Avg. Number of Dwelling Units: 197
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

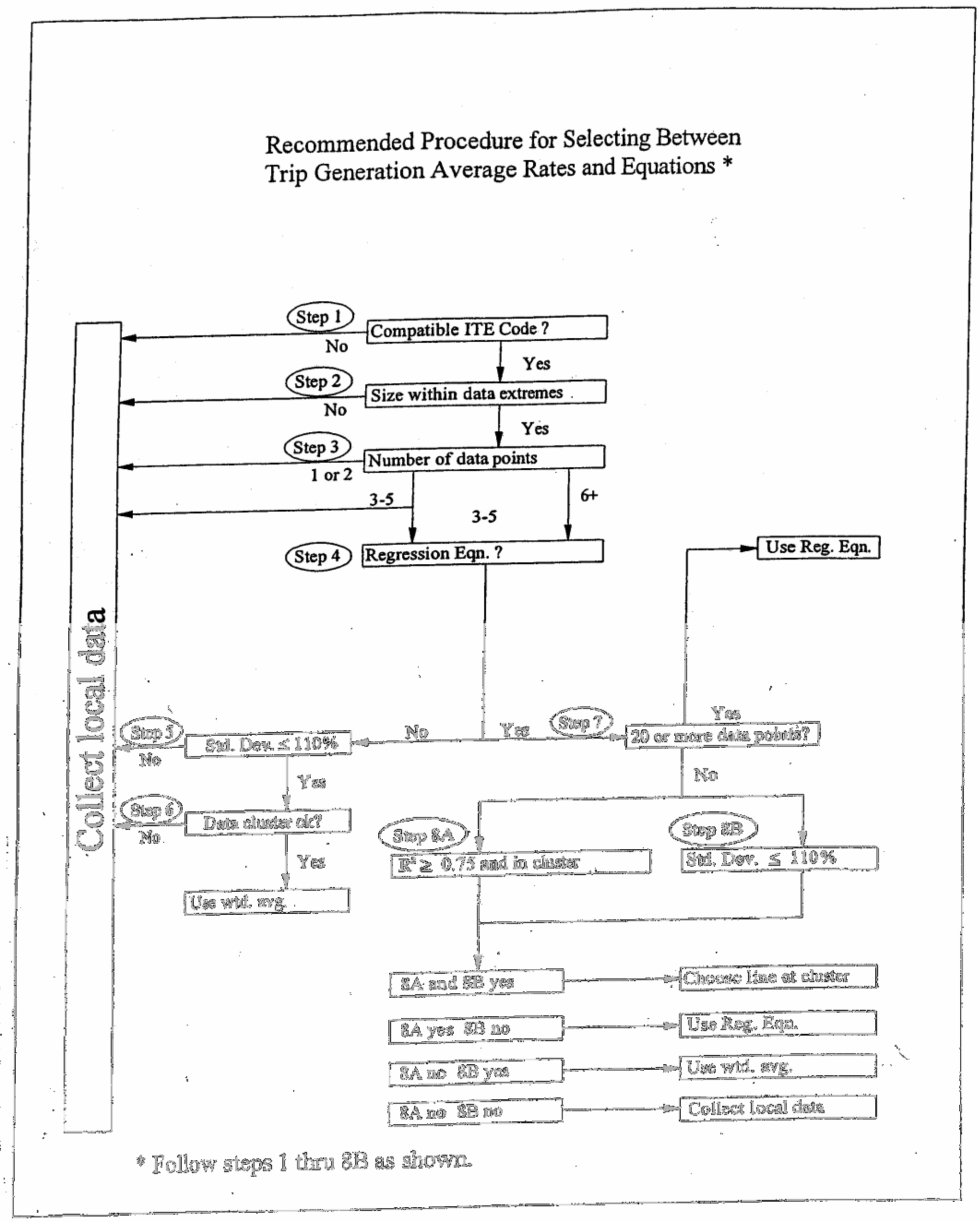
Average Rate	Range of Rates	Standard Deviation
9.57	4.31 - 21.85	3.69

Data Plot and Equation



Trip Generation, 7th Edition 269 Institute of Transportation Engineers

Figure 3


Recommended Procedure for Selecting Between
Trip Generation Average Rates and Equations *
Collect local data
Step 1
Compatible ITE Code ?
No
Yes
Step 2
Size within data extremes
No
Yes
Step 3
Number of data points
1 or 2
3-5
6+
3-5
Step 4
Regression Eqn. ?
Use Reg. Eqn.
Step 5
Std. Dev. ≤ 110%
No
Yes
Step 7
20 or more data points?
Yes
No
Step 6
Data cluster ok?
No
Yes
Use wtd. avg.
Step 8A
R² ≥ 0.75 and in cluster
Step 8B
Std. Dev. ≤ 110%
8A and 8B yes
Choose line at cluster
8A yes 8B no
Use Reg. Eqn.
8A no 8B yes
Use wtd. avg.
8A no 8B no
Collect local data
* Follow steps 1 thru 8B as shown.

Solving for T gives 2857 trips. Using the average rate of 9.57 trips per dwelling unit would give 300 x 9.57 = 2671. So, there is a discrepancy between the two methods and a decision must be made as to which method to use. As seen on p. 269 of the ITE Trip Generation, 7th Edition, 2004 there were 350 studies for this land use code. Applying Figure 3 from the ITE Engineers Trip Generation Handbook, it is obvious that the equation should be used, instead of the average.

For a second example consider a proposed mini-warehouse facility with 125 units, land use code 151. In this case there is an equation given, but the formula is based upon only 14 studies. As per Figure 4, we see that the number of data points is less than 20, so we check the standard deviation and see that it is 1.78 versus the average of 2.50 for a percentage of 72%. Since the R^2 value is 0.73, which is less than 0.75, we would use the average of 2.50 per unit. This would result in 2.50 x 125 = 313 trips. The equation would have given:

$$Ln(T) = 1.01 \times Ln(125) + 0.82.$$

Solving for T gives 298 trips. Again, this is a different result than we would get with the average rate, but in this case the ITE Trip Generation Handbook recommends use of the average rate.

As seen above, care must be used when developing trip generation estimates from the ITE Trip Generation, 7th edition, 2004 and the guidelines of the ITE Trip Generation Handbook must be used to make the correct selection between the use of average rates and equations provided.

V. Trip Distribution

Trip distribution may be done using data from the ARTS Long-Range Plan or by developing a distribution using traffic flow and socioeconomic data. Trip distribution is provided in tables available through ARTS. In some cases it may be possible to gain access to the ARTS model, revise trip generation for the traffic analysis zones being studied, and then compute the expected trip distribution after completion of the development-in-question; this will require coordination with the maintainer of the ARTS model, the Georgia DOT. Normally, this effort would only be required for extremely large developments of regional impact, such as a large shopping mall, a large manufacturing plant, or a very large residential development.

