

ROUTE 419 CORRIDOR STUDY

PREPARED BY THE STAFF
of the
FIFTH PLANNING DISTRICT COMMISSION

MARCH, 1987

This study was prepared by the staff of the Fifth Planning District Commission through the assistance of the United States Department of Transportation, Federal Highway Administration, and the Virginia Department of Transportation.

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views nor the policy of the Federal Highway Administration or the Virginia Department of Transportation. This report does not constitute a standard, specification, or regulation.

The Federal Highway Administration and the Virginia Department of Transportation acceptance of this report as evidence of fulfillment of the objectives of this planning study does not constitute endorsement/approval of the need for any recommended improvements, nor does it constitute approval of their location and design, nor a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

ACKNOWLEDGMENTS

The advice, assistance, and professional skills of numerous individuals were invaluable in the completion of this project. The Chief of Transportation wishes to acknowledge and thank the following members of the Corridor 419 Study Team from each participating agency:

Mr. Kenneth R. Myers, Federal Highway Administration
Mr. Joe Orcutt, Virginia Department of Transportation
Mr. Herman Hollins, Virginia Department of Transportation
Mr. L. C. Taylor, Virginia Department of Transportation, Salem District
Mr. Fred Altizer, Virginia Department of Transportation, Salem District
Mr. John Peters, County of Roanoke
Mr. Rob Stalzer, County of Roanoke
Mr. Marvin Sowers, City of Salem
Mr. Bob Bengtson, City of Roanoke
Ms. Christine Driscoll, Greater Roanoke Transit Company

In addition to the Study Team, special appreciation is expressed to Mr. Gordon Dixon for his moral and administrative support.

Thanks are also expressed to Ms. Eunice Doyle for her irreplaceable word-processing skill.

With acknowledgment of the excellent assistance and support of the above mentioned individuals, any errors or omissions in this report are the responsibility of the author.

EXECUTIVE SUMMARY

The 419 Corridor Study revealed that the overall highway level-of-service (LOS) of Route 419 is B during the morning peak hour (7:30-8:30 A.M.) and the off-peak period; it is C during the evening peak hour (4:45-5:45 P.M.) The overall highway LOS is acceptable for both the morning and the evening peak hours as well as for the off-peak travel.

Traffic congestion on Route 419 is culminated by the delays at the intersections; insufficient highway capacity is not the fundamental cause of congestion.

Intersection LOS of Route 419 ranges from A to F during the different time periods. Travel during the morning peak hour will encounter serious congestion at both the Apperson Drive intersection and the Melrose Avenue intersection. Travel during the evening peak hour from Route 220 to the Starkey Road intersection endures serious stop delay. The Apperson Drive intersection and the Melrose Avenue intersection also endure very serious congestion.

To relieve traffic congestion on Route 419, the first priority for improvement is the Apperson Drive intersection; second, the Melrose Avenue intersection; and third, the section from Route 220 to the Starkey Road intersection.

Recommendations to improve travel conditions on Route 419 are in three categories: (1) traffic engineering; (2) traffic control system; and (3), highway construction.

Traffic engineering improvement includes the widening of the congested intersections, reducing the speed limit between Route 220 and Chaparral Drive from 45 mph to 35 mph, improving highway exit/entrance between the Brambleton Avenue intersection and the Keagy Road intersection, etc.

Traffic control improvement suggests study pertinent to the possibility of replacing the current pre-timed signal system with the installation of a real time signal system.

Major highway construction to widen Route 419 northbound from Route 220 to Chaparral Drive, and from Braeburn Drive to Apperson Drive, is recommended. This will increase highway capacity and relieve congestion.

Enactment of a local ordinance which would require a site traffic impact study is also recommended. The purpose of this study would be to reduce roadside traffic interference and to maintain roadway travel acceptability.

With respect to long-term improvement, more than fifteen years, widening the entire road from four to six lanes is an option. The construction of the Route 11 Extension from Salem to Apperson Drive, and the South Salem Circumferential, will relieve congestion at both the Apperson Drive and the Melrose Avenue intersections; therefore, these improvements are recommended.

TABLE OF CONTENTS

	PAGE
1. INTRODUCTION	
1.1 Problem Statement	1
1.2 Goals and Objectives	1
1.3 Research Approach	2
2. TRAVEL DEMAND ANALYSIS	
2.1 Existing Traffic Flow and Pattern	3
2.2 1995 Traffic Projection	4
2.3 Existing Land Use and Traffic Generators	5
2.4 Future Land Use	5
3. TRAVEL SUPPLY ANALYSIS	
3.1 Roanoke Primary Highway System	6
3.2 Highway 419 Capacity Analysis	7
4. SERVICE LEVEL ANALYSIS	
4.1 Highway Service Level	8
4.2 Intersection Service Level	8
4.3 Problem Area Identification	9
4.4 Service Level Analysis	10
4.5 Accident Rate Analysis	11
5. TRANSPORTATION IMPROVEMENT ELEMENTS	
5.1 Corridor Transportation Management Strategies	12
5.2 Application of Transportation Management System (TMS) in 419 Corridor	13
5.3 Local Traffic Ordinance	14
5.4 South Salem Circumferential	14
6. CONCLUSION	16
TABLES	17
FIGURES	46

TABLES

	PAGE
Table 2.1 Peak Hour Intersection Traffic Turning Movement	17
Table 2.2 Highway 419 Sectional Performance	21
Table 2.3 Highway 419 Overall Performance	27
Table 2.4 Traffic Growth on Highway 419	28
Table 2.5 Traffic Generators Along Highway 419	29
Table 3.1 Highway 419 Sectional Volume/Capacity Ratio	30
Table 4.1 Definition of Level of Service	31
Table 4.2 Highway and Intersection Level of Service	32
Table 4.3 Overall Level of Service of Highway 419	35
Table 4.4 Problem Area Identification	36
Table 4.5 Problem Area Deficiency Rating	37
Table 4.6 Combined Deficiency Ratings for Both Travel Directions	38
Table 4.7 Identification of Problem Regions.	39
Table 4.8 Surveyed Intersection Stop Probability.	40
Table 4.9 Highway 419 Accident Rate.	41
Table 5.1 Traffic Engineering Improvement.	42
Table 5.2 Traffic Control System Improvement.	44
Table 5.3 Major Highway Construction Improvement	45

FIGURES

	PAGE
Figure 2.1 Intersection Peak Hour Traffic Volume	46
Figure 2.2 Highway 419 Traffic Projection	48
Figure 2.3 Traffic Growth Comparison	52
Figure 3.1 Roanoke Primary Highway Network	53
Figure 3.2 Geometric Layout - 419 Intersections	54
Figure 3.3 Route 419 Volume/Capacity Ratio	56

I. INTRODUCTION

This study examines existing traffic flow and forecasts future traffic volume on Virginia Primary Highway 419 (Route 419) for the section beginning at Penarth Road intersection in Roanoke City and ending at the Interstate I-81 interchange in Roanoke County.

The focus of this study is:

- (A) Identification of sites contributing to traffic congestion.
- (B) Analysis of the congestion causes.
- (C) Evaluation of the proposed alternatives to relieve the congestions.

1.1 Problem Statement

Travel conditions on Route 419 have attracted the attention of residents of southwest Roanoke City, southwest Roanoke County, and southeast Salem City for many years. The lengthy delays and bumper to bumper travel, along with the difficulties encountered by local residents in efforts to either enter or to cross Route 419, are the major complaints and the main topics of discussion.

The alternatives which have been proposed in the Roanoke Valley Area 1975-1995 Transportation Plan to improve traffic flow are:

- (A) A six-lane center-divided highway, or
- (B) A southern circumferential route.

To provide an objective evaluation of the current traffic conditions along Route 419, the Fifth Planning District Commission included provision for the Route 419 Corridor Study in the FY'86 Unified Transportation Work Program (UTWP). Absence of a transportation planner delayed this project until September, 1986, at which time the study was formally conducted.

1.2 Goals and Objectives

Transportation is comparable to water access or sewage disposal in the infrastructure of an area development. Transportation is not a goal but a means of providing accessibility to the served area. The goals to improve traffic conditions on Route 419 to an acceptable level-of-service (LOS) have two domains: (1) to promote local commercial activities within the planned commercial area by offering accessibility, and (2) to maintain the beauty of the landscape and the quiet environment of the residential area.

To achieve goals outlined in this study, project objectives are designed to provide short term improvements for prompt relief of existing traffic congestion during the peak hours, and to recommend long term improvements to accommodate

future traffic growth which will avoid deterioration of the roadway level-of-service. The possible short term improvements include intersection widening, signal coordination, site traffic circulation control, etc. The long term improvements are mainly new highway construction, or provision of additional lanes for travel.

1.3 Research Approach

A Scope of Work for the Corridor Study of Route 419 was submitted in April, 1985 and was approved with a budget of \$20,000 in the 1986 UTWP. The basic work approach was to rely on field investigations by a Corridor Study Team (CST) and the Metropolitan Planning Organization (MPO) staff supplemented by available background data. The CST was formed on September 17, 1986 during the Transportation Technical Committee Meeting of the Fifth Planning District Commission.

The float-car method was employed by the MPO staff in conducting the travel time survey. Both morning and evening peak hours, in addition to the off-peak period, were studied. Seven inbound and outbound trips were conducted during the weekdays of a two-week period for both morning and evening peak hours. No survey was conducted for Monday morning or Friday evening peak hours because the travel pattern is not typical of that of the normal peak hours. Four trips, two morning and two afternoon, were also conducted during the off-peak period. For the final analysis, four off-peak trips, and six out of the seven peak hour trips, were selected as a base.

Average travel speed and running speed, in conjunction with average stop delay, were calculated after travel time and travel distance were summarized. Data of route traffic volumes, highway and intersection layouts, highway capacity, and accident rates were later either collected or calculated. LOS was then assigned to each intersection and highway segment for problem area identification. During discussions of problem area identifications, and causes of congestion, the short-term and long-term improvement programs were proposed and evaluated. Research findings and recommendations were disclosed in preparation of the final report.

2. TRAVEL DEMAND ANALYSIS

2.1 Existing Traffic Flow and Pattern

From 1979 to 1985 the average daily traffic (ADT) on Route 419 increased approximately 4.45% each year. The 1985 survey showed the average daily traffic at various locations on Route 419 ranged from 8,500 to 38,600 vehicles per day.

The morning peak hour, from 7:30 A.M. to about 8:30 A.M., constitutes 5.6% to 11.4% of the daily traffic with an average of 8.0% depending on the section of the road. The evening peak hour begins at 4:45 P.M., ends about 5:45 P.M., and constitutes 7.6% to 11.9% of the daily traffic with an average of 9.5%. The percentage rate indicates that the peak hour traffic is heavier during the evening than during the morning; also, the peak period lasts longer during the evening than during the morning.

Figure 2.1 illustrates the intersection peak hour traffic volumes along Route 419. During the morning peak hour, the intersection at Apperson Drive has the highest traffic volume, (3900 veh/hr); the Brambleton Avenue intersection has the second highest, (3750 veh/hr). During the evening peak hour, the intersection of Route 419 and the southbound ramp of Route 220 has the highest traffic volume, (7000 veh/hr); the Brambleton Avenue intersection has the second highest.

For the intersections along Route 419, the traffic on 419 constitutes 52.1% to 98% during the morning peak hour, and 46.1% to 95% during the evening peak hour. Table 2.1 shows the directional traffic volume at each intersection. It is noted that those cross streets of Route 419 with high traffic volumes during the morning peak hour are: Brambleton Avenue (US 221), 40%; Apperson Drive (US 11), 41.8%; and Melrose Avenue (US 460 - East Main Street), 47.9%.

During the evening peak hour, the intersection traffic volume for Route 221 is 39%; for Route 11, 53.9%; and for Route 460, 51.3%. In addition, Roanoke Boulevard also has a high cross street traffic volume during this period, (49.2%).

The percentages indicate the functions of Routes 221, 11, and 460 to be as important as that of Route 419 during the evening peak hour at which time both Route 11 and Route 460 have higher traffic volumes than Route 419.

2.1.1 Traffic Turning Movement

During the morning peak hour, through traffic on Route 419 ranges from 32% to 99.5% with an average of 82.5%. The section of 419 in front of Tanglewood Mall has the highest through traffic percentage. During the evening peak hour, through traffic ranges from 57% to 93% with an average of 81.9%.

The high through traffic percentages identify Route 419 as an important corridor serving as a connective arterial between southeast Roanoke County and south Salem.

During the morning peak hour, turning movements from cross streets to Route 419 range from 25% to 100% with an average of 73.5%. During the evening peak hour, turning movements from cross streets to Route 419 range from 26% to 99% with an average of 75%. Turning volume from cross streets to Route 419 accounts for 2% to 25.6% of the intersection traffic volume during the morning peak hour, and 7% to 30.6% during the evening peak hour. The traffic feeding into Route 419 from cross streets is 7,566 vehicles and 11,482 vehicles during morning and evening peak hours. The statistics of the cross street traffic and its turning movements identify the collective and feeding functions of the cross streets.

2.1.2 Travel Speed

The average sectional highway running speed, travel speed, and stop delay percentage for both travel directions during each survey period are presented in Table 2.2. The overall highway performance is presented in Table 2.3. The stop delay percentage is lowest during the off-peak period, 18% for both directions; and highest during the evening peak, 28%-31%. An interesting factor disclosed is that the morning inbound average running speed, (39.9 MPH), is slightly higher than the off-peak average running speed, (37.7 MPH). Preference for increased rate of speed during morning peak may be attributed to work schedules and travel pressure.

Average running speed from Route 220 to Keagy Road is consistently less than the 45 MPH speed limit. However, the spot speed between Brambleton Avenue and Keagy Road tends to be higher than the 45 MPH speed limit, especially near the uncontrolled intersection of Routes 685 and 1636. The spot speed is often higher than 50 MPH.

In addition, the average running speed on Route 419 between Indiana Street and Melrose Avenue tends to be higher than the 35 MPH speed limit.

2.2 1995 Traffic Projection

Advance planning which will provide adequate transportation service to accommodate future travel growth, while maintaining perspective for area economic growth, is important to prevent deterioration of roadway service. Traffic projection is, thus, a task to forecast the future travel demand as a base to determine the needed transportation supply.

Table 2.4 shows the projected traffic volume for Route 419 which was included in the Roanoke Valley Area 1975-1995 Transportation Plan. The 1995 traffic volume was projected in 1978, therefore, accuracy could be adjusted using the 1979 to 1985 traffic count. The average growth rate of actual traffic change on each section of the road from 1979 to 1985 was used as a factor to provide an updated 1995 traffic forecast for comparison and is also shown in Table 2.4. Both the past and the projected trends of traffic growth for various localities on Route 419 are illustrated in Figure 2.2.

