Regional Bicycle Suitability Study

Phase I

Prepared by the

Roanoke Valley Area Metropolitan
Planning Organization

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Roanoke Valley Alleghany Regional Commission

This report was prepared by the Roanoke Valley Area Metropolitan Planning Organization (RVAMPO) in cooperation with the U.S. Department of Transportation (USDOT), the Federal Highway Administration (FHWA), and the Virginia Department of Transportation (VDOT). The contents of this report reflect the views of the staff of the Roanoke Valley Metropolitan Planning Organization (MPO). The MPO staff is responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the FHWA, VDOT, or RVARC. This report does not constitute a standard, specification, or regulation. FHWA or VDOT 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 or a commitment to fund any such improvements. Additional project level environmental impact assessments and/or studies of alternatives may be necessary.

Note: For bicycle accommodations to be considered as part of roadway improvements using Federal and State funding, the roadway must be included in an approved bikeway plan. The 1997 Bikeway Plan for the Roanoke Valley Area (RVAMPO, 1997) is the approved bikeway document for the MPO, thereby fulfilling this requirement. As such, the 1997 Bikeway Plan should be referenced when specific roadways are cited for bicycle accommodations. Phase I of the Regional Bicycle Suitability Study is not intended to supercede or replace the 1997 Plan in this capacity. Instead it should complement the efforts and goals of the 1997 Plan and facilitate the provision of bicycle accommodation in the MPO.

Roanoke Valley Alleghany Regional Commission

List of Figures

List of Tables

List of Acronyms

AADT	Average Annual Daily Traffic
ASSHTO	American Association of State Highway and Transportation Officials
BCI	Bicycle Compatibility Index Model
BL	Bike Lane
BLOS	Bicycle Level of Service
CTPP	Census Transportation Planning Package
EAC	Early Action Compact
HV%	Heavy Vehicle Percentage
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
LOS	Level of Service
LRTP	Long Range Transportation Plan
MPO	Metropolitan Planning Organization
MSA	Metropolitan Statistical Area
NPTS	National Personal Transportation Survey
NHTS	National Household Transportation Survey
RVAMPO	Roanoke Valley Area Metropolitan Planning Organization
RVARC	Roanoke Valley Alleghany Regional Commission
TEA-21	Transportation Enhancement Act for the 21st Century
TIP	Transportation Improvement Plan
VDOT	Virginia Department of Transportation
WCL	Wide Curb Lane

Introduction

The *Regional Bicycle Suitability Study* is a component of the *FY 2002-2003 Unified Transportation Work Program* for the Roanoke Valley Area Metropolitan Planning Organization (RVAMPO). It represents the combined efforts of the Metropolitan Planning Organization (MPO) staff, the Regional Bicycle Suitability Study Planning Committee, local agencies, advocacy groups, and citizens in the Roanoke Area. The study is intended to be a resource document to facilitate development of a regionally significant bikeway network in the RVAMPO service area. Although this plan is regional in focus, the study findings and work products are useful for guidance in developing local, as well as regional, bicycling facilities and plans.

Project Purpose

To develop or improve roadways for shared use by motor vehicles and bicycles, it is important to first evaluate the existing roadway network to determine what bicyclists considered user-friendly. The purpose of the *Regional Bicycle Suitability Study* is to develop ***planning level data and tools*** to assess the current level of service (LOS) offered by the existing roadway network in regards to bicycle travel in the region. Additionally, attention is also devoted to linkages and connectivity between the Roanoke Valley Greenway system, the public transportation system (i.e., Valley Metro), activity centers (e.g., village centers, schools, commercial centers, etc.), and scenic corridors in the Roanoke Valley. In doing so, the existing resources, deficiencies and opportunities are identified. The complete Project Scope is included in Appendix A.

Note: For bicycle accommodations to be considered as part of roadway improvements using Federal and State funding, the roadway must be included in an approved bikeway plan. The 1997 Bikeway Plan for the Roanoke Valley Area (RVAMPO, 1997) is the approved bikeway document for the MPO, thereby fulfilling this requirement. As such, the 1997 Bikeway Plan should be referenced when specific roadways are cited for bicycle accommodations. Phase I of the Regional Bicycle Suitability Study is not intended to supercede or replace the 1997 Plan in this capacity. Instead it should complement the efforts and goals of the 1997 Plan and facilitate the provision of bicycle accommodation in the MPO.

Study Area

The study area includes the urbanized portions of Botetourt and Roanoke counties, the cities of Roanoke and Salem, and the town of Vinton. Work products developed from the *Regional Bicycle Suitability Study* will be applicable and available for use by all localities in the region, as outlined in the *Unified Transportation Work Program*. Work products developed in Phase I of the study will be incorporated into the *Rural Transportation Planning Program* in Phase II.