For most projects, the development of trip distribution will require numerical methods to analyze trips that will be newly made to and from the site (new trips) and trips that will be made by drivers already traveling past the site (pass-by trips). In addition, in some limited cases, there may be trips that are diverted from one street to another as a result of a new development.

The methods discussed in the ITE publication Guidelines for Development of Traffic Impact Studies are generally considered acceptable for use in Aiken. The most common model used for trip distribution is the gravity model. In short, this model distributes trips to and from generators in direct proportion to the trip productions and attractions and in inverse proportion to the travel time required to reach the destination or return to the origin. As discussed in the ITE publication, the gravity model is appropriate for new trips for both commercial and residential developments. Data from ARTS may be used to establish trip distribution for new trips.

Figure 4

Mini-Warehouse
(151)

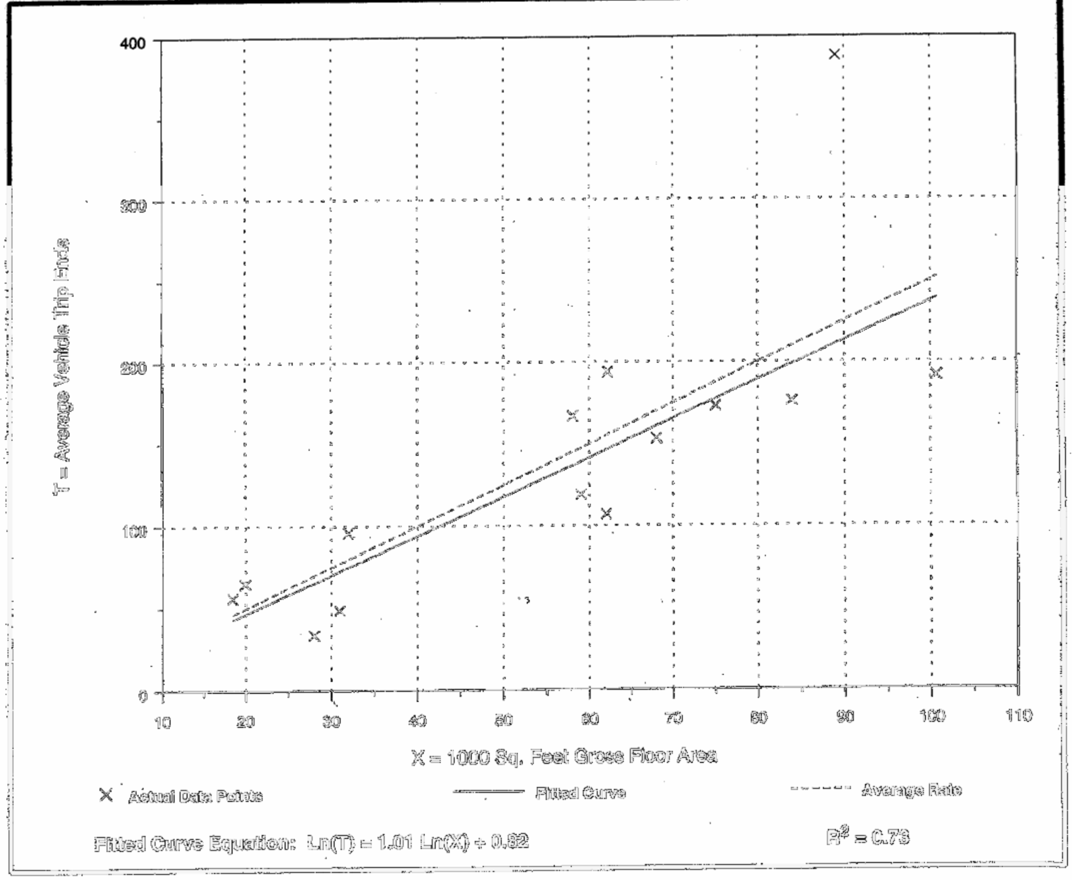
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area
On a: Weekday

Number of Studies: 14
Average 1000 Sq. Feet GFA: 56
Directional Distribution: 50% entering, 50% exiting

Trip Generation per 1000 Sq. Feet Gross Floor Area

Average Rate	Range of Rates	Standard Deviation
2.50	1.21 - 4.36	1.78

Data Plot and Equation



Trip Generation, 7th Edition 227 Institute of Transportation Engineers

A "short-cut" method is to analyze the population of each traffic analysis zone (TAZ) within the expected travel circumference of the proposed development and distribute the trips based on the population distribution. For example, a proposed commercial site will be developed with land uses such that the site has an expected maximum travel time of 20 minutes for new trips to the site. Assume the average travel speed is 30 mph. This would mean that the radius of travel to the site would generally be within 10 miles (30 mph x 20 minutes / 60 minutes/hr). So we would then review the population data for all TAZ within 10 miles of the site and develop a matrix indicating the percentage distribution of population within those TAZ. Assuming the four cardinal directions, we might find that for example, 20% of the population lives to the north of the site, 30% to the south, 15% to the west and 35% to the east. We would then distribute the trips to and from the site using those proportions. If the site were to generate 1000 new trips, we would then assume for example that 350 (35%) would come and go from the east. This method can also be augmented with travel time data from and to the surrounding zones if available. Programs such as The Highway Emulator (T.H.E.) use zonal trip data and travel time data to develop a trip table of most likely travel paths within a network where existing traffic turning movements exist.

Another method is to use market survey data when available. For example, a new grocery store chain may have done a market survey to assess whether or not to enter a new market. Their survey may indicate where potential shoppers live and in what proportions. Again, these proportions could be used to distribute new trips.

Pass-by trips are normally distributed in proportion to the current traffic flow patterns. For example, if during the morning peak hour 60% of the traffic passing a site were northbound, we would assume that 60% of the pass-by trips would come from vehicles already passing the site northbound.

A more complete description of these methods is provided in several resources including the ITE Guidelines for Traffic and Site Impact Studies as well as publications from the Northwestern University Traffic Institute.

There are automated methods available for trip distribution in addition to the ARTS model. Among these are SITE, Traffix and many more. These models are acceptable for use provided that they are discussed and approved in advance by the Planning Director in the project scoping process.