Figure 2.3 presents the comparison of traffic growth along different sections of Route 419. This figure and the analysis of traffic growth from 1979 to 1985 show the section from Starkey Road to Brambleton Avenue has a higher growth

rate than any other section of Route 419. The growth rate from 220 South off-ramp to Starkey Road is the second highest.

2.3 Existing Land Use and Traffic Generator

The existing land use along Route 419 can be described as commercial from Penarth Road to Brambleton Avenue, residential and office from Brambleton Avenue to Keagy Road, and a combination of commercial and industrial from Keagy Road to Melrose Avenue.

The belt from Penarth Road to Chaparral Drive which extends south to Franklin Road is a highly developed commercial area; shopping malls, supermarkets, restaurants, and automobile dealers are among major businesses located along this belt. Expanding residential developments located behind the commercial areas share the same exits and entrances to Route 419 used by commercial activities.

Development along Route 419 from Brambleton Avenue to Keagy Road consists mainly of office buildings and residential housing with the exception of limited commercial activities near each intersection. From Keagy Road to Melrose Avenue, the development is more sparse than that near Tanglewood Mall. The industrial park of the General Electric Plant is the only major activity in this area since the Lakeside Park closure.

Major traffic generators along Route 419 have been surveyed and are listed on Table 2.5. These traffic generators help define the land use and varied activities along Route 419.

2.4 Future Land Use

In order to forecast future traffic patterns and trip characteristics, it is necessary to understand the planning and control of the land use. Planning and zoning control are tools used to regulate development of the land. Both rely on the policy of land use. Land use policy plays an important role in transportation planning toward providing adequate roadway facilities and service. Since Route 419 falls within the boundaries of Roanoke County, the City of Roanoke, and the City of Salem, it would be advantageous for the three jurisdictions to establish policy concerning land development along this corridor. Currently the trend for land use seems to indicate high density commercial development between the Penarth Road intersection and the Brambleton Avenue intersection. Vacant land remains available for commercial development in this area, therefore, market demand will influence future development.

Office development may become more active from Brambleton Avenue to Grandin Road Extension. This will require improvement of the local traffic circulating in and out of the residential areas.

The area from Apperson Drive to Roanoke Boulevard in the City of Salem has the potential to become more commercially active, however, this will depend on the market demand and the land use policy.

3. TRAVEL SUPPLY ANALYSIS

3.1 Existing Highway Network and Control

3.1.1 Roanoke Primary Highway System

The existing highway network in the Roanoke Metropolitan Area includes the following interstate and primary systems:

(A) Interstate System

Interstate I-81 passes through the north preferential of the Roanoke Valley and functions as the main artery to connect the Valley to the nationwide interstate highway network. Interstate I-581 (Route 220) bisects Roanoke Valley and serves as the main artery for north and south traffic in addition to serving as a collective function for I-81.

(B) Primary System

Primary highways in the area include U.S. 11, 220, 221, and 460, which radiate in and out of the central business district of the metropolitan area.

The interstate and primary highways, plus secondary highways, compose the major highway network of the study area as illustrated in Figure 3.1.

3.1.2 Roanoke Transportation and Role of Route 419

Roanoke is the largest metropolitan area in southwest Virginia, and a regional activity center. Seven airlines serve the Roanoke Regional Airport with sixty daily flights. The Norfolk & Western Railway Company (presently Norfolk Southern) operates a piggyback facility in Roanoke and has its eastern and western regional headquarters here. Super highways feed into the valley making Roanoke very accessible.

Route 419 connects Route 220 (extension of Interstate 581) in southwest Roanoke City, I-81 in north Roanoke County, and crosses the area's major arterials; U.S. 221, 11, and 460. Interstate 81 and 581, together with Route 419, form a loop for travel inside Roanoke Valley. U.S. 11, 220, 221 and 460 radiate in and out of this loop throughout the area. With the assistance of these radial routes, the loop formed by I-81, I-581, and 419 provides the most convenient travel path inside the Roanoke metropolitan area.

3.1.3 Traffic Control of Route 419

Route 419 is mainly a center-divided four lane highway with an exclusive left-turn lane, and a tapered right-turn lane at most intersections. Lane width for 419 is the standard twelve foot lane. Traffic in front of Tanglewood Mall

has an additional lane which is shared for through and right-turn traffic instead of a tapered right-turn lane because of the short distance between intersections. A geometric layout of each intersection within the study area is illustrated in Figure 3.2.

Traffic control on Route 419 can be categorized into (A) intersection signal control, and (B) posted speed limit control.

(A) Intersection Signal Control

Control of the intersection signals along Route 419 is governed by two pretimed computerized systems. Intersections from Penarth Road to Brambleton Avenue are controlled by one system maintained by the Salem District of the Virginia Department of Transportation. Intersections from Keagy Road to Lynchburg/Salem Turnpike are controlled by another system maintained by the City of Salem. Both systems are operated in pretimed four continuous-rotated timing settings: (1) morning peak, (2) off-peak, (3) evening peak, and (4) off-peak. In addition, at most of the intersections a traffic detector is installed on the left-turn lane to allow deletion of the exclusive left-turn phase if no left-turn vehicle is detected.

(B) Posted Speed Limit Control

The posted speed limit on Franklin Road is 35 MPH but increases to 45 MPH soon after the 220-S off-ramp even though the traffic in front of Tanglewood Mall is usually congested. The 45 MPH speed limit is maintained until passing Keagy Road then drops to 35 MPH to Melrose Avenue. After the Melrose Avenue intersection, the speed limit reverts to 45 MPH. The posted speed limit on the opposite side of the road is about the same. The 35 MPH limit is posted from Melrose Avenue to Keagy Road then raised to 45 MPH until passing through the Route 220 interchange.

3.2 Route 419 Capacity Analysis

The principle used to calculate highway capacity (at LOS E) is to adjust the service flow rate under ideal conditions to reflect actual roadway conditions and traffic composition. The capacity and existing traffic volume of each section of Route 419 is thus calculated according to the 1985 Highway Capacity Manual and presented in Table 3.1 and Figure 3.3.

4. SERVICE LEVEL ANALYSIS

Analysis of the level of service (LOS) for Route 419 can be divided into two parts: (1) LOS for each segment of the highway, and (2) LOS of the intersections. The approach and results are presented in this chapter.

4.1 Highway Service Level

The service quality of a highway can be appraised by the difference between the free flow travel speed and the average travel speed. The greater the difference, the lower the service level. Based on this principle, the 1985 Highway Capacity Manual (HCM) classifies highway service quality using six levels: A, B, C, D, E, and F. "A" denotes the highest level of service. As traffic increases, the service level gradually decreases to B, C, and D before reaching the capacity level of E with travel speed of about 15 MPH. The forced bumper to bumper (stop and go) traffic flow has the lowest service level of F. The definition of LOS is illustrated in Table 4.1.

Using either the posted speed limit or the surveyed running speed as free flow speed, whichever is higher, and comparing with the surveyed average travel speed, each segment of Route 419 is given a two-scored LOS for morning and evening peak periods according to the 1985 Highway Capacity Manual. The results are presented in Tables 4.2. The overall evaluation of Route 419 within the study area is illustrated in Table 4.3. It is noted from Table 4.3 that both inbound (southbound) and outbound (northbound) directions of Route 419 have an overall LOS B for both the morning peak hour travel and the off-peak travel. During the evening peak hour, both directions have LOS C.

When evaluating each highway segment separately, the segment from Route 220 S Exit to Tanglewood Mall has D LOS during the off-peak outbound travel. For the off-peak inbound travel, the LOS from Indiana Street to Apperson Drive is E.

During the morning peak hour, the outbound (north) travel from Braeburn Drive to Apperson Drive has E LOS; the inbound (south) travel has no section with LOS lower than D.

During the evening peak hour, the LOS from Tanglewood Mall to Ogden Road is E and drops to F in front of Starkey Road; from Braeburn Drive to Apperson Drive, E; and from Lynchburg/Salem Turnpike to Melrose Avenue, E for the outbound travel. For the inbound travel, the LOS from Indiana Street to Apperson Drive is F, and from Chaparral Drive to Starkey Road, E.

4.2 Intersection Service Level

The service level of intersections is appraised by the average vehicle stop delay (second/vehicle) caused by the timing of the traffic signal. The longer the delay, the lower the service level. The classification of service levels according to the 1985 Highway Capacity Manual is also illustrated in Table 4.1. Using the HCM as a guide, the LOS of each intersection along Route 419 is presented in Table 4.2. It can be noted from Table 4.2 that the off-peak

intersection LOS ranges from A to E for outbound travel, and from A to D for inbound travel. The intersection at Melrose Avenue, outbound, has LOS E, the lowest of all the intersections.

During the morning peak hour, travelers on Route 419 endure LOS F for both inbound and outbound directions at Melrose Avenue; the outbound approach at Apperson Drive also experiences F LOS.

During the evening peak hour, for the outbound approach, both Apperson Drive and Melrose Avenue intersections experience LOS F; Starkey Road, LOS E. For the inbound approach, both Apperson Drive and Brambleton Avenue intersections have LOS equal to F. Also inbound, intersections at Melrose Avenue, Grandin Road Extension, and Starkey Road have E LOS.

4.3 Problem Area Identification

After LOS has been granted to each highway intersection, and to each highway segment, sites of congestion can be identified for improvement analysis. Considering areas with LOS lower than D as problem sites, the areas which qualify the criteria are listed in Table 4.4.

To more accurately compare the deficiency of the problem areas, each problem highway section, and each intersection, is assigned a weight for comparison. A one point weight is given to an area with LOS E, and a two point weight is given to an area with LOS F.

Using the information accumulated by travel time surveys conducted during the morning peak hour, evening peak hour, and off-peak, a summation of the points recorded for these periods has been calculated as shown in Table 4.5 which discloses the relative deficiency rating of the problem areas during a day.

Table 4.5 clearly indicates that the outbound direction at Melrose Avenue intersection affords the lowest LOS endured on the 419 Corridor, followed by the Apperson Drive and the Starkey Road intersections. For inbound travel, the Melrose Avenue intersection again offers the lowest LOS, followed by the Brambleton Avenue and the Apperson Drive intersections.

Having identified problem areas for each travel direction, Table 4.6 now combines problem weights of both directions to illustrate the comparative deficiency of each problem site.

Among all of the intersections, the Melrose Avenue intersection and the Apperson Drive intersection are definitely the more deficient problem sites. For highway sections, the block between Indiana Street and Braeburn Drive is the most deficient.

Inasmuch as the analyses of intersections and highway congestion are closely related, Table 4.7 illustrates the problem regions considering the combination of intersections and highway sections. Along Route 419, the region around Apperson Drive offers the lowest LOS, and the region around Melrose Avenue offers the second lowest. Either Table 4.6 or Table 4.7 can thus be considered a priority rank table for improvement.

4.4 Service Level Analysis

Service level analysis is used to analyze the possible reasons for congestion, such as short street blocks, bad signal timing, insufficient capacity, etc.

Using problem area identifications listed in the previous section, the reasons for congestion are carefully investigated.

The area around Apperson Drive intersection offers the lowest LOS in the 419 corridor with an accumulation of eleven points of deficiency; intersection problems contribute six of these points, and highway segments contribute five points.

The Apperson northbound approach has LOS F for both peak hours; the southbound approach has LOS F for the evening peak hour. In addition, the stop probability, Table 4.8, at this intersection is 100% for both morning and evening peak hours, and 75% during off-peak periods. Since traffic volumes on the four approaches are lower than the highway segment capacities, (Table 3.1), insufficient highway capacity is not the cause of congestion at this site. The intersection traffic volumes are 3930 veh/hr for the morning peak hour and 5320 veh/hr for the evening peak hour; both numbers exceed the maximum capacity of the two-lane approach intersection (3600 veh/hr). It is thus concluded that the intersection congestion is caused by high stop probability and insufficient intersection dissipation rate.

The area around the Melrose Avenue/Route 419 offers the second lowest LOS. The morning peak hour traffic volume is 2190 veh/hr; the evening peak, 3010 veh/hr. The stop percentage of this intersection is also higher than 80%. Both peak hour V/C ratios are less than 1, therefore, insufficient highway capacity is not the cause of delay and congestion. However, at the northbound approach only one lane is used for both left-turn traffic and through traffic. The left-turn vehicles often block through traffic. Also, the roadway markings are misleading and increase lane-change conflict.

The area from Route 220 S off-ramp to Starkey Road endures D to F LOS during the evening peak hour. Short block distances, high traffic volume, and complicated turning maneuvers are the major problems. Also, many driveways from roadside stores, and two median openings without signal control to permit left-turn maneuvers complicate the dilemma. The left-turn bay and the right turn taper are too short to accommodate turning vehicles which block through traffic. The block distance is even shorter due to recent installation of a new signal at the intersection of Route 706 (in front of Avenham Manor).

Paved shoulders between northbound Ogden Road and Starkey Road, and between southbound Starkey Road and 220 S on-ramp are non-continuous and cannot be effectively used for driveway entrance/exit maneuvers.

Also offering low LOS is the southbound approach at the intersection of 220 S on-ramp. Delay of vehicles traveling toward northbound 220, and the high intersection traffic volume contribute to the problem. Measures to improve the traffic flow entering Route 220, and the left-turn accommodations for traffic leaving the Route 220 S off-ramp should be addressed to improve LOS at this intersection.

The southbound approach at the Brambleton Avenue intersection discloses LOS E during the evening peak hour. Causes are the high traffic volume, left-turn vehicles blocking through traffic, and insufficient right-turn taper.

4.5 Accident Rate Analysis

The current Highway Capacity Manual does not consider the accident rate when evaluating LOS, however, the number of accidents on a route does contribute to the LOS measure. Therefore, the accident rates for segments of Route 419 for 1984 and 1985 are listed in Table 4.9 to provide a more comprehensive evaluation.

It is noted from Table 4.9 that both sections of Route 419 which interchange with Route 220 or I-81 have high accident rates. For 1984 the accident rate in the Commonwealth of Virginia for primary roads was 205 accidents/100 million vehicle-miles (MVM). During the same time period, the accident rate in Roanoke County was 221 accidents/100 MVM for primary roads.

Near the Route 220 interchange the accident rate for 1984 was 1,490 and for 1985, 811. Near I-81 interchange, the accident rate for 1984 was 822 and for 1985, 1,189. Both sites have accident rates more than four or five times higher than the state average.

The accident rate from WCL Roanoke to Starkey Road (Route 904) is also higher than average. It is concluded that the segment of Route 419 from Route 220 S Exit to Starkey Road, and the interchange of I-81/419 are notably dangerous.

Statistics reveal that the accident rate for the segment from Brambleton Avenue to Keagy Road is lower than either the county or the state average. However, this section should be recognized as potentially dangerous due to the fact that high speed traffic on 419 prohibits a comfortable margin of safety when trying to make entry without benefit of signal control. The turning movement in this section is especially difficult, and dangerous, at night because of insufficient lighting facilities.