Project Goal

The primary goal of the study is to provide planners, transportation engineers, bicycle coordinators and enthusiasts, and citizens, tools and data for use in developing facilities and other accommodations to enhance safe bicycle travel within the MPO. Data and tools developed as part of the study are useful in identifying current and future problems facing the bicycling public, facilitating the planning and design of a bicycle-friendly transportation system, and determining possible options regarding operational and design requirements for new facilities.

Work Products

Study findings and work products are available to localities in the region, and can be easily incorporated in the development of regional and local plans. Work products developed in Phase I of the study include the following ***planning level data and tools***:

- Bicycle Compatibility Index (BCI) and Bicycle Level of Service (BLOS) model worksheets for level of service calculations;
- Planning committee to facilitate effective application and use of study end products in future bicycle facility planning and design;
- Detailed analysis and summary of survey responses;
- Prioritized lists of routes, corridors, destinations, and activity centers to be connected via a significant regional bicycling network;
- Maps of existing and proposed bicycle facilities, and other spatial data relevant to the study;
- Review of existing conditions and opportunities, and obstacles in creating a more bicycle-friendly transportation network;
- Overview of local, regional, state, and national bicycle facility planning efforts;
- Trained data collectors to assist in BCI and/or BLOS modeling;
- Bicycle facility design workshop;
- Database of operational and design parameters for roads in the 'study network';
- Regional Bicycle Suitability Study website

Phase II of the *Regional Bicycle Suitability Study* will consist primarily of the application of work products developed in Phase I, as outlined in the FY 2003-2004 *Unified Transportation Work Program.*