VI. Trip Assignment

Trip assignment is the step in the process in which new trips are allocated to the existing and proposed facilities in the study area and in which turning movement data is adjusted for both new trips and pass-by trips. Trip assignment may be done utilizing the ARTS model. For most projects, an inspection of the trip generation and distribution will indicate the routes most likely to be used by new and pass-by vehicles. There are numerous ways to assign trips to the various segments of street networks. These methods are numerical and take into account capacity, typical operating speeds, existing traffic control measures in place, and many other factors. Normally the methods are so complicated that computer assistance is needed. Many of the computerized traffic analysis programs such as SITE, QRS, T.H.E., and others are available for use. However, in Aiken, it will normally not be necessary to reach that level of detail, except for extremely large projects. In most cases, a manual manipulation of numbers taking into account travel distances and speeds and general street conditions will be sufficient to assign trips. For most studies, a site will have access permitted on no more than one or two sides, which simplifies the assignment process. Sometimes local data and information can be useful in establishing the assignment of trips to the study network.

The assignment of trips to the various access points of a proposed development does require assumptions and the use of information that may be available on current traffic patterns. For example, a commercial development with more than one access point is likely to have traffic at all its driveways. Generally, in the lack of other data, drivers will normally enter the first available driveway as opposed to the 2^{nd}, in a ratio of about 70%:30%. If there are three driveway accesses, the distribution is generally expected to be about 70%:20%:10%. If there are access points on more than one frontage, patterns may be different. (See the graphic given in Figure 5.) Every individual case may be different and numerous factors come into play. The positioning of the access points in relation to the "center of gravity" of the development has an effect on which driveway is used. The land use of any outparcels also has a large effect. Finally, traffic control is a big factor. Drivers may favor a particular traffic signal, for example, because it allows for safer or more convenient access to the site.

VII. Traffic Flow Analysis

Methodology Plan

Prior to development of traffic flow analysis for both existing and future conditions, a review will be made by the consultant and a proposed plan will be submitted to and discussed with the Planning Director. This plan will address the methods to be used in data collection and analysis.

Use of Highway Capacity Manual

Generally, traffic flow analysis will be by the current version of the Highway Capacity Manual (HCM). Computerized software packages such as HCS+, Synchro, SimTraffic, Corsim, and other programs may be used with prior approval of the Planning Director.

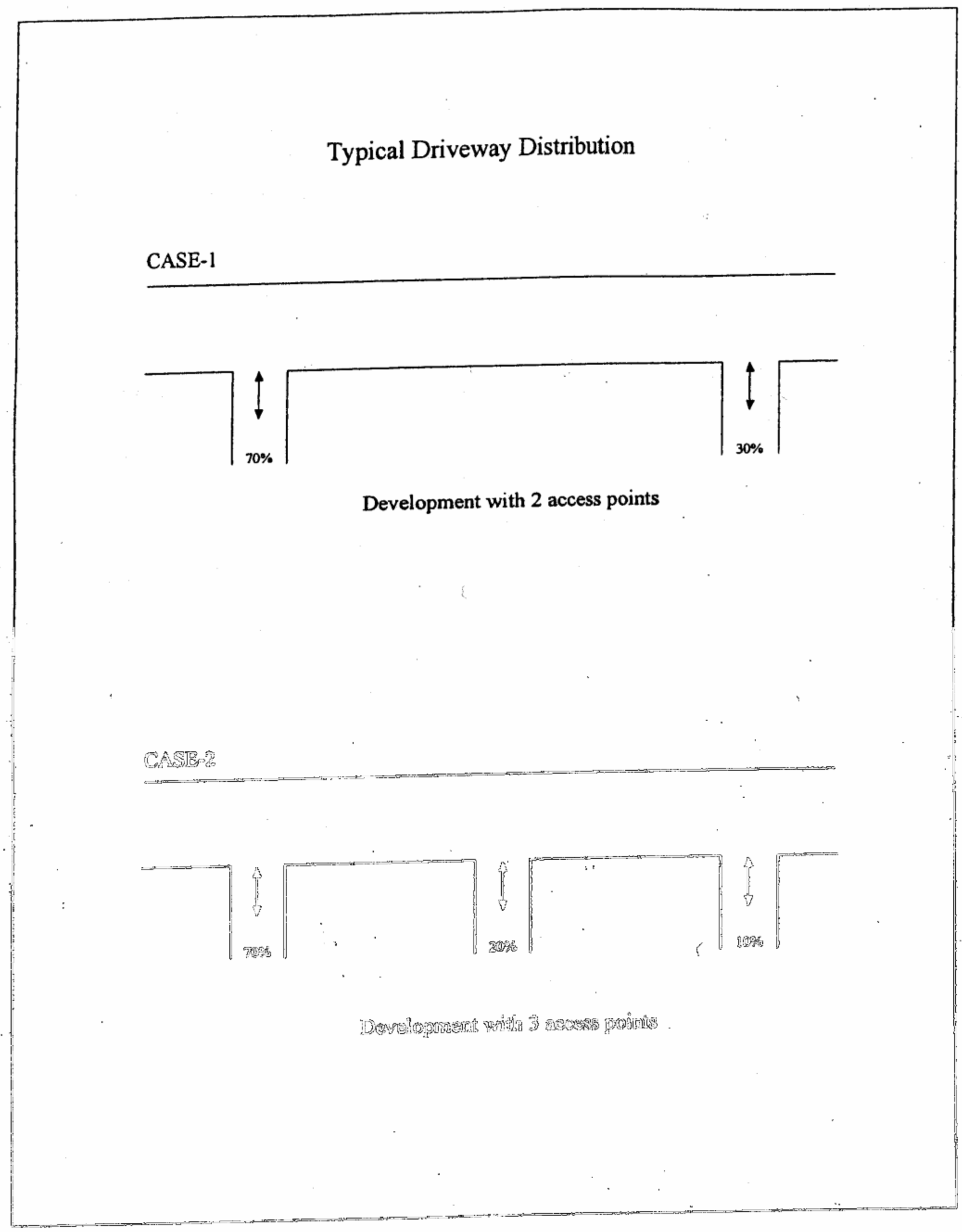
Acceptable Practices for Use of Traffic Flow Analysis Techniques

The consultant will employ practices and use standards and guidelines normally accepted by the ITE and the SCDOT. Any deviations from typical values for parameters used in the HCM or any software packages will require prior approval of the Planning Director. Among these parameters are standard normal ranges of saturation flow for travel lanes, general traffic signal timing settings, normal values for percentages of heavy vehicles, and various adjustment factors. The consultant should discuss the use of any extraordinary settings for these and any other parameters with the Planning Director before use. For example, the Highway Capacity Manual normally recommends the use of a saturation flow of 1900 vehicles per hour for arterial streets. Use of a saturation flow rate substantially different would require prior approval of the Planning Director.