5. TRANSPORTATION IMPROVEMENT ELEMENTS

5.1 Corridor Transportation Management Strategies (TSM)

Application of transportation management strategies to a corridor can do much to manage the movement of people and vehicles especially during peak period traffic or during major roadway reconstruction. A strong transportation management program in a corridor includes implementing capacity improvement strategies such as traffic signal systems and high occupancy vehicle (HOV) lanes along with modifying strategies such as employer based ridership programs and park-and-ride lots.

This chapter briefly describes transportation management strategies and their effectiveness when applied to an arterial corridor. Possible strategies to relieve the congestion of Route 419 are then presented.

5.1.1 Traffic Engineering Improvements

Traffic engineering improvements such as traffic channelization, left/right turn lanes, one-way streets, reversible traffic lanes, intersection widening, bus turnout bays, and improved signs and pavement markings are the most commonly implemented transportation management actions in corridors. Based on experiences in small, medium, and large size communities, capacities have increased by fifteen percent and safety has increased by twenty percent with these improvements. Because of the type and scope of use, the costs of these improvements vary considerably, however, the benefits usually exceed the costs.

5.1.2 Traffic Control Systems

Traffic control systems are designed to reduce travel times, delays, and stops, and to improve average speeds along the roadways. These systems include actions such as coordination of traffic signals, continuous updating or optimizing signal timing plans, computer-based traffic signal control, bus priority signal systems, and freeway traffic management. Typical experiences have shown at least a ten percent decrease in travel times and vehicle delay on arterials as a result of improved traffic signal systems.

5.1.3 Fringe and Corridor Parking Facilities

Fringe and corridor parking facilities serve to shift parking supply from the downtown/activity center to the outlying areas which reduces traffic congestion and vehicle travel demand through a corridor.

5.1.4 Transit Service Improvements

In a corridor application, transit service improvements include express bus service, bus transfer centers, more frequent runs, and limited stop bus routes.

5.1.5 Corridor Ridesharing Programs

Corridor ridesharing programs including carpooling, vanpooling, and buspooling

are aimed at reducing vehicle demand by increasing vehicle occupancy rate in a corridor. This strategy is especially important to congested arterial or freeway corridors with limited potential to build additional vehicle lanes. Ridesharing programs have been most effective when implemented in cooperation with major employers or developers who wish to establish ridesharing programs at specific sites. Specific corridor management ridesharing programs include employer-based efforts, corridor-wide carpool matching services, highway informational signs, and corridor-wide promotions.

5.2 Application of TMS in 419 Corridor

In the Roanoke Area 1995 Transportation Plan, it is proposed that Route 419 be widened to six lanes to accommodate traffic growth. However, the current demand (volume) supply (capacity) analysis, Table 3.1 indicates that traffic volume on Route 419 has not yet reached capacity level. Because the current LOS is acceptable except at the sites of intersections, the widening of selected intersection approaches to relieve intersection congestion and decrease stop delay, in conjunction with the application of other TMS for short term improvement, is strongly recommended.

5.2.1 Traffic Engineering Improvements

Application of the TMS traffic engineering improvements on Route 419 includes intersection widening, left/right turn lanes extension, control of median cuts (crossovers), pavement resurfacing, sign/markings improvements, etc. The detailed traffic engineering improvements and expected impacts are listed in Table 5.1.

5.2.2 Traffic Control Systems

Alternatives of traffic control system to improve continuity of traffic flow without major highway construction are:

- (1) Improve coordination of existing traffic signals.

Turning movements should be surveyed at reasonable and regular intervals, and the timing set adjusted accordingly.

- (2) Installation of a Real-Time Internal Control System to replace existing off-line pre-timed system.

Installation of a real-time traffic control system is an investment which would necessitate a detailed analysis of cost effectiveness prior to installation.

An inter-connect system with only nine traffic signals (from the intersection of Duke of Gloucester to intersection of Chaparral Drive) might be considered prior to installing a corridor-wide system.

Table 5.2 illustrates the recommendations on traffic control systems.

5.2.3 Transit Service and Ridesharing Programs

The Greater Roanoke Transit Company (Valley Metro) operated by Roanoke City currently has no corridor transit service along Route 419. The high turning movements on Route 419 make prediction of ridership difficult. Although a bus service from Tanglewood Mall to the Roanoke County Library may reduce traffic and its circulation at this section, financial funding from Roanoke County for this service would be a consideration.

It is difficult to perceive the effectiveness of a Ridesharing Program specifically for Route 419. Most working trips in the Roanoke area are within twenty minutes' travel distance. Route 419 is not a city to city corridor. The Ridesharing Program is expected to be effective for people commuting between outside Roanoke and the metropolitan area.

5.2.4. Major Highway Construction Improvement

Major highway construction improvement is areawide; it is not a site specific improvement. Recommendations are:

(1) Highway Section Outbound from Route 220 S Exit to Starkey Road

Add an outbound lane to relieve problem of intermingling through/turning traffic; accommodate anticipated traffic growth.

(2) Highway Section from Braeburn Drive to Apperson Drive

Add an outbound lane to increase intersection capacity; accommodate traffic growth

Details of recommended highway construction improvements are listed in Table 5.3.

5.3 Local Traffic Ordinance

The short term TMS can help relieve the current traffic delays and congestion problems and it is expected to be effective for five to ten years. To enhance the effectiveness of the TMS, a site traffic impact study from a new roadside business will help control traffic circulation along the road. A site impact study discloses how many trips the site will generate per day, how the traffic will enter/exit the site, and whether or not the site has adequate space to accommodate its parking needs. A local ordinance which rules the requirements for submitting a site impact study prior to issuing a construction permit can assist to regulate the site traffic circulation.

5.4 South Salem Circumferential

By the year 2000 the Peters Creek Road Extension is expected to be completed. This will relieve some of the traffic on Route 419 between Apperson Drive and Melrose Avenue, but it will not relieve the traffic between Route 220 and Apperson Drive. For long term improvement, more than fifteen years, different alternatives can be considered to maintain the acceptability of the road. The

first option is to widen the road to six lanes. This will enable accommodation of future traffic growth; however, intersections might continue to have high congestion and delay, and no space will be available for further widening of the intersections.

The second option includes the construction of Route 11 Extension from Salem to Apperson Drive, and the South Salem Circumferential as recommended in the 1995 Roanoke Area Thoroughfare System. This option will relieve the heavy turning movements on Route 419 at both the Apperson Drive and the Melrose Avenue intersections.

The rolling terrain and significant road grade between Grandin Road Extension and Keagy Road suggests that the site of the new intersection between S. Salem Circumferential and Route 419 as indicated in the 1995 Thoroughfare System be given selective consideration. It may prove possible to avoid construction of a new intersection, and to preserve the beauty of the landscape while encouraging promotion of local commercial activity.

The south circumferential between Route 220 and South Salem Circumferential is given less priority for Route 419 improvement. The heavy turning movements on Route 419 does not suggest that a high percentage of through travel on 419 will shift to use the south bypass. In addition, the extra travel distance does not favor use of this bypass.

6. CONCLUSION

The 419 Corridor Study employed a vehicle travel time survey to disclose the service performance of each highway section and each intersection; Tables 2.2, 2.3, 3.1, 4.1, 4.3, 4.8. A weight to identify the relative degree of delay and congestion was assigned to each intersection and each highway section with LOS lower than D. Problem sites and causes were identified and ranked with improvement priority; Tables 4.4, 4.5, 4.6, and 4.7. The areas around the Apperson Drive intersection and the Melrose Avenue intersection have the highest priority for first improvements.

The study revealed that insufficient intersection capacity is the major cause of delay and accounts for twenty to thirty percent of the total travel time. Delays at some intersections are even longer than signal cycle length. Widening intersections is thus the principal recommendation for short-term improvement.

In addition, the transportation management strategies (TMS) are recommended to enhance the effectiveness of widening the intersections; Tables 5.1, 5.2, and 5.3.

A local ordinance which would require a site traffic impact study would be very useful in efforts to maintain the roadway travel acceptability and to reduce roadside traffic interference.

With respect to long-term improvement, more than fifteen years, widening the entire road from four lanes to six lanes is an option, however, the intersections may remain sites of congestion.

The construction of Route 11 Extension from Salem to Apperson Drive, and the South Salem Circumferential, will relieve the congestion problems at both the Apperson Drive and the Melrose Avenue intersections, however, it is suggested that further study be given as to the location of the intersection connecting Route 419 and the South Salem Circumferential.

The south bypass loop (south circumferential) between Route 220 and South Salem Circumferential is given less priority because of the high turning movements on Route 419 and the extra travel distance.

TABLES

Table 2.1 Peak Hour Intersection Traffic Turning Movement

Name of Cross Street	Route	Intersection AM Peak Hour Volume	Volume from Each Approach							
			E	M	N	S				
Penarth Rd.		2060	41	2.0%	124	6.0%	968	47.0%	927	45.0%
Rte. 220 N-Ent.		2818	--	--	479	17.0%	1804	64.0%	564	20.0%
Rte. 220 S-Ent.		3250	683	21.0%	--	--	1853	57.0%	715	22.0%
Tanglewood Mall		3045	30	1.0%	30	1.0%	1797	59.0%	1218	40.0%
Ogden Rd.	Rte. 867	3220	483	15.0%	64	2.0%	1546	48.0%	1159	36.0%
Starkey Rd.	Rte. 904	3046	91	3.0%	457	15.0%	1340	44.0%	1127	37.0%
Chaparral Dr.	Rte. 800	2760	--	--	718	26.0%	1132	41.0%	911	33.0%
Colonial Ave.	Rte. 720	2748	357	13.0%	412	15.0%	1017	37.0%	962	35.0%
Brambleton Ave.	Rte. 221	3746	599	16.0%	899	24.0%	1274	34.0%	974	26.0%
Grandin Rd. Ext.		2369	0	0.0%	15	0.7%	843	35.6%	1511	63.8%
Keagy Rd.		2635	140	5.3%	119	4.5%	1188	45.1%	1191	45.2%
Braeburn Dr.		2473	94	3.8%	47	1.9%	1098	44.4%	1234	49.9%
Apperson Dr.	Rte. 11	3929	652	16.6%	990	25.2%	959	24.4%	1324	33.7%
Indiana St.		2298	23	1.0%	205	8.9%	961	41.8%	1110	48.3%
Roanoke Blvd.		3102	596	19.2%	552	17.8%	903	29.1%	1052	33.9%
Lynchburg Tpk.		1835	273	14.9%	143	7.8%	580	31.6%	839	45.7%
Melrose Ave.	Rte. 460	2193	704	32.1%	346	15.8%	432	19.7%	711	32.4%
Tanglewood 2	Rte. 706	2841	11	0.4%	28	1.0%	1761	62.0%	1051	37.0%

Table 2.1 - 2

Name of Cross Street	Route	Intersection PM Peak Hour Volume	Volume from Each Approach				
			E	W	N	S	
Penarth Rd.		3315	99	199	1624	1392	
Rte. 220 N-Ent.		4067	--	447	1952	1708	
Rte. 220 S-Ent.		6983	1746	--	2933	2304	
Tanglewood Mall		3697	481	37	1331	1812	
Ogden Rd.	Rte. 867	4561	547	228	1961	2052	
Starkey Rd.	Rte. 904	3459	242	415	1591	1557	
Chaparral Dr.	Rte. 800	2759	--	359	1104	1269	
Colonial Ave.	Rte. 720	3089	371	185	1421	1112	
Brambleton Ave.	Rte. 221	6713	1611	1007	2282	1813	
Grandin Rd. Ext.		2957	0	26	1799	1132	
Keagy Rd.		3864	622	290	2029	923	
Braeburn Dr.		3035	358	137	1502	1041	
Apperson Dr.	Rte. 11	5316	882	1983	1398	1053	
Indiana St.		2532	86	127	1314	1008	
Roanoke Blvd.		3348	1158	489	753	947	
Lynchburg Tpk.		2484	283	296	725	1180	
McIrose Ave.	Rte. 460	3012	756	789	346	1117	
Tanglewood 2	Rte. 706	3135	94	63	1285	1662	
			0.03	0.02	0.41	0.53	

Turning From East			Turning From West			Turning From North			Turning From South		
L	S	R	L	S	R	L	S	R	L	S	R
55%	8%	37%	37%	5%	57%	5%	92%	3%	5%	92%	4%
--	--	--	71%	--	29%	--	57%	43%	--	95%	5%
5%	--	95%	--	--	--	--	91%	9%	8%	92%	--
79%	3%	18%	84%	11%	5%	4%	92%	4%	2%	88%	10%
60%	2%	38%	59%	41%	0%	22%	77%	2%	--	82%	18%
10%	38%	52%	29%	6%	65%	6%	82%	12%	22%	75%	2%
--	--	--	62%	--	38%	--	84%	16%	31%	69%	--
24%	23%	52%	11%	49%	41%	20%	72%	8%	7%	82%	11%
33%	54%	13%	38%	46%	16%	12%	76%	13%	22%	65%	12%
--	--	--	42%	0%	58%	1%	96%	4%	2%	98%	0%
67%	21%	12%	36%	26%	39%	4%	93%	3%	5%	89%	6%
22%	13%	65%	62%	26%	12%	8%	82%	9%	5%	92%	3%
6%	48%	46%	12%	41%	47%	27%	59%	8%	40%	58%	2%
35%	30%	35%	26%	7%	67%	1%	93%	6%	12%	81%	6%
48%	35%	17%	13%	27%	35%	5%	88%	7%	13%	73%	15%
33%	59%	8%	13%	74%	14%	14%	85%	1%	3%	80%	17%
25%	50%	25%	25%	50%	25%	10%	80%	10%	37%	36%	37%
16%	1%	83%	36%	5%	58%	6%	92%	2%	4%	93%	3%