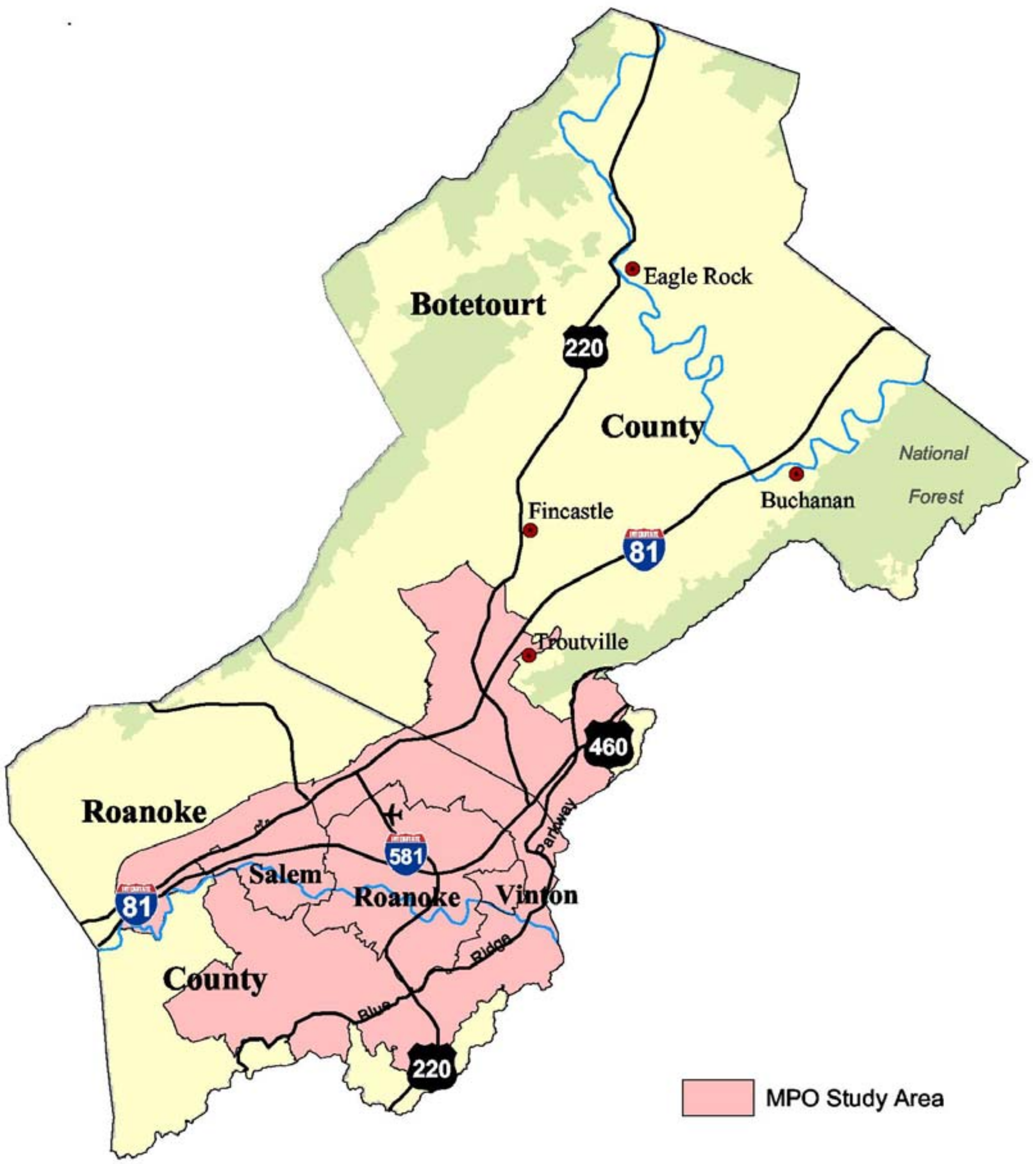


Figure 1.1. Regional Bicycle Suitability Study Area

Regional Cooperation and Public Involvement

Developing a regionally significant bicycling network will require cooperation among the local governments in the MPO and public involvement in the planning process. Working in conjunction with local governments, citizens, VDOT representatives and consultants, Regional Commission staff sought to facilitate and encourage regional cooperation and public input. This section provides brief overview of efforts to achieve Regional Cooperation and Public Involvement.

- **Surveys**

To gain a better understanding of the effectiveness of the bicycle network and the needs of cyclists, RVAMPO staff solicited public comments about cycling in the area via a survey conducted during March and April of 2003. A copy of the survey is included in Appendix B. The survey provided an opportunity for citizen input and involvement in the study. The level of survey responses was impressive, not only in number, but also in the quality of the information yielded. A complete overview of the survey and a detailed analysis of survey responses are presented in Chapter 2 and Chapter 5, respectively. The survey will continue to be available on the Regional Commission's website (http://www.rvarc.org/bike/home.htm) and analysis will be updated as additional surveys are received.

- **Regional Bicycle Suitability Study Planning Committee**

As part of the study, a planning committee, composed of interested stakeholders, was established to assist in various aspects of the study. Representation from a varied cross-section of stakeholders was sought in selecting members. The planning committee is composed of Regional Commission staff, local planning and traffic engineering staff, Greenway representatives, VDOT representatives, bicycling advocates, and citizens. The committee will continue to assist in the development of a regionally significant bicycling network by guiding the application of work products in Phase II, facilitating continued regional cooperation in bicycle facility planning, and data collection.

- **Data Collection Training Seminar**

Several models have been developed to evaluate the level of service (LOS) offered by existing roadways or proposed bicycle facility improvements. Of these models the BLOS and BCI are widely accepted models for bicycle level of service calculations. Although each model has advantages and disadvantages, the data requirements are similar. As consistency in data collection is imperative for valid results, trained data collectors will assist Regional Commission staff in collecting data and modeling the study network. The Regional Commission also hosted a training seminar to provide instruction on data requirements and collection methods needed for the each model. The May 28, 2003, training seminar was lead by Toole Design Group of Laurel, Maryland, a consulting firm specializing in bicycle and pedestrian facility design. The seminar was well attended and included Regional Commission staff, planners, traffic/transportation engineers, others involved in bicycle facility planning from localities in the MPO, as well as Greenways and VDOT representatives, and bicycling advocates. Information from the training seminar is included in Appendix C.

- **Bicycle Facility Design Workshop**

Following the training seminar, the Regional Commission hosted a bicycle facility design workshop. The workshop was open to all stakeholders and interested citizens and was advertised through articles in the *Roanoke Times*, flyers distributed to all area bike shop and outfitters, and notices to all local governments. The workshop provided a general overview of bicycle facility design and planning and served as a forum for discussion of bicycling related issues in the Roanoke Valley. Examples of bicycle-friendly communities throughout the United States were also presented and discussed. Although attendance was less than anticipated, those present engaged in a constructive and thoughtful discussion of bicycling in the area and provided useful feedback to be incorporated in the planning process. To accommodate those who were not able to attend the workshop, material was made available on the *Regional Bicycle Suitability Study* homepage (http://www.rvarc.org/bike/home.htm). Workshop material is also included in Appendix C.

Coordination with Regional Greenways and Public Transit

A regionally significant bikeway network in the MPO will include the Roanoke Valley Greenway system and public transit system. The greenway system is an integral component of the recreational infrastructure in the area, providing open and recreational space for Roanoke Valley residents. Review of the *Conceptual Greenway Plan* shows the greenway system is also a potentially integral component of a regionally significant bicycling network by providing linkages and connectivity. As such, the bicycling survey sought to solicit information on the use of greenways for bicycling purposes. To accomplish this task, several greenway-related questions were included in the survey. Additional information regarding Roanoke Valley Greenways is available at http://www.greenways.org/.