VIII. Traffic Safety Analysis

Some developments will be proposed for locations already having traffic safety problems. Adding new traffic or imposing revised traffic patterns at an intersection or along a stretch of street which already has a safety problem must be carefully considered. In addition, at some

Figure 5


Typical Driveway Distribution
CASE-1
70%
30%
Development with 2 access points
CASE-2
70%
20%
10%
Development with 3 access points

locations with geometric deficiencies but with low traffic volumes, there may not be a documented safety problem in terms of the number or rate of collisions. Adding traffic at such locations might create a safety concern, and these locations will require additional scrutiny. In all cases, the Planning Director will determine whether a traffic safety analysis is required as part of a Traffic Management Study.

A study of traffic safety conducted as part of a Traffic Management Study will include a review of the site's collision history and an assessment of how the proposed development might affect the potential for increased safety problems. The study will include any mitigation efforts necessary to address known problems or situations that may arise as a result of the proposed development. For example, the location of a new residential development with proposed access on the inside of a sharp, horizontal curve may need closer review if the curve has adverse geometry and/or a history of collisions attributed to the curvature. The safety analysis would attempt to predict the likely impacts on traffic safety with the new development in place and recommend measures to mitigate any impacts. Such mitigations might include revising the geometry of the curve by rebuilding or "flattening" it, installing turn lanes, or installing traffic control devices to warn motorists of hazards. Another example might be a signalized intersection having a history of left-turn collisions. If a new development will add a significant number of new left turns to the intersection, it may be that the location will require addition of a left-turn phase to the signal or some other measure as a mitigation effort, based on *safety* as opposed to traffic level of service.

Each case will be reviewed individually when required to be part of the study by the Planning Director. The City will provide access to any safety data it may have including reports and data summaries. Traffic collision data is also available from SCDOT and the South Carolina Department of Public Safety. Analysis of traffic safety data normally involves (1) a review of collision rates and severity and (2) observations of traffic flow as related to existing hazards. Collision diagrams may be required in order to assess safety deficiencies and determine remedies for existing problems. Other examples of safety analysis for specific types of problems are given in the Appendices.

Discussion of safety issues so that analysis can be included in the Traffic Management Study will occur in the initial discussions between the developer's engineer and City staff.

IX. Development of Conclusions and Recommendations

The general approach is that existing traffic counts, traffic control, and intersection and street data are used as inputs to the Highway Capacity Manual analysis methods to develop assessments of existing conditions. The HCM methods are used to analyze peak hour conditions for the hours required in the study. Generally, the peak 60 minutes within the morning and afternoon peak hours are analyzed. Software such as Synchro, Transyt, and many others are available for use when pre-approved by the Planning Director. ARTPLAN software may also be used for general level of service analysis of daily traffic flow data.

New trips to be added to existing traffic flow are estimated using the standard methods of the ITE. Trip generation is predicted and trips are distributed and assigned to the street system along with any background growth to provide a picture of traffic flow at full buildout of the proposed development. The traffic analysis methods for capacity and level of service analysis are then used to assess traffic conditions with the project and to compare to existing conditions. These results are used to identify traffic movements that become difficult as a result of the proposed development. For example, an intersection may have a good overall level of service with acceptable delays and queues. After the addition of a proposed project, it may be found that a certain movement may result in extensive congestion and long queues. The next step would be to determine the causes of the potential traffic problems and identify potential corrections or mitigations such as installation of a traffic signal or turning lanes or other measures.

The determination of the need for additional through lanes on major streets or on side-street approaches will be made by looking at the existing and future capacity versus traffic demand. Only very large developments would normally require the addition of through lanes. Many other developments may require the addition of turning lanes.

Analysis of the need for left-turn lanes should include but not be limited to the methods presented in Chapter 15 of the South Carolina Highway Design Manual, 2003 (SCHDM). These methods generally parallel those of the American Association of State Highway and Transportation Officials (AASHTO). Pertinent data and charts from this Manual are given in Appendix 1.

For an example of the review of the need for a left-turn lane, consider a site with a proposed access point that will generate 60 *new* left turns during the design hour on an existing two-lane street which does not have turn lanes, along with 40 *new* vehicles in the opposing traffic stream. If the speed limit is 40 mph, the existing advancing volume is 350 and the existing opposing volume is 500, the chart from page 15.5(9) of the SCHDM would be used. Since we predict 60 left turns, we are expecting 60 / (350 + 60) or 15% left turns for this movement. Entering the chart at V_O = 540 and V_A = 410, we see that the threshold for needing a left turn lane is about 6 to 7%. Since we expect to have 15% left turns, we would conclude that a left turn lane is warranted. See Appendix 2 for the application of this chart and method.

Guidelines for right-turn lanes at unsignalized intersections on two-lane highways are given in Figure 15.5A of the SCDHM. As an example, consider a proposed development that will generate 75 new right-turns in the design hour. Assume the existing through volume is 450 and that the speed limit is 45 mph. Entering the chart at a right-turn volume of 100 with a total design hour volume of 550 gives a point above the line, indicating that a right-turn lane should be considered. See Appendix 3 for an example of the application of this chart and method.

Capacity analysis using the HCM and software such as Synchro can also be used to determine levels of congestion and queues at proposed access points, giving an indication of the need for a left-turn lane or a right-turn lane. Data from these analyses can indicate possible extension of queues that might affect through lanes, indicating the need for new or extended turn lanes. Safety considerations are also very important. Any location with high speeds and/or a history of left-turn or rear-end accidents that might indicate the need for a turning lane should have further review even if the criteria of the chart are not exceeded. Also, for cases where the use of the SCDHM charts indicate that thresholds are met, additional references and/or methodology must be presented in order for consideration to be given to not providing auxiliary turning lanes. *In all cases, the City Planning Director shall review the materials presented and shall determine whether or not turning lanes will be required as mitigation of traffic impacts.*

X. Format and Submittal of Report

Reports must be bound and submitted in triplicate to the Planning Director. A CD of any software data sets may be required in individual cases. An electronic version of the report may also be submitted to the Planning Director. Printed reports should be delivered to the Planning Director at 214 Park Ave. SW, Aiken, SC, or at the City Hall building during normal business hours, or mailed to Post Office Box 1177, Aiken, SC 29802.

Reports should have flat binding for ease of filing. The report should be prepared using at least a 12-font size type. The report should contain a table of contents, a list of figures and appendices that are clearly noted for data sets and any software printouts. The report should contain discussion of all of the major facets of the study including background data, traffic data collected, trip generation, trip distribution and assignment, analysis of conditions with and without the proposed project, recommended mitigation measures, and appendices with pertinent data. Renderings of the proposed development are recommended for inclusion in the report.