Table 2.2 Highway 419 Sectional Performance

Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	AM Inbound (South Bound) Survey Average							
			Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveyed	% of Stop Surveyed	
I-81 N-Ent.	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Melrose Ave.	1.83	1.83	203.8	141.9	61.9	32.3	46.4	85.7	6	28.6
Lynchburg Tpk.	0.64	2.47	72.5	61.8	10.7	31.8	37.3	28.6	2	42.9
Roanoke Blvd.	0.79	3.26	94.4	71.4	23.0	30.1	39.9	42.9	3	42.9
Indiana St.	0.35	3.61	45.1	37.5	7.6	27.9	33.6	100.0	3	100.0
Apperson Dr.	0.23	3.84	54.9	29.8	25.0	15.1	27.8	0.0	7	0.0
Braeburn Dr.	0.55	4.39	52.1	52.1	0.0	38.0	38.0	0.0	0	0.0
Keagy Rd.	0.18	4.57	21.9	18.0	3.9	29.6	36.0	14.3	1	14.3
Grandin Rd. Ext.	1.43	6.00	126.2	120.4	5.8	40.8	42.8	14.3	1	14.3
Brambleton Ave.	1.78	7.78	174.6	143.6	31.1	36.7	44.6	57.1	4	57.1
Colonial Ave.	0.53	8.31	72.5	50.8	21.7	26.3	37.5	42.9	4	42.9
Chaparral Dr.	0.55	8.86	65.6	52.6	13.0	30.2	37.7	57.1	3	57.1
Starkey Rd.	0.35	9.21	73.6	37.0	36.5	17.1	34.0	57.1	4	57.1
Ogden Rd.	0.35	9.56	50.9	34.7	16.2	24.8	36.3	28.6	4	28.6
Tanglewood	0.25	9.81	28.1	26.5	1.6	32.0	34.0	28.6	2	28.6
Rte. 220 S-Ent.	0.20	10.01	25.3	23.0	2.4	28.4	31.4	14.3	2	14.3
Rte. 220 N-Ent.	0.10	10.11	13.5	11.2	2.4	26.6	32.3	14.3	1	14.3
Penarth Rd.	0.20	10.31	18.1	17.9	0.2	39.7	40.1	14.3	1	14.3

Table 2.2 - 2

AM Outbound (North Bound) Survey Average

Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveye	% of Stop Surveye
Duke of Gloucester	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.0
Penarth Rd.	0.25	0.25	32.7	32.2	0.5	27.5	27.9	1	16.7
Rte. 220 N-Ent.	0.20	0.45	21.2	18.0	3.2	33.9	40.0	1	16.7
Rte. 220 S-Ent.	0.10	0.55	10.7	10.7	0.0	33.8	33.8	0	0.0
Tanglewood Mall	0.20	0.85	24.7	22.9	1.8	29.2	31.5	1	16.7
Ogden Rd.	0.25	1.00	32.4	26.1	6.3	27.8	34.5	2	33.3
Starkey Rd.	0.35	1.35	56.0	39.0	17.0	22.5	32.3	2	33.3
Chaparral Dr.	0.35	1.70	49.1	33.8	15.2	25.7	37.2	3	50.0
Colonial Ave.	0.55	2.25	79.1	50.9	28.2	25.0	38.9	5	83.3
Brambleton Ave.	0.53	2.78	89.6	55.2	34.4	21.3	34.6	4	66.7
Grandin Rd. Ext.	1.78	4.56	171.0	150.1	20.8	37.5	42.7	4	66.7
Keagy Rd.	1.43	5.99	130.1	121.7	8.4	39.6	42.3	4	66.7
Braeburn Dr.	0.18	6.17	40.5	21.8	18.7	16.0	29.7	4	66.7
Apperson Dr.	0.55	6.72	165.1	77.0	88.0	12.0	25.7	6	100.0
Indiana St.	0.23	6.95	29.3	29.3	0.0	28.3	28.3	0	0.0
Roanoke Blvd.	0.35	7.30	35.5	35.5	0.0	35.5	35.5	0	0.0
Lynchburg Tpk.	0.79	8.09	76.5	76.5	0.0	37.2	37.2	0	0.0
Melrose Ave.	0.64	8.73	133.2	64.7	68.5	17.3	35.6	5	83.3
I-81 N-Entrance	1.83	10.56	145.8	145.8	0.0	45.2	45.2	0	0.0

Table 2.2 - 3

PM Inbound (South Bound) Survey Average

Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveyed	% of Stop Surveyed
I-81 N-Ent.	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.0
Melrose Ave.	1.83	1.83	190.3	140.9	49.4	34.6	46.8	4	66.7
Lynchburg Tpk.	0.64	2.47	79.4	62.3	17.1	29.0	37.0	3	50.0
Roanoke Blvd.	0.79	3.26	103.8	78.7	25.1	27.4	36.1	5	83.3
Indiana St.	0.35	3.61	54.6	38.4	16.2	23.1	32.8	5	83.3
Apperson Dr.	0.23	3.84	109.7	35.2	74.5	7.5	23.5	6	100.0
Braeburn Dr.	0.55	4.39	53.0	53.0	0.0	37.4	37.4	0	0.0
Keagy Rd.	0.18	4.57	18.4	18.4	0.0	35.2	35.2	0	0.0
Grandin Rd. Ext.	1.43	6.00	164.2	120.7	43.5	31.4	42.7	5	83.3
Brambleton Ave.	1.78	7.78	247.0	155.2	91.8	25.9	41.3	5	83.3
Colonial Ave.	0.53	8.31	71.0	51.7	19.3	26.9	36.9	4	66.7
Chaparral Dr.	0.55	8.86	69.9	49.7	20.2	28.3	39.8	2	33.3
Starkey Rd.	0.35	9.21	93.4	36.8	56.6	13.5	34.2	5	83.3
Ogden Rd.	0.35	9.56	63.3	41.1	22.2	19.9	30.7	6	100.0
Tanglewood	0.25	9.81	30.2	30.2	0.0	29.8	29.8	0	0.0
Rte. 220 S-Ent.	0.20	10.01	31.8	20.6	11.2	22.6	35.0	2	33.3
Rte. 220 N-Ent.	0.10	10.11	12.2	11.4	0.9	29.4	31.6	1	16.7
Penarth Rd.	0.20	10.31	18.0	17.3	0.7	40.0	41.5	1	16.7

Table 2.2 - 4

PM Outbound (North Bound) Survey Average

Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveyed	% of Stop Surveyed
Duke of Gloucester	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.0
Penarth Rd.	0.25	0.25	46.7	39.9	6.8	19.3	22.6	4	66.7
Rte. 220 N-Ent.	0.20	0.45	26.9	19.4	7.4	26.8	37.1	2	33.3
Rte. 220 S-Ent.	0.10	0.55	19.0	13.7	5.3	18.9	26.2	1	16.7
Tanglewood	0.20	0.85	36.7	26.9	9.7	19.6	26.7	3	50.0
Ogden Rd.	0.25	1.00	60.5	32.0	28.6	14.9	28.1	3	50.0
Starkey Rd.	0.35	1.35	106.8	52.4	54.4	11.8	24.1	4	66.7
Chaparral Dr.	0.35	1.70	36.8	36.8	0.0	34.3	34.3	0	0.0
Colonial Ave.	0.55	2.25	75.4	49.4	26.0	26.3	40.1	6	100.0
Brambleton Ave.	0.53	2.78	92.9	57.8	35.1	20.5	33.0	5	83.3
Grandin Rd. Ext.	1.78	4.56	170.0	156.9	13.1	37.7	40.8	2	33.3
Keagy Rd.	1.43	5.99	124.7	114.7	9.9	41.3	44.9	2	33.3
Braeburn Dr.	0.18	6.17	32.3	17.9	14.3	20.1	36.1	3	50.0
Apperson Dr.	0.55	6.72	135.1	56.9	78.1	14.7	34.8	6	100.0
Indiana St.	0.23	6.95	34.6	32.4	2.2	23.9	25.5	2	33.3
Roanoke Blvd.	0.35	7.30	45.4	40.3	5.1	27.8	31.3	3	50.0
Lynchburg Tpk.	0.79	8.09	77.3	77.3	0.0	36.8	36.8	0	0.0
Melrose Ave.	0.64	8.73	184.8	71.7	113.1	12.5	32.1	6	100.0
I-81 N-Entrance	1.83	10.56	147.7	147.7	0.0	44.6	44.6	0	0.0

Table 2.2 - 5

Off-Peak Inbound (South Bound) Survey Average									
Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveyed	% of Stop Surveye
I-81 N-Ent.	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0
Melrose Ave.	1.83	1.83	178.2	142.2	36.1	37.0	46.3	4	100
Lynchburg Tpk.	0.64	2.47	72.2	60.7	11.5	31.9	38.0	2	50
Roanoke Blvd.	0.79	3.26	113.8	81.3	32.6	25.0	35.0	2	50
Indiana St.	0.35	3.61	50.6	42.7	7.9	24.9	29.5	3	75
Apperson Dr.	0.23	3.84	69.7	34.4	35.3	11.9	24.1	2	50
Braeburn Dr.	0.55	4.39	50.7	50.7	0.0	39.0	39.0	0	0
Keagy Rd.	0.18	4.57	19.7	19.7	0.0	32.9	32.9	0	0
Grandin Rd. Ext.	1.43	6.00	147.2	131.4	15.8	35.0	39.2	2	50
Brambleton Ave.	1.78	7.78	160.4	156.1	4.3	40.0	41.1	2	50
Colonial Ave.	0.53	8.31	60.6	53.5	7.1	31.5	35.7	3	75
Chaparral Dr.	0.55	8.86	82.7	57.7	25.0	23.9	34.3	4	100
Starkay Rd.	0.35	9.21	55.9	37.6	18.4	22.5	33.6	1	25
Ogden Rd.	0.35	9.56	56.8	37.5	19.3	22.2	33.6	4	100
Tanglewood	0.25	9.81	29.5	29.5	0.0	30.5	30.5	0	0
Rte. 220 S-Ent.	0.20	10.01	30.2	21.7	8.5	23.9	33.2	1	25
Rte. 220 N-Ent.	0.10	10.11	14.0	11.6	2.4	25.8	31.1	1	25
Penarth Rd.	0.20	10.31	30.6	17.8	12.8	23.5	40.4	2	50

Table 2.2 - 6

Off-Peak Outbound (North Bound) Survey Average

Name of Cross Street	Block Distance in Miles	Cumulative Distance in Miles	Average Travel Time	Average Running Time	Average Stop Delay	Average Travel Speed	Average Running Speed	Number of Stop Surveyed	% of Stop Surveye
Duke of Gloucester	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0
Penarth Rd.	0.25	0.25	44.7	38.7	6.0	20.2	23.3	2	50
Rte. 220 N-Ent.	0.20	0.45	22.9	20.6	2.3	31.5	35.0	1	25
Rte. 220 S-Ent.	0.10	0.55	21.3	12.2	9.1	16.9	29.6	1	25
Tanglewood	0.20	0.85	51.8	28.9	23.0	13.9	25.0	4	100
Ogden Rd.	0.25	1.00	29.7	29.7	0.0	30.3	30.3	0	0
Starkey Rd.	0.35	1.35	46.9	34.9	12.0	26.9	36.1	1	25
Chaparral Dr.	0.35	1.70	50.9	35.5	15.4	24.8	35.5	3	75
Colonial Ave.	0.55	2.25	72.4	54.0	18.4	27.4	36.6	2	50
Brambleton Ave.	0.53	2.78	85.2	52.6	32.6	22.4	36.3	3	75
Grandin Rd. Ext.	1.78	4.56	167.1	150.3	16.8	38.4	42.6	2	50
Keagy Rd.	1.43	5.99	117.8	114.4	3.5	43.7	45.0	1	25
Braeburn Dr.	0.18	6.17	18.3	18.3	0.0	35.5	35.5	0	0
Apperson Dr.	0.55	6.72	75.8	56.9	18.9	26.1	34.8	3	75
Indiana St.	0.23	6.95	35.0	30.2	4.8	23.7	27.4	2	50
Roanoke Blvd.	0.35	7.30	50.5	34.4	16.2	24.9	36.7	1	25
Lynchburg Tpk.	0.79	8.09	72.3	72.3	0.0	39.3	39.3	0	0
Melrose Ave.	0.64	8.73	109.5	63.8	45.7	21.0	36.1	4	100
I-81 N-Entrance	1.83	10.56	147.0	147.0	0.0	44.8	44.8	0	0

Table 2.3 Highway 419 Overall Performance

Time Travel Direction	A.M. Peak Hour		P.M. Peak Hour		Off-Peak Period	
	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
Average Travel Speed in MPH	31.28	28.82	26.55	26.21	30.85	31.36
Average Running Speed in MPH	39.94	37.65	38.67	36.54	37.73	38.27
Average Delay %	21.64%	23.29%	31.32%	28.14%	18.50%	18.11%
Average Number of Stop	6.57	6.66	9.00	8.67	8.25	7.50
Intersection Stop %	38.66%	39.22%	52.94%	50.98%	48.53%	44.12%

Table 2.4 Traffic Growth on Highway 419

		Average daily Traffic (ADT)							
From:	Rte. 220	Rte. 904	Rte. 221	SCL Salem	Rte. 11	MCL Salem	I-81	I-81	
To:	Rte. 904	Rte. 221	SCL Salem	Rte. 11	Rte. 460	Rte. 311			
1979	23455	22705	25330	29196	20468	10885	7690		
1980	31895	22670	25490	29310	20570	10775	7820		
1981	31860	22710	25910	24750	20290	10425	8160		
1982	32430	22775	25595	24847	20991	10515	8335		
1983	34120	23885	26480	24943	20493	10585	8080		
1984	36770	25265	26180	28300	21420	10420	7315		
1985	38605	26715	27535	28410	21527	11525	8455		
1986	40122	28175	27929	30010	19350	11646	8613		
1987	41699	29714	28328	30127	19447	11768	8774		
1988	43337	31337	28733	30245	19544	11892	8938		
1989	45040	33049	29144	30362	19642	12017	9105		
1990	46810	34855	29561	30481	19740	12143	9276		
1991	48649	36759	29984	30600	19839	12270	9449		
1992	50561	38768	30412	30719	19938	12399	9626		
1993	52548	40886	30847	30839	20037	12529	9806		
1994	54613	43120	31288	30959	20138	12661	9989		
1995	56759	45476	31736	31080	20238	12794	10176		
Growth %	9.27%	2.78%	1.43%	-0.74%	-0.90%	1.05%	1.87%		
Used									
Growth %	3.93%	5.46%	1.43%	0.39%	0.50%	1.05%	1.87%		
1995 Plan									
Estimated	51200	39000	45100	45600	45600	10000	10000		
Difference									
% in	10.86%	16.60%	-29.63%	-31.84%	-55.62%	27.94%	1.76%		
Estimation									

* Traffic Volume after Year 1986 are Predicted

Table 2.5 Traffic Generators Along Highway 419

No. Name of Cross Street	Trip Generators between Cross Street
0. Duke of Gloucester	Kmart Shopping Center Townside Plaza
1. Penarth Road	
2. Rte. 220 N-Entrance	
3. Rte. 220 S-Entrance	
4. Tanglewood Mall	Tanglewood Mall Tanglewood Mall Avenham Manor Apartments Division of Motor Vehicles Grand Pavilion Shopping Center
5. Ogden Road	Winn-Dixie/Revco Shopping Center Professional Building Tanglewood West Office Building
6. Starkey Road	Fralin & Waldron Office Park
7. Chaparral Drive	Promenade Park
8. Colonial Avenue	
9. Brambleton Avenue	Springwood Park (mini-mall) County Public Library County Post Office State Farm Insurance Oak Grove Plaza Atlantic Companies Allstate Insurance Prudential Insurance Lewis Gale Hospital
10. Grandin Road Ext.	
11. Keagy Road	
12. Braeburn Drive	
13. Apperson Drive	
14. Indiana Street	Thriftree Discount Store Duvall Veterinary Hospital
15. Roanoke Boulevard	General Electric Plant
16. Lynchburg/Salem Tpk.	Old Lakeside Amusement Park
17. Melrose Avenue	
18. I-81 Interchange	