The report must be signed and sealed by a traffic engineer registered in the state of South Carolina on the cover or table of contents page.

XI. Review and Approval of Report

The report will be reviewed by City staff for completeness and content. City staff will notify the applicant within 10 business days if any components of the study have been omitted. The City will notify the applicant within 15 days of submission of a complete application as to approval or disapproval. All facets of the report will be reviewed. If any discrepancies are observed, the submitting engineer will be notified and asked to make necessary corrections or submit missing data or portions of the analysis. The report will be used to justify the proposed access plan for the project.

Appendices

1. Criteria for auxiliary right-turn lanes and left-turn lanes from Highway Design Manual, South Carolina Department of Transportation, 2003

2. Example of application of SCDHM criteria for left-turn lane

3. Example of application of SCDHM criteria for right-turn lane

References

1. Trip Generation, 7th Edition, 2004 by Institute of Transportation Engineers
2. Trip Generation Handbook by Institute of Transportation Engineers
3. Guidelines for Traffic and Site Impact Studies by Institute of Transportation Engineers
4. Highway Capacity Manual by Transportation Research Board
5. Highway Design Manual, 2003, South Carolina Department of Transportation
6. Florida Department of Transportation Web Site www.dot.state.fl.us/planning
7. Access and Roadside Management Standards, South Carolina Department of Transportation

15.5 AUXILIARY TURN LANES

15.5.1 Turn Lane Guidelines

15.5.1.1 Guidelines for Right-Turn Lanes

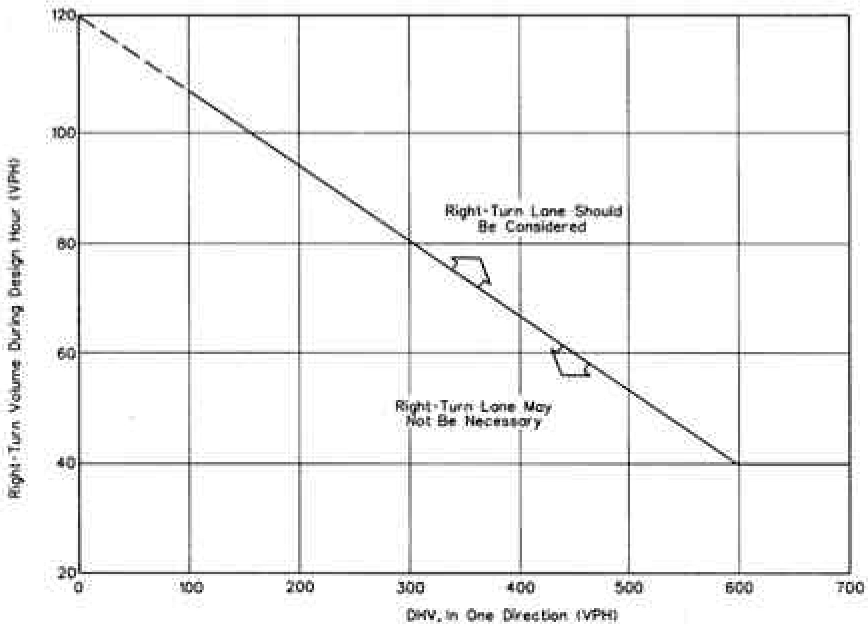
The use of right-turn lanes at intersections can significantly improve operations. Consider exclusive right-turn lanes:

- at the free-flowing leg of any unsignalized intersection on a two-lane urban or rural highway which satisfies the criteria in Figure 15.5A;
- at the free-flowing leg of any unsignalized intersection on a high-speed, four-lane urban or rural highway which satisfies the criteria in Figure 15.5B;
- at any intersection where a capacity analysis determines a right-turn lane is necessary to meet the level-of-service criteria;
- as a general rule, at any signalized intersection where the projected right-turning volume is greater than 300 vehicles per hour and where there is greater than 300 vehicles per hour per lane on the mainline;
- for uniformity of intersection design along the highway if other intersections have right-turn lanes;
- at railroad crossings where the railroad is parallel to the facility and is located close to the intersection and where a right-turn lane would be desirable to store queued vehicles avoiding interference with the movement of through traffic; or
- at any intersection where the crash experience, existing traffic operations, sight distance restrictions (e.g., intersection beyond a crest vertical curve), or engineering judgment indicates a significant conflict related to right-turning vehicles.

15.5.1.2 Guidelines for Left-Turn Lanes

The accommodation of left turns is often the critical factor in proper intersection design. Left-turn lanes can significantly improve both the level of service and intersection safety. Always use an exclusive left-turn lane at all intersections with public roads on divided urban and rural highways with a median wide enough to accommodate a left-turn lane, regardless of traffic volumes. Consider using an exclusive left-turn lane for the following:

- at any unsignalized intersection on a two-lane urban or rural highway which satisfies the criteria in Figures 15.5C, 15.50, 15.5E, 15.5F or 15.5G;
- at any signalized intersection. At locations where you have 300 vehicles per hour, consider a traffic review to determine if dual left-turn lanes are required;
- at all entrances to major residential, commercial and industrial developments;
- at all median crossovers;
- for uniformity of intersection design along the highway if other intersections have left-turn lanes (i.e., to satisfy driver expectancy); or
- at any intersection where the crash experience, traffic operations, sight distance restrictions (e.g., intersection beyond a crest vertical curve), or engineering judgment indicates a significant conflict related to left-turning vehicles.



Note: For highways with a design speed below 50 miles per hour with a DHV < 300 and where right turns > 40, an adjustment should be used. To read the vertical axis of the chart, subtract 20 from the actual number of right turns.

Example

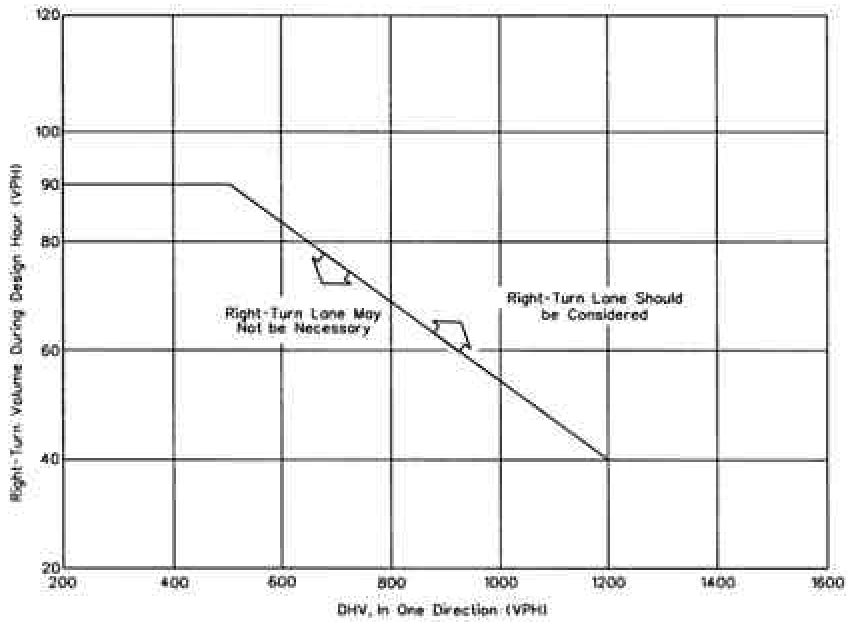
Given: Design Speed = 35 miles per hour (mph)
DHV = 250 vehicles per hour (vph)
Right Turns = 100 vehicles per hour (vph)

Problem: Determine if a right-turn lane is necessary.

Solution: To read the vertical axis, use 100 – 20 = 80 vehicles per hour. The figure indicates that a right-turn lane is not necessary, unless other factors (e.g., high crash rate) indicate a lane is needed.

GUIDELINES FOR RIGHT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS

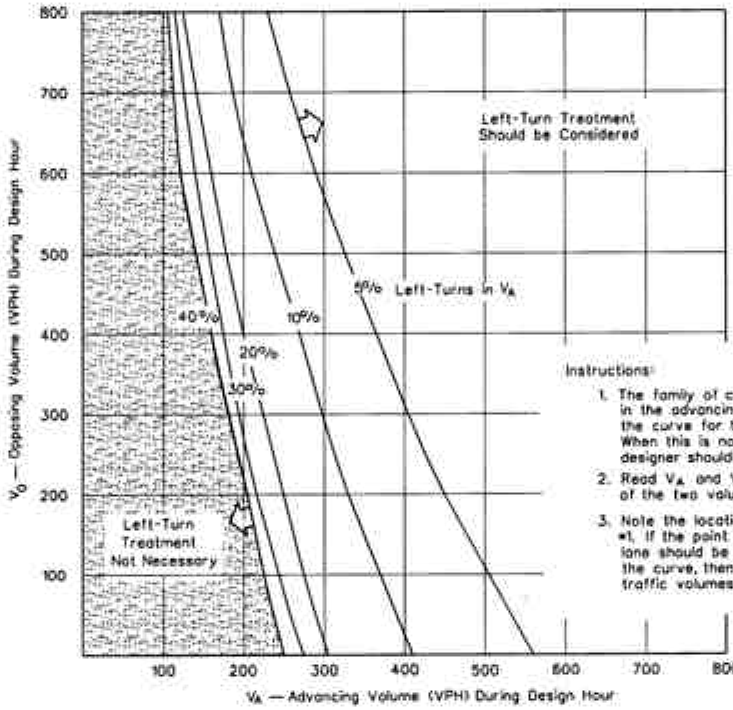
Figure 15.5A



Note: Figure is only applicable on highways with a design speed of 50 miles per hour or greater.

GUIDELINES FOR RIGHT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON FOUR-LANE HIGHWAYS

Figure 15.5B



V_A = Total advancing traffic volume which includes all turning traffic

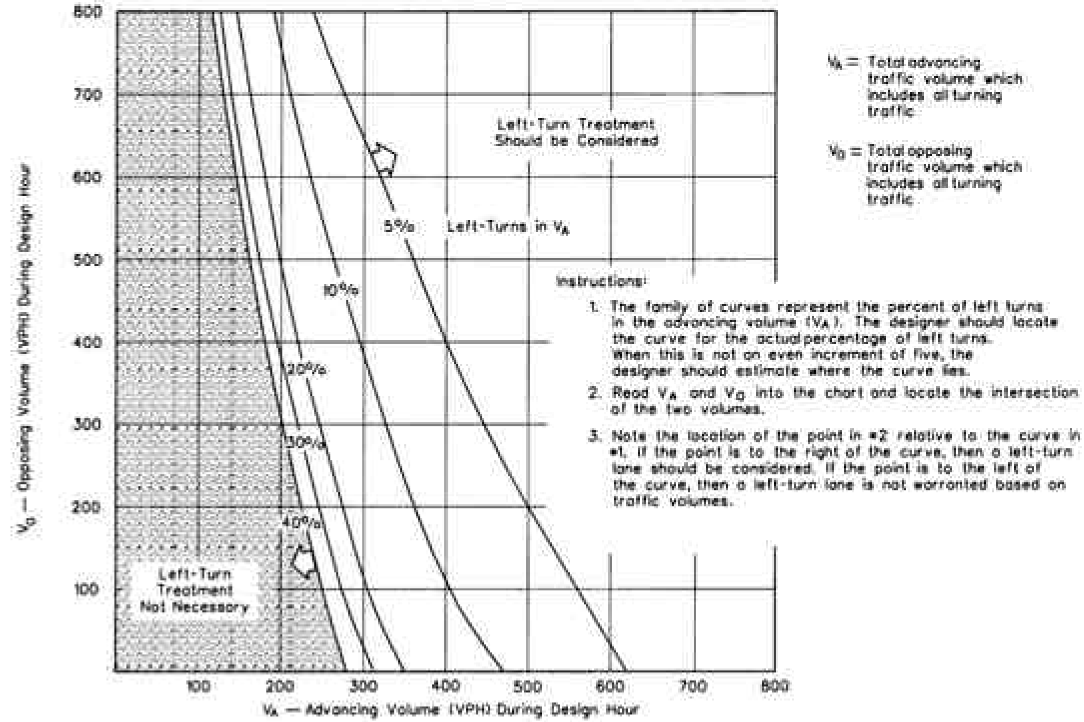
V_O = Total opposing traffic volume which includes all turning traffic

Instructions:

1. The family of curves represent the percent of left turns in the advancing volume (V_A). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read V_A and V_O into the chart and locate the intersection of the two volumes.
3. Note the location of the point in #2 relative to the curve in #1. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.