Table 3.1 Highway 419 Sectional
Volume/Capacity Ratio

Name of Cross Street	Travel Lanes		MSF*	Truck %	Et	Fhv	Capacity		Peak Hour Traffic		Volume/Capacity Ratio		P.M. S.B.			
	N.B.	S.B.					N.B.	S.B.	N.B.	S.B.	N.B.	S.B.		A.M.	P.M.	
Penarth Rd.	2	2	1800	5%	2	0.952	3429	3429	930	970	1390	1620	27.1%	28.3%	40.5%	47.3%
220 N-Ent.	2	2	1800	5%	2	0.952	3429	3429	560	1800	1710	1950	16.3%	52.5%	49.9%	56.9%
220 S-Ent.	2	2	1800	5%	2	0.952	3429	3429	720	1850	2304	2930	21.0%	54.0%	67.2%	85.5%
Tanglewood Mall	3	2	1800	5%	2	0.952	5143	3429	1220	1800	1810	1330	23.7%	52.5%	35.2%	38.8%
Ogden Rd.	2	2	1800	5%	2	0.952	3429	3429	1160	1550	2050	1960	33.8%	45.2%	59.8%	57.2%
Starkey Rd.	2	2	1800	5%	2	0.952	3429	3130	1130	1340	1560	1590	33.0%	42.8%	45.5%	50.8%
Chaparral Dr.	2	2	1800	5%	4	0.870	3130	3130	910	1130	1270	1100	29.1%	36.1%	40.6%	35.1%
Colonial Ave.	2	2	1900	5%	4	0.870	3304	3167	960	1020	1110	1420	29.1%	32.2%	33.6%	44.8%
Brambleton Ave.	2	2	1900	5%	5	0.833	3167	2923	970	1270	1810	2280	30.6%	43.4%	57.2%	78.0%
Grandin Rd. Ext.	2	2	2000	5%	7	0.769	3077	3077	1210	820	950	1470	39.3%	26.7%	30.9%	47.8%
Keagy Rd.	2	2	2000	5%	7	0.769	3077	2963	1190	1190	920	2030	38.7%	40.2%	29.9%	68.5%
Braeburn Dr.	2	2	1800	5%	8	0.741	2667	3273	1230	1100	1040	1500	46.1%	33.6%	39.0%	45.8%
Apperson Dr.	2	2	1800	5%	3	0.909	3273	3000	1320	960	1050	1400	40.3%	32.0%	32.1%	46.7%
Indiana St.	2	2	1800	5%	5	0.833	3000	3429	1110	960	1010	1310	37.0%	28.0%	33.7%	38.2%
Roanoke Blvd.	2	2	1800	5%	2	0.952	3429	3273	1050	900	950	750	30.6%	27.5%	27.7%	22.9%
Lynchburg Tpk.	2	2	1800	5%	3	0.909	3273	3273	840	580	1180	730	25.7%	17.7%	36.1%	22.3%
MeIrose Ave.	2	2	1800	5%	3	0.909	3273	2667	710	430	1120	350	21.7%	16.1%	34.2%	13.1%
I-81	2	2	2000	5%	8	0.741	2963	2963	330	500	500	500	11.1%	16.9%	16.9%	16.9%

* MSF: Maximum Saturation Flow - (veh/hr)

* Et: Truck Equivalent - (passenger car/truck)

* Fhv: Heavy Vehicle Adjustment Factor

Table 4.1 Definition of Level of Service

Level-of-Service Criteria for Signalized Intersection

Level of Service	Stopped Delay Per Vehicle (Sec)
A	= < 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	> 60.0

Level-of-Service Criteria for Arterial

Arterial Class	I	II	III
Range of Free Flow Speed (mph)	45 to 35	35 to 30	35 to 25
Typical Free Flow Speed (mph)	40 mph	33 mph	27 mph
Level of Service	Average Travel Speed (mph)		
A	>= 35	>= 30	>= 25
B	>= 28	>= 24	>= 19
C	>= 22	>= 18	>= 13
D	>= 17	>= 14	>= 9
E	>= 13	>= 10	>= 7
F	< 13	< 10	< 7

* To classify the Arterial Class for Route 419, either the surveyed running speed or the posted speed limit, whichever is higher, is used as free flow speed.

Table 4.2 Highway and Intersection Level of Service
A.M. Peak Hour

No.	Street Name	Intersection N/S Bound (Out/In)	Highway N/S Bound (Out/In)
0.	Duke of Gloucester		
1.	Penarth Road	A/A	B/A
2.	Rte. 220 N-Entrance	A/A	B/B
3.	Rte. 220 S-Entrance	A/A	A/B
4.	Tanglewood Mall	A/A	A/B
5.	Ogden Road	B/C	C/C
6.	Starkey Road	C/D	C/D
7.	Chaparral Drive	C/B	C/B
8.	Colonial Avenue	D/C	C/C
9.	Brambleton Avenue	D/D	D/A
10.	Grandin Road Ext.	C/B	A/A
11.	Keagy Road	B/A	A/B
12.	Braeburn Drive	C/A	D/A
13.	Apperson Drive	F/C	E/D
14.	Indiana Street	A/B	B/B
15.	Roanoke Boulevard	A/C	A/B
16.	Lynchburg/Salem Tpk.	A/B	A/B
17.	Melrose Avenue	F/F	D/B
18.	I-81 Interchange	-	A/-

Table 4.2 - cont.

P.M. Peak Hour

No.	Street Name	Intersection N/S Bound (Out/In)	Highway N/S Bound (Out/In)
0.	Duke of Gloucester		
1.	Penarth Road	B/A	C/A
2.	Rte. 220 N-Entrance	B/A	C/B
3.	Rte. 220 S-Entrance	B/B	C/C
4.	Tanglewood Mall	B/A	D/B
5.	Ogden Road	D/C	E/C
6.	Starkey Road	E/E	F/E
7.	Chaparral Drive	A/C	B/B
8.	Colonial Avenue	D/C	C/C
9.	Brambleton Avenue	D/F	D/C
10.	Grandin Road. Ext.	B/E	A/B
11.	Keagy Road	B/A	A/A
12.	Braeburn Drive	B/A	D/A
13.	Apperson Drive	F/F	E/F
14.	Indiana Street	A/C	B/C
15.	Roanoke Boulevard	A/D	B/C
16.	Lynchburg/Salem Tpk.	A/C	A/B
17.	Melrose Avenue	F/E	E/B
18.	I-81 Interchange	-	A/-

Table 4.2 - cont.

Off-Peak Period

No.	Street Name	Intersection N/S Bound (Out/In)	Highway N/S Bound (Out/In)
0.	Duke of Gloucester		
1.	Penarth Road	B/B	C/C
2.	Rte. 220 N-Entrance	A/A	A/B
3.	Rte. 220 S-Entrance	B/B	D/C
4.	Tanglewood Mall	C/A	E/B
5.	Ogden Road	A/C	B/C
6.	Starkey Road	B/C	C/C
7.	Chaparral Drive	C/C	C/C
8.	Colonial Avenue	C/B	C/B
9.	Brambleton Avenue	D/A	C/A
10.	Grandin Road. Ext.	C/C	A/B
11.	Keagy Road	A/A	A/A
12.	Braeburn Drive	A/A	A/A
13.	Apperson Drive	C/D	B/E
14.	Indiana Street	A/B	B/B
15.	Roanoke Boulevard	C/D	C/B
16.	Lynchburg/Salem Tpk.	A/B	A/B
17.	Melrose Avenue	E/D	D/A
18.	I-81 Interchange	-	A/-

Table 4.3 Overall Level of Service
of Highway 419

	A. M.	P. M.	Off-Peak
Outbound: (North B.)	B	C	B
Inbound: (South B.)	B	C	B

Table 4.4 Problem Area Identification

A. Identification Criteria:

Level of Service Lower than D

B. Areas Satisfy the Criteria:

North Bound (Outbound)

a. Intersection

1. Starkey Road
2. Apperson Drive
3. Melrose Avenue

b. Highway section

1. Rte. 220 S-Ent. to Tanglewood Mall
2. Tanglewood Mall to Ogden Road
3. Ogden Road to Starkey Road
4. Braeburn Drive to Apperson Drive
5. Salem Turnpike to Melrose Avenue

South Bound (Inbound)

a. Intersection

1. Starkey Road
2. Brambleton Avenue
3. Grandin Road Ext.
4. Apperson Drive
5. Melrose Avenue

b. Highway section

1. Chaparral Drive to Starkey Road
2. Indiana Street to Apperson Drive

Table 4.5 Problem Area Deficiency Rating

A. Deficiency Rating:

- a. Level of Service E: 1 point
- b. Level of Service F: 2 points

B. Summation of Problem Area Deficiency Rating:

North Bound (Outbound)

a. Intersection

- 1. Melrose Avenue: $2 + 2 + 1 = 5$ (AM, PM, Off-Peak)
- 2. Apperson Drive: $2 + 2 + 0 = 4$
- 3. Starkey Road: $0 + 1 + 0 = 1$

b. Highway section

- 1. Ogden Road to Starkey Road: $0 + 2 + 0 = 2$
- 2. Brasburn Drive to Apperson Drive: $1 + 1 + 0 = 2$
- 3. Rte. 220 S-Ent. to Tanglewood Mall: $0 + 0 + 1 = 1$
- 4. Tanglewood Mall to Ogden Road: $0 + 1 + 0 = 1$
- 5. Salem Turnpike to Melrose Avenue: $0 + 1 + 0 = 1$

South Bound (Inbound)

a. Intersection

- 1. Melrose Avenue: $2 + 1 + 0 = 3$
- 2. Brambleton Avenue: $0 + 2 + 0 = 2$
- 3. Apperson Drive: $0 + 2 + 0 = 2$
- 4. Starkey Road: $0 + 1 + 0 = 1$
- 5. Grandin Road Ext.: $0 + 1 + 0 = 1$

b. Highway section

- 1. Indiana Street to Apperson Drive: $0 + 2 + 1 = 3$
- 2. Chaparral Drive to Starkey Road: $0 + 1 + 0 = 1$

Table 4.6 Combined Deficiency Rating
for both Travel Directions:

a. Intersection

1. Melrose Avenue: 8 points
2. Apperson Drive: 6 points
3. Starkey Road: 2 points
3. Brambleton Avenue: 2 points
5. Grandin Road Ext.: 1 point

b. Highway section

1. Indiana Street to Apperson Drive: 3 points
2. Braeburn Drive to Apperson Drive: 2 points
2. Ogden Road to Starkey Road: 2 points
4. Chaparral Drive to Starkey Road: 1 point
4. Rte. 220 S-Ent. to Tanglewood Mall: 1 point
4. Tanglewood Mall to Ogden Road: 1 point
4. Salem Turnpike to Melrose Avenue: 1 point

Table 4.7 Identification of Problem
Regions

1. Around Apperson Dr. Intersection:	11 points
2. Around Melrose Ave. Intersection:	9 points
3. Around Starkey Rd. Intersection:	5 points
4. Around Brambleton Ave. Intersection:	2 points
5. Around Tanglewood Mall:	1 point
5. Around Ogden Rd. Intersection:	1 point
5. Around Grandin Rd. Ext. Intersection:	1 point

Table 4.8 Surveyed Intersection Stop Probability

No.	Street Name	A. M.	P. M. N/S Bound (Out/In) %	Off-Peak
1.	Penarth Road	17/14	67/17	50/50
2.	I-581 N. On-ramp	17/14	33/17	25/25
3.	I-581 S. Off-ramp	0/29	17/33	25/25
4.	Tanglewood Mall	17/29	50/0	100/0
5.	Ogden Road	33/57	50/100	0/100
6.	Starkey Road	33/57	67/83	25/25
7.	Chaparral Drive	50/43	0/33	75/100
8.	Colonial Avenue	83/57	100/67	50/75
9.	Brambleton Avenue	67/57	83/83	75/50
10.	Grandin Road. Ext.	67/14	33/83	50/50
11.	Keagy Road	67/14	33/0	25/0
12.	Braeburn Drive	67/0	50/0	0/0
13.	Apperson Drive	100/100	100/100	75/50
14.	Indiana Street	0/43	33/83	50/75
15.	Roanoke Boulevard	0/43	50/83	25/50
16.	Lynchburg/Salem Tpk.	0/29	0/50	0/50
17.	Melrose Avenue	83/86	100/67	100/100
18.	I-81 Interchange	-/-	-/-	-/-
	Average Stop Number	7/7	9/9	8/8
	Average Stop %	39/39	51/53	44/48

Table 4.9 Highway 419 Accident Rate

Accident Summary by Section
(Unit: Accident/Million Vehicle Miles)

From:	Rte. 220	WCL Roanoke	Rte. 904	Rte. 221	NCL Salem	Rte. 780	I-81 SB
To:	WCL Roanoke	Rte. 904	Rte. 221	SCL Salem	Rte. 780	I-81 SB	Rte. 311
1984	1490	619	226	169	30	822	920
1985	811	525	271	129	134	1189	599

1984 Virginia primary Average: 205 Acc./MVM
 1984 Roanoke Regional Average: 221 Acc./MVM

Table 5.1 Traffic Engineering Improvements

Recommended Improvement	From:	Location	To:	Purpose
Adjust Speed Limit From 45 MPH to 35 MPH	220 S Off-Ramp	Chaparral Dr. Intersection		Maintain constant travel speed; reduce repetitive acceleration-deceleration
Install Oversized Speed Limit Sign	Brambleton Ave. Intersection	Keagy Road Intersection		Precautionary warning; improve egress/ingress safety for residential areas; lower spot speed
Roadway Marking for Left-turn/Through Traffic	Apperson Dr. intersection northbound approach			Reduce vehicle lane-change conflict; increase safety and approach capacity
Roadway Marking for Right-turn/Through Traffic	Melrose Ave. intersection northbound approach			
Relocate Guide Sign	Melrose Ave. intersection, northbound approach			To confirm roadway marking; reduce vehicle lane-change conflict
Improve Exit and Entrance	Brambleton Ave. Intersection	Keagy Rd. Intersection		Improve turning radius and sight distance of non-signal controlled intersection; enhance safety
Widen Intersections	- Ogden Road, northbound approach - Starkey Rd. Intersection, north and west bound approaches - Brambleton Ave. Intersection, southbound approach - Apperson Dr. Intersection, north and south bound approaches - Melrose Ave. Intersection, northbound approach			Increase intersection capacity; reduce stop delay

Table 5.1 - cont.