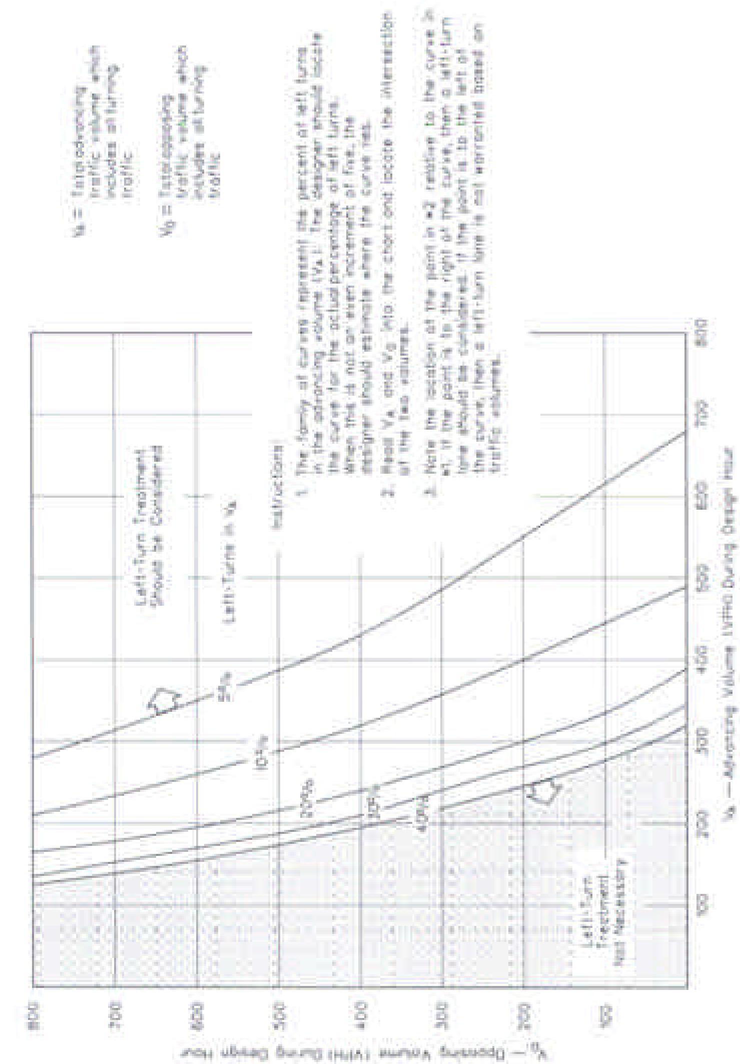
VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (60 MPH)

Figure 15.5C



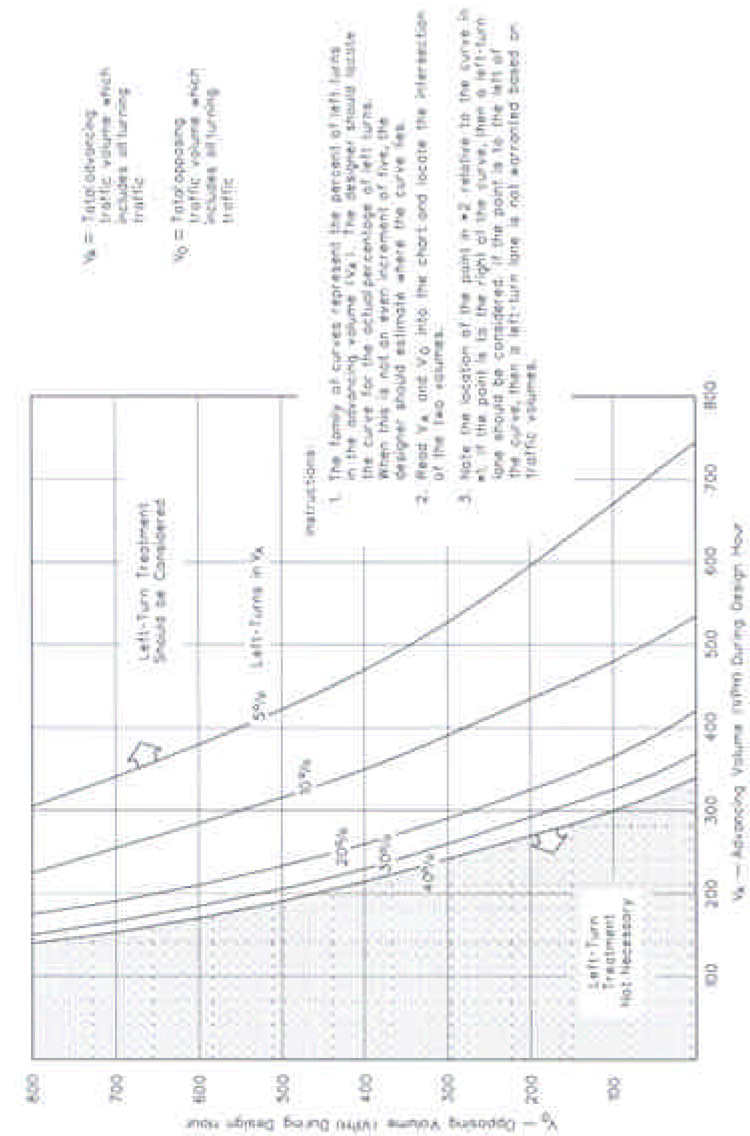
VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (55 MPH)

Figure 15.5D



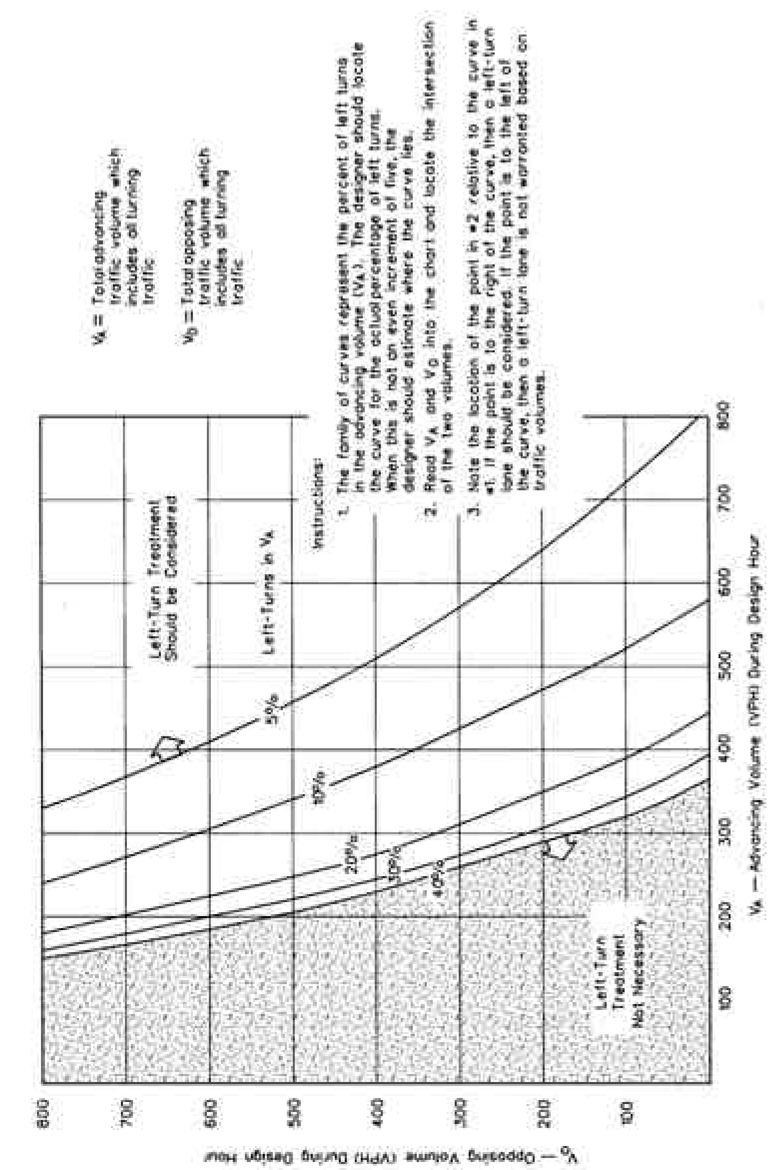
VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (50 MPH)