Recommended Improvement	From:	Location	To:	Purpose
Improve Bridges	(1) - Bridge on Apperson Dr. (2) - Bridge on Route 419 at Apperson Dr. Intersection			Decrease road grade, increase approach capacity
	Chaparral Dr. Railroad Overpass			Increase roadside lateral clearance
Resurface Pavement	Apperson Dr. Intersection	Roanoke Blvd. Intersection		Prevent further deterioration, improve roadway surface and service
Improve Roadside Curb, Geometry, and Channelization	419/Texas St. Intersection, southbound approach and entrance to Route 419 from Texas Street			Improve vehicle turning safety
Improve Lighting, Median Marker, and Edge Line Marking	Brambleton Ave. Intersection	Keagy Road Intersection		Improve travel visibility during night time to increase travel safety and reduce accident potential
Limit New Median Cuts - Crossovers	Starkey Road	Melrose Avenue		Reduce uncontrolled traffic flow and head-on turning conflict

Table 5.2 Traffic Control System Improvement

Recommended Improvement	From:	Location	To:	Purpose
Real Time Signal System	Duke of Gloucester	Chaparral Dr. Intersection		Reduce: Stop percentage, travel time Intersection stop delay Fuel consumption
Real Time Signal System	Keagy Rd. Intersection	Roanoke Blvd. Intersection		Increase: Travel speed Maintenance of constant speed

Table 5.3 Major Highway Construction Improvement

Recommended Improvement	From:	Location	To:	Purpose
Widen Roadway 419 Northbound	220 S Off-Ramp	Chaparral Dr. Intersection		Increase highway capacity to accommodate traffic growth, eliminate factors for roadway blockage by turning traffic
	Braeburn Dr. Intersection	Apperson Dr. Intersection		
Improve Interchange	Interchange of Route 220 and Highway 419			Improve site safety, increase northbound on-ramp capacity
	Interchange of Interstate 81 and Highway 419			reduce turning movement conflict, improve site safety

FIGURES

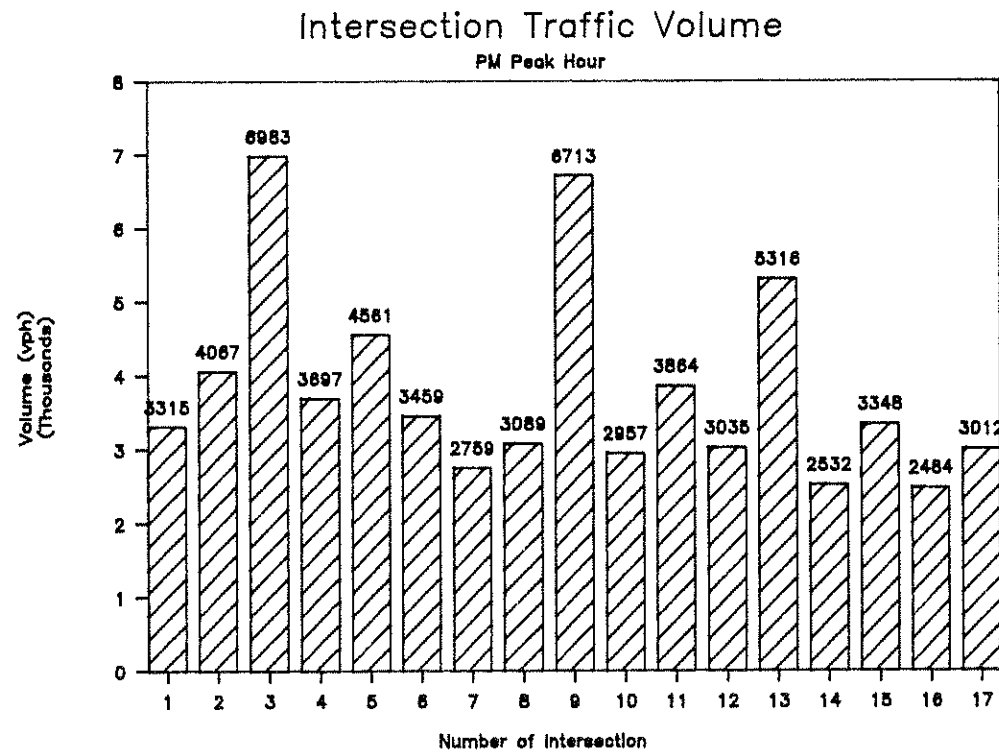
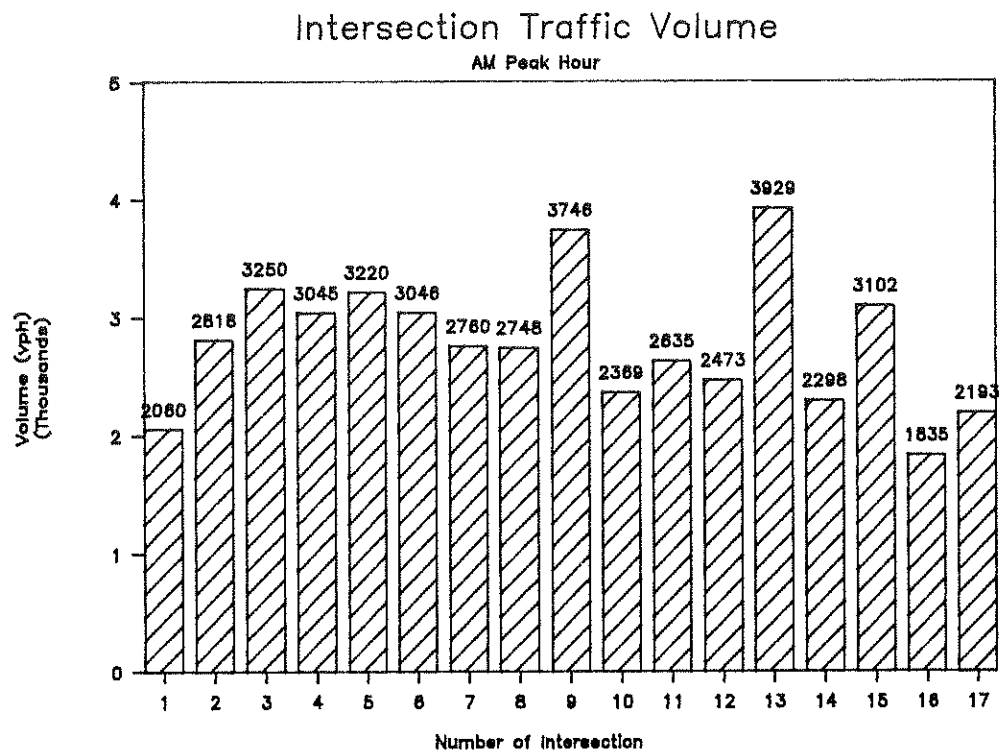


Figure 2.1 Intersection Peak Hour Traffic Volume

Number	Name of Cross Street
1.	Penarth Road
2.	Rte. 220 N-Entrance
3.	Rte. 220 S-Entrance
4.	Tanglewood Mall
5.	Ogden Road
6.	Starkey Road
7.	Chaparral Drive
8.	Colonial Avenue
9.	Brambleton Avenue
10.	Grandin Road. Ext.
11.	Keagy Road
12.	Braeburn Drive
13.	Apperson Drive
14.	Indiana Street
15.	Roanoke Boulevard
16.	Lynchburg/Salem Tpk.
17.	Melrose Avenue

Figure 2.1 - cont'd.

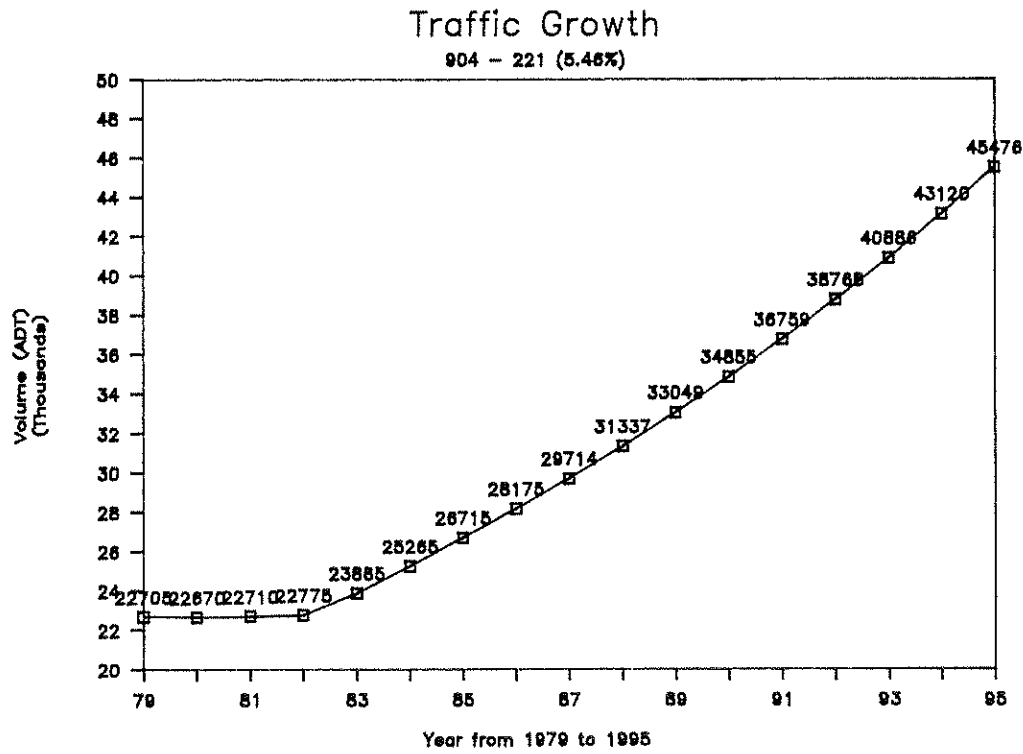
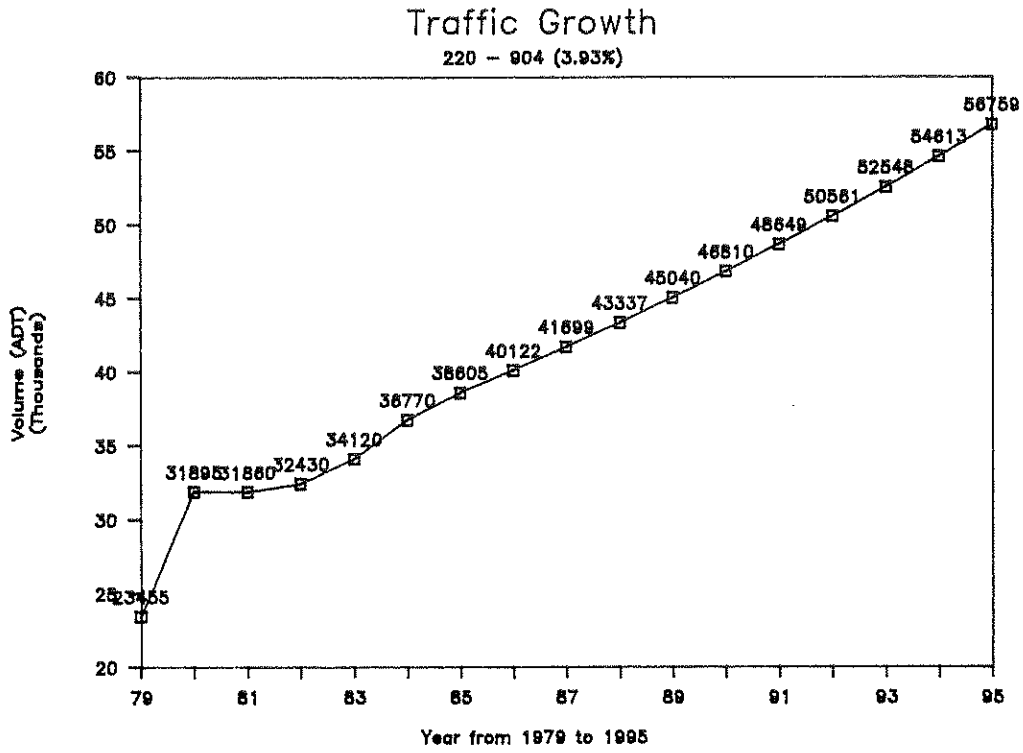
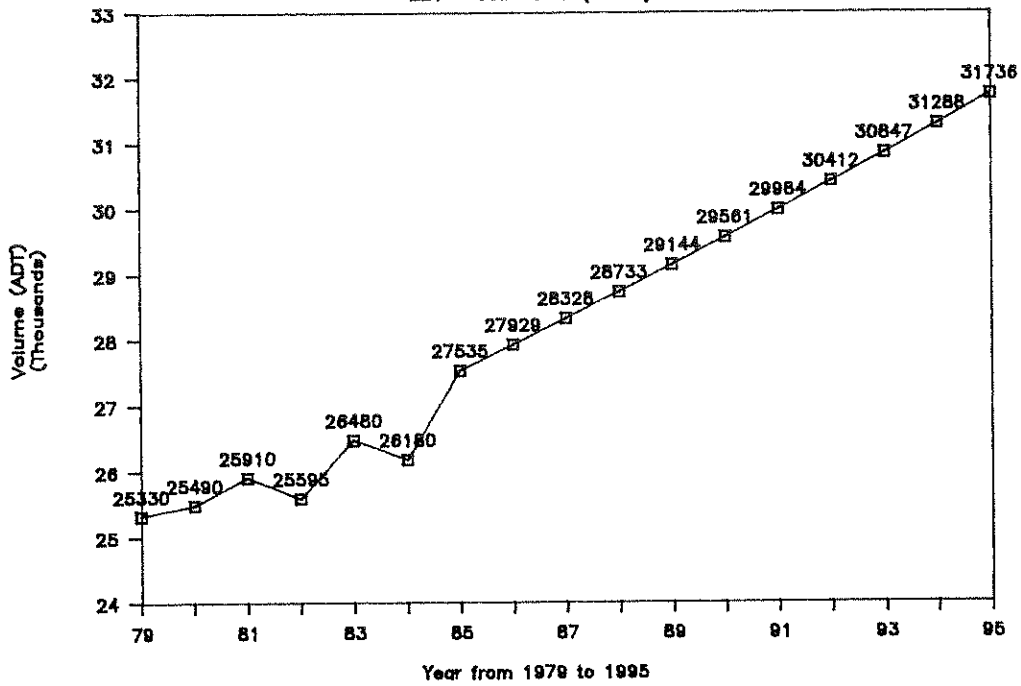


Figure 2.2 Highway 419 Traffic Projection

Traffic Growth

221 - SCL Salem (1.43%)



Traffic Growth

SCL Salem - 11 (0.39%)

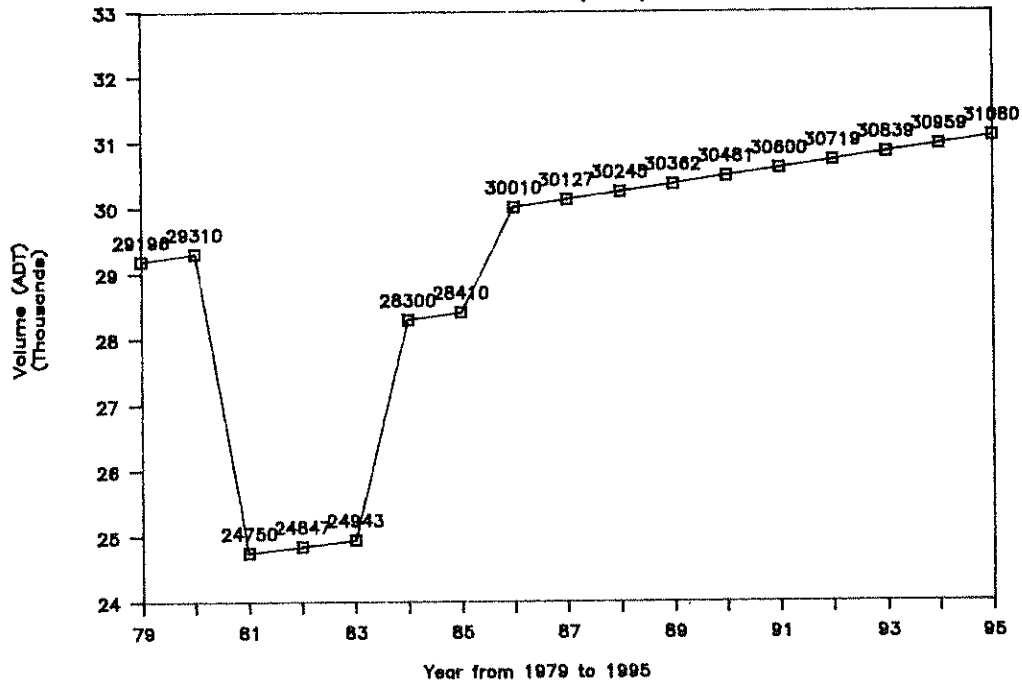


Figure 2.2 - cont'd.

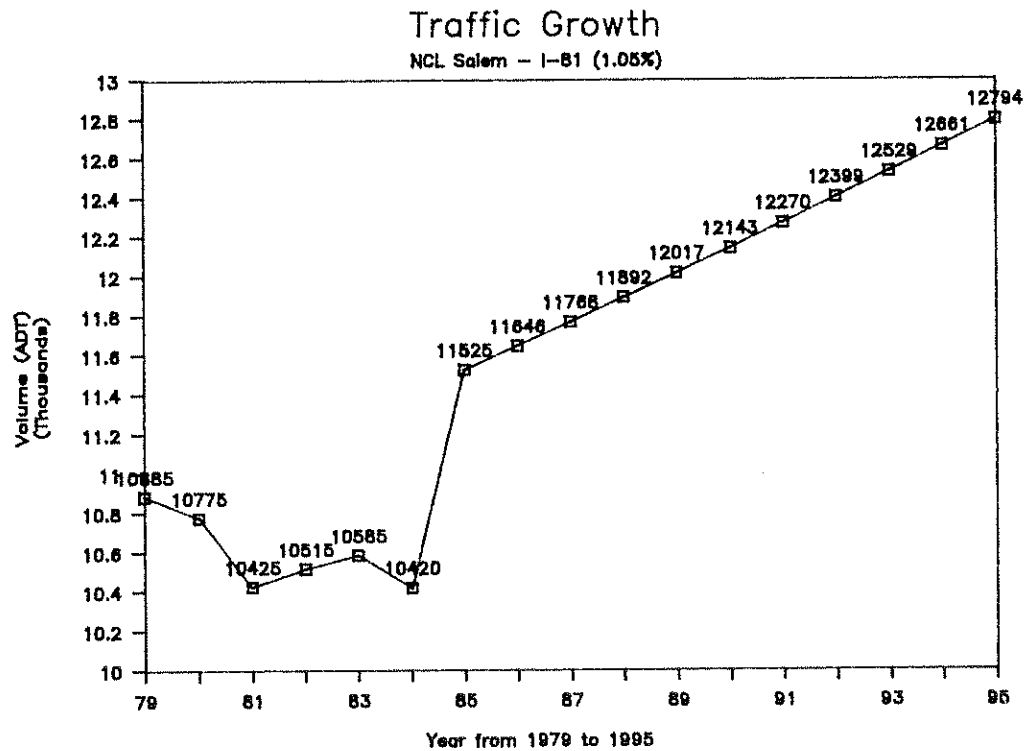
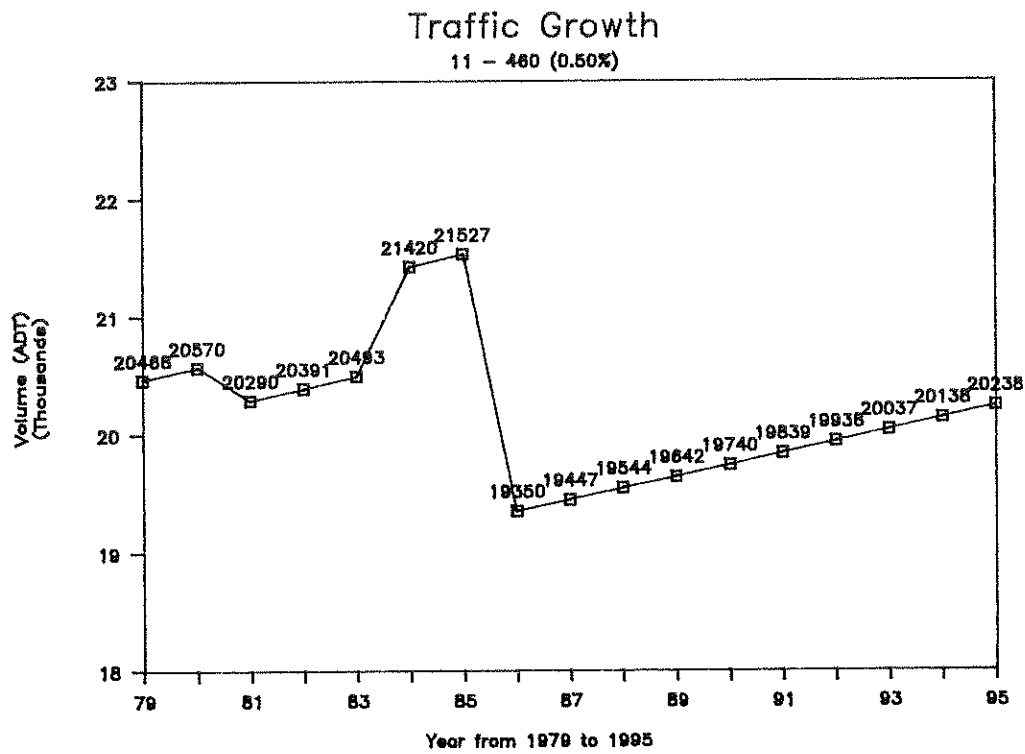


Figure 2.2 - cont'd.

Traffic Growth

I-81 - 311 (1.87%)

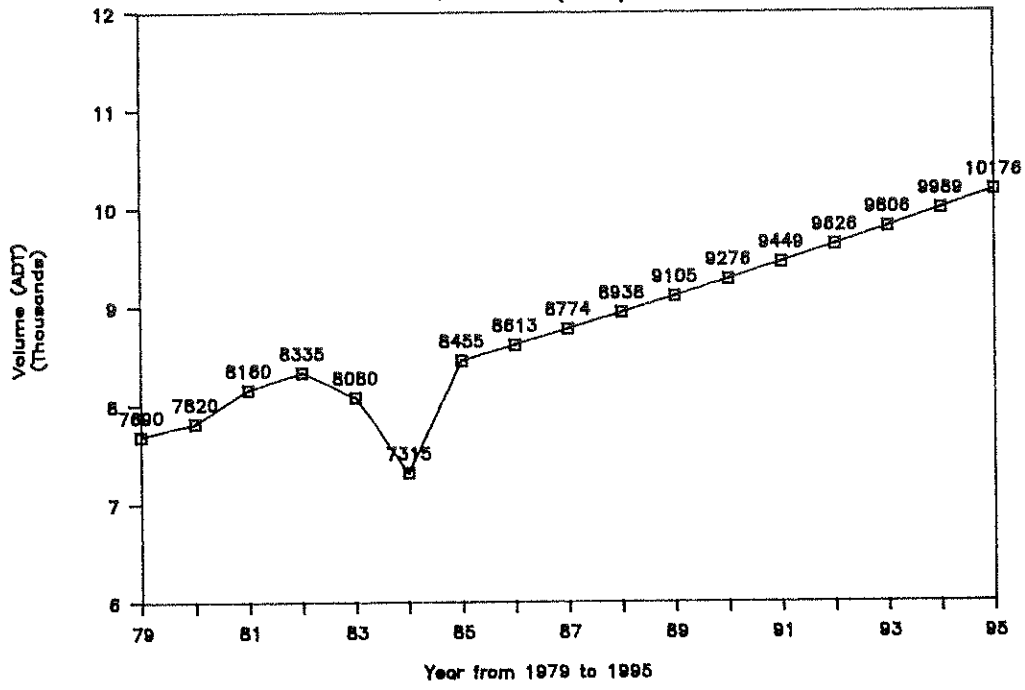


Figure 2.2 - cont'd.

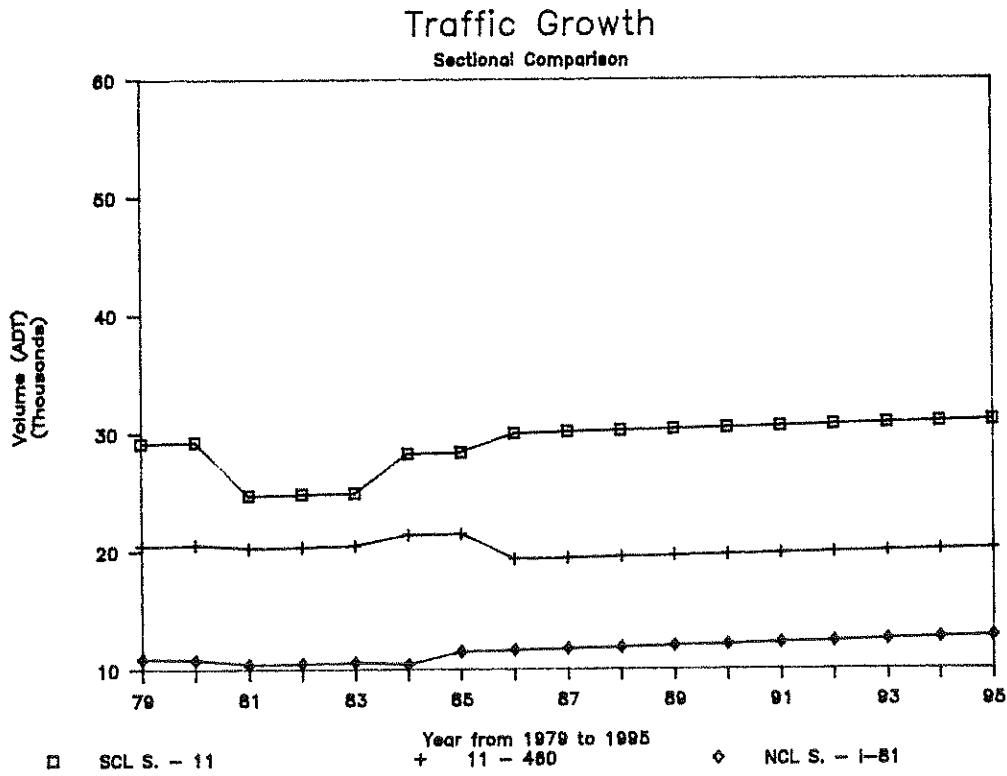
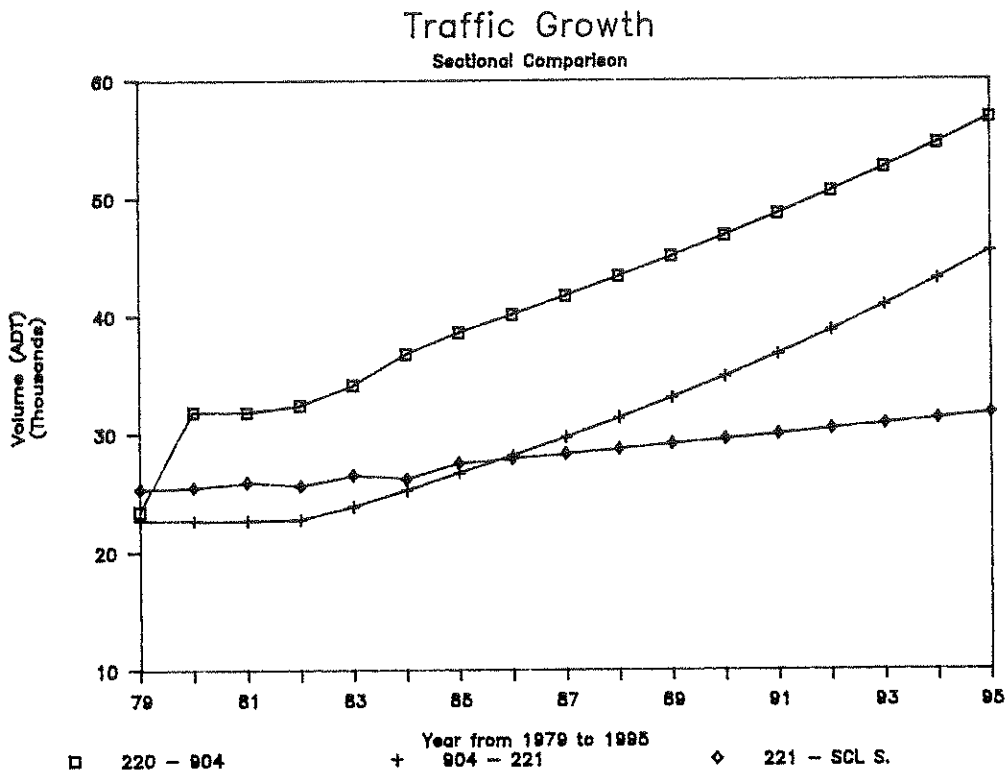