Figure 15.5E



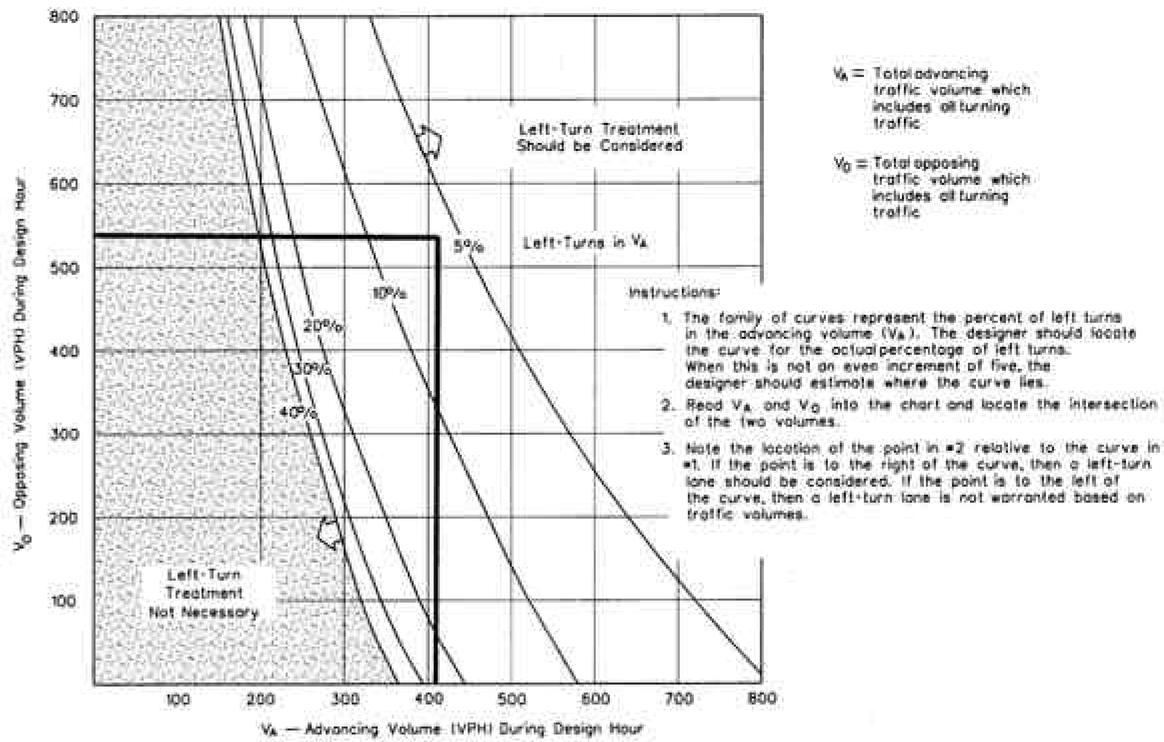
VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (45 MPH)

Figure 15.5F



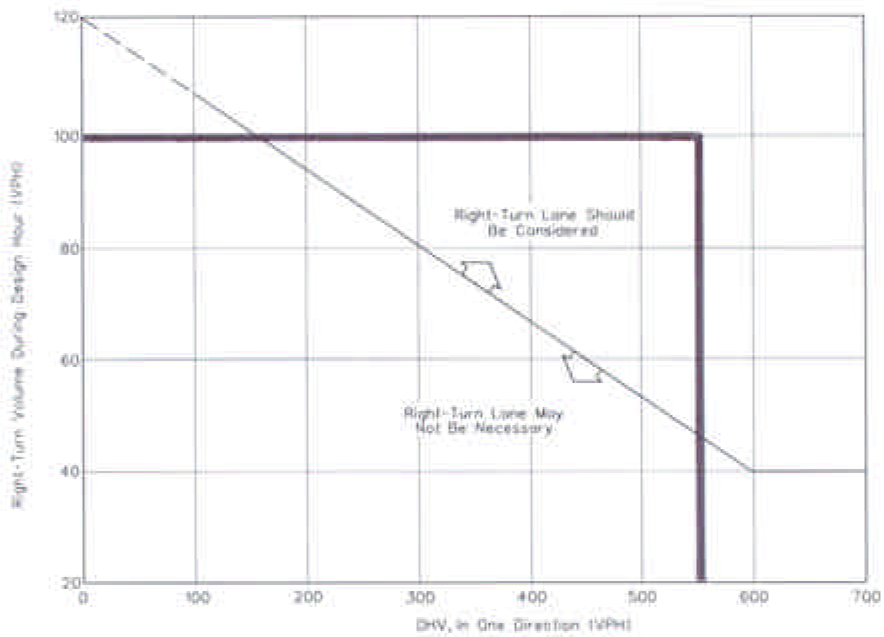
VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (40 MPH)

Figure 15.5G



VOLUME GUIDELINES FOR LEFT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS (40 MPH)

Figure 15.5G



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Problem: Determine if a right-turn lane is necessary.

Solution: To read the vertical axis, use 100 – 20 = 80 vehicles per hour. The figure indicates that a right-turn lane is not necessary, unless other factors (e.g., high crash rate) indicate a lane is needed.

GUIDELINES FOR RIGHT-TURN LANES AT UNSIGNALIZED INTERSECTIONS ON TWO-LANE HIGHWAYS

Figure 15.5A