Figure 2.3 Traffic Growth Comparison

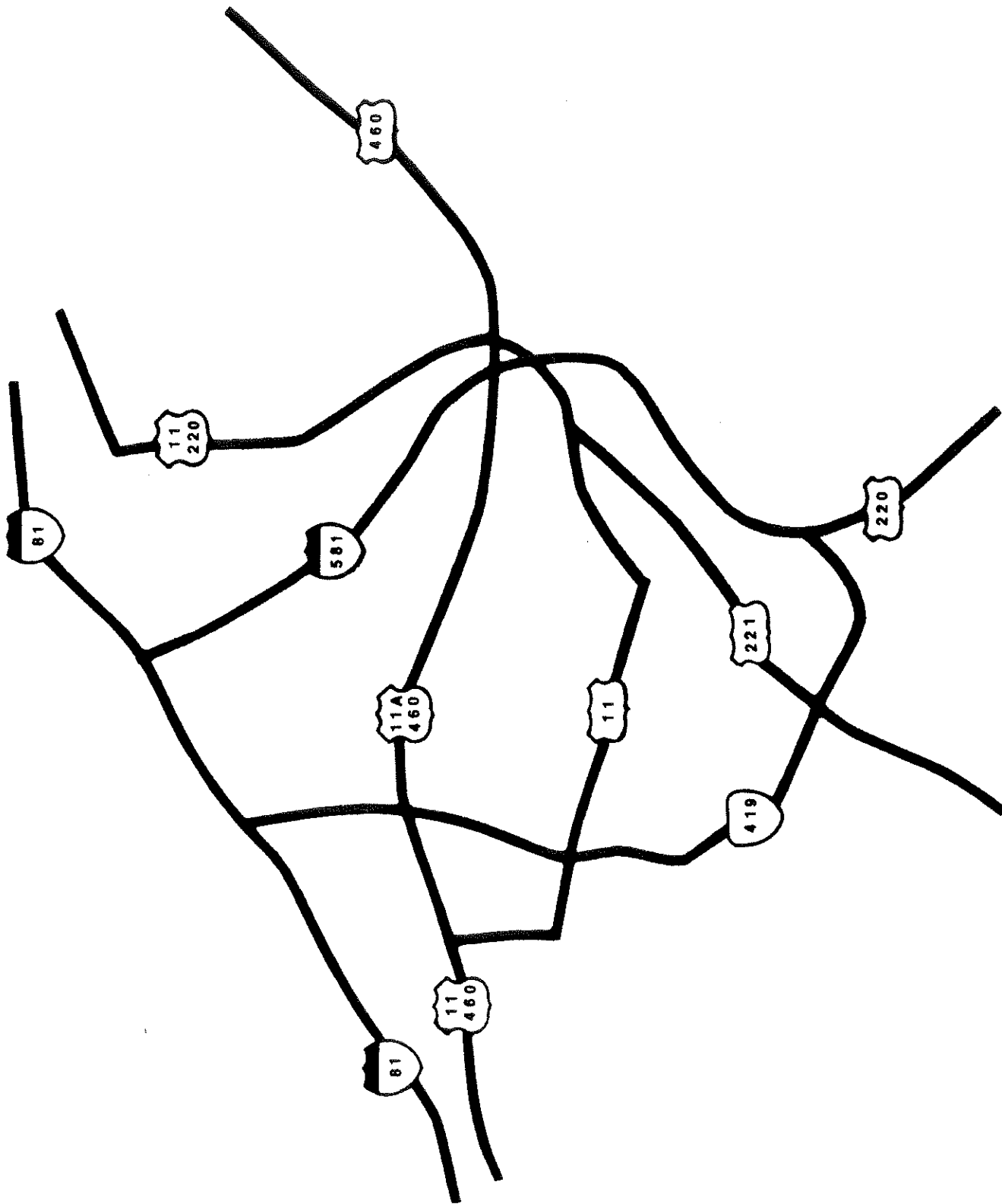


FIGURE 3.1 ROANOKE PRIMARY HIGHWAY NETWORK

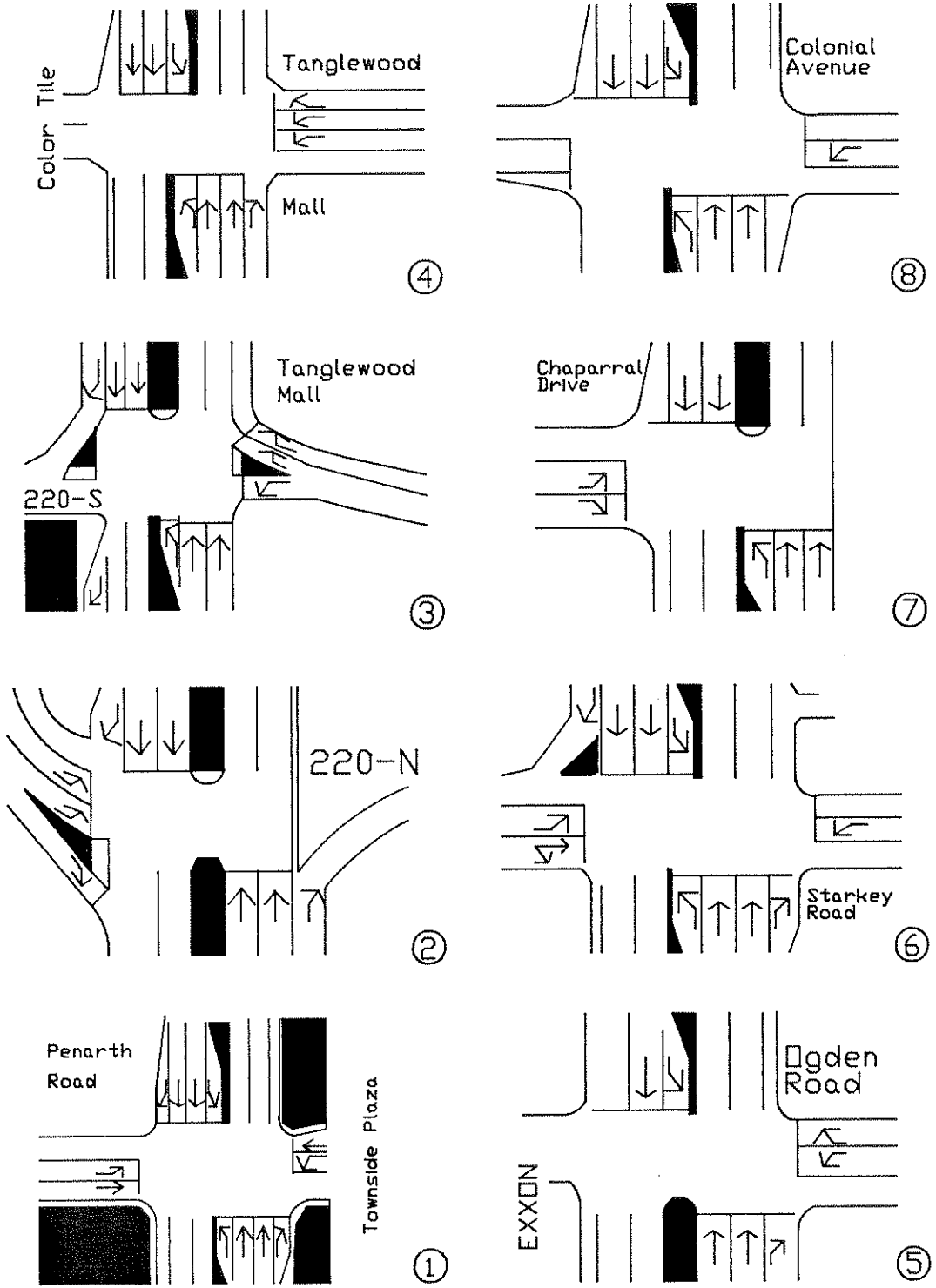
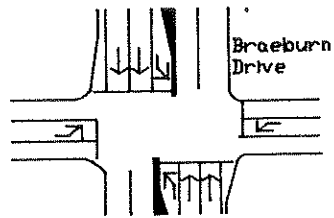


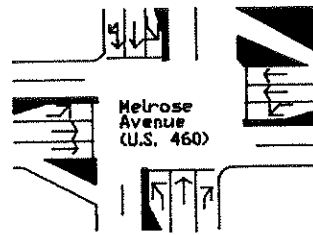
Figure 3.2 Geometric Layout - 419 Intersections



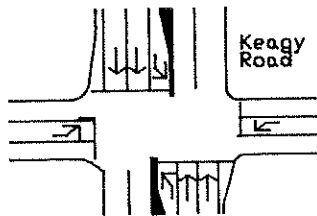
13



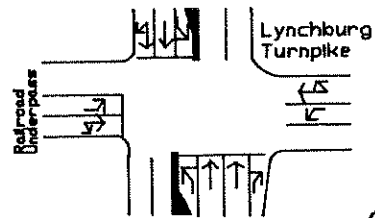
12



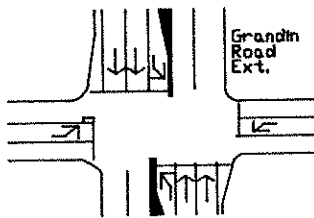
17



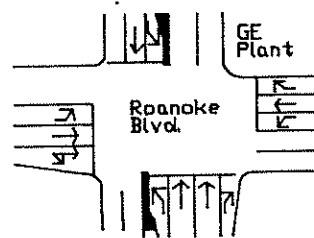
11



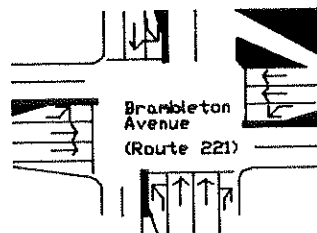
16



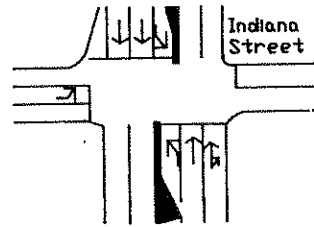
10



15



9

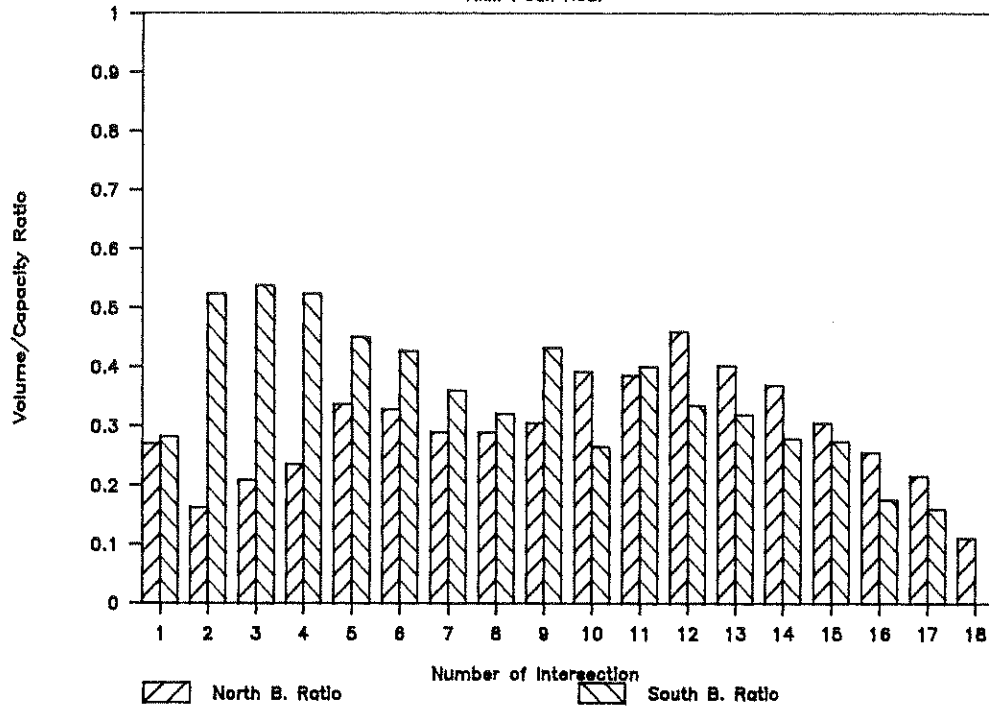


14

Figure 3.2 - cont'd

Highway 419 Volume/Capacity Ratio

A.M. Peak Hour



Highway 419 Volume/Capacity Ratio

P.M. Peak Hour

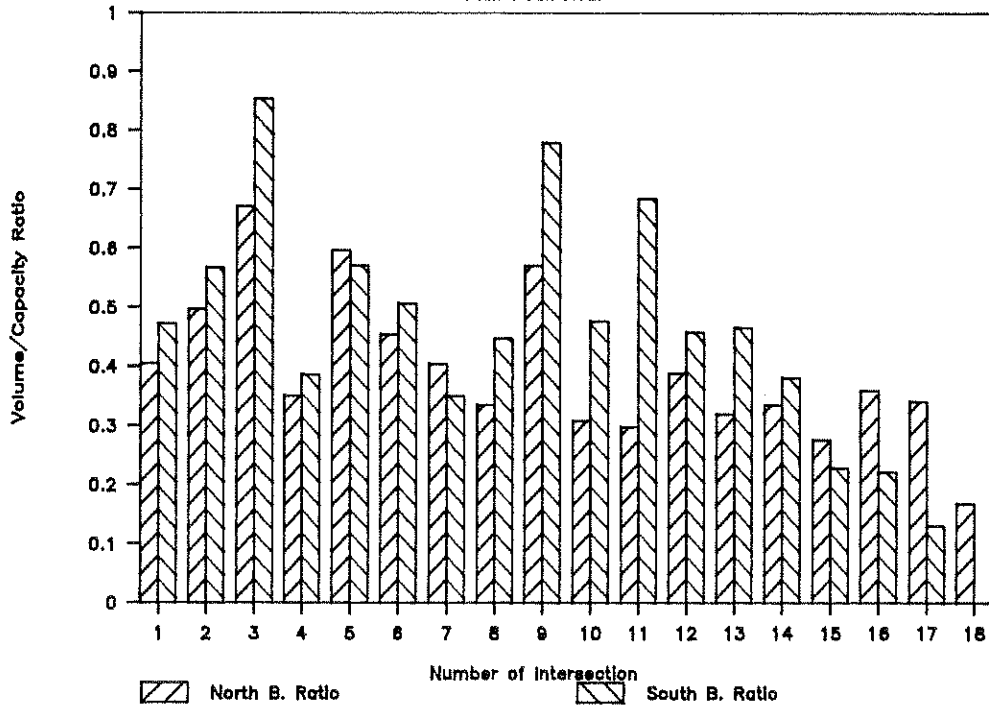


Figure 3.3 - Route 419 Volume/Capacity Ratio