As the federally designated transportation planning agency for the Roanoke urbanized area, the RVAMPO is responsible for developing the *Long Range Transportation Plan* (LRTP) and the *Transportation Improvement Program* (TIP). The federal Transportation Equity Act for the 21st Century (TEA-21), enacted in 1998, calls for integrating all modes of transportation - cars, buses, trains, trucks, walking and biking - into a single, multi-modal, efficient transportation system. Multimodalism is an important concept in the integration of all modes of transportation. The *Regional Bicycle Suitability Study* attempts to understand the relationship between bicycling and public transit in the area, both of which are important components of multi-modalism. To facilitate this understanding, the bicycling survey also incorporated several transit-related questions. Further discussion of the relationship between greenways, public transit, and bicycling facilities is included throughout the study. Additional information on Valley Metro, the Roanoke Valley's public transit provider, is available at http://www.valleymetro.com/home.htm.

Benefits of Bicycling

There are numerous benefits associated with bicycling. Bicycling offers health and fitness benefits through increased exercise; environmental benefits through reduced vehicular emissions; and transportation benefits by providing an alternative transportation option to the automobile.

Health and Physical Fitness Benefits

According the Office of the Surgeon General (Office of the Surgeon General, 2003), more Americans than ever before are overweight or obese. The Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity lists the following facts about overweight and obesity from 1999:

- 61% of adults in the United States were overweight or obese (BMI > 25) in 1999.
- 13% of children aged 6 to 11 years and 14% of adolescents aged 12 to 19 years were overweight in 1999. This prevalence has nearly tripled for adolescents in the past 2 decades.
- The increases in overweight and obesity cut across all ages, racial and ethnic groups, and both genders.
- 300,000 deaths each year in the United States are associated with obesity.
- Overweight and obesity are associated with heart disease, certain types of cancer, type 2 diabetes, stroke, arthritis, breathing problems, and psychological disorders, such as depression.
- The economic cost of obesity in the United States was about $117 billion in 2000.

The causes of overweight and obesity in Americans are varied and include of a combination of genetic, metabolic, behavioral, environmental, cultural, and socioeconomic factors. Of these factors, behavioral and environmental factors provide the greatest opportunity for actions and interventions designed for prevention and treatment. Increased physical activity is an effective way to address these factors. The Surgeon General recommends Americans accumulate at least 30 minutes (adults) or 60 minutes (children) of moderate physical activity most days of the week (Office of the Surgeon General, 2003).

Incorporating bicycling into everyday life is an easy way to increase physical activity. The Centers for Disease Control states, "the most effective activity regimens may be those that are moderate in intensity, individualized, and incorporated into daily activity" (Centers For Disease Control, 2003). The 1995 *National Personal Transportation Survey* (NPTS) found that approximately 40 percent of all trips are less than 2 miles in length, a distance that can be easily traveled on a bicycle. Bicycling to work, school, shopping, or elsewhere as part of one's regular day-to-day routine can be both a sustainable and a time-efficient exercise regimen for maintaining an acceptable level of fitness.

Environmental Benefits

Bicycling does not generate the numerous pollutants that automobiles produce and emit into the atmosphere during the combustion process. Vehicular emissions reduce air quality and have been shown to have adverse environmental and health effects. In an effort to address air quality, in 1990 Congress amended the Federal Clean Air Act, a comprehensive law that regulates airborne emissions from area, mobile, and stationary sources nationwide. This law authorizes the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment. The EPA currently has two NAAQS for ozone, the 1-hour peak standard and 8-hour standard. Areas formally declared in violation of the NAAQS and adjacent contributing areas are designated as "non-attainment areas" and as such, have to meet certain Clean Air Act requirements as mandated in the legislation.

Currently, ground-level ozone concentrations in the Roanoke Metropolitan Statistical Area (MSA) exceed the 8-hour ozone standard. The RVAMPO and the EPA signed an *Early Action Compact* (EAC) in December 2002, to address reduction of ozone levels by 2007. The EAC postpones the effective date of non-attainment while allowing the RVAMPO to create and implement air quality improvement strategies, such as reducing mobile sources of pollution. Failure to reduce ozone levels to standards set by the EPA will result in immediate reversion to the traditional non-attainment process.

Measures to increase the use of non-polluting transportation, such as bicycling and walking, are effective ways to aid compliance with the 8-hour ozone standard. Using a bicycle instead of a car whenever possible reduces the amount of daily pollutants produced and released into the atmosphere, leading to improved air quality and a reduction in associated adverse health effects.

Transportation and Economic Benefits

Improved bicycle facilities would likely increase the usage of bicycling as a means of transportation, while giving those who do not drive or own a car more transportation options. Recent national and local surveys have found that people are more willing to bicycle, and do so more frequently, if better bicycle facilities were available. A 1995 Rodale Press survey found that 40 percent of U.S. adults would commute by bike if safe facilities were available.

If more people shift to bicycles for their entire trip, or to a transit station, the transportation system would be able to have a higher capacity without increasing congestion or emissions. Significant economic savings could be realized through a reduction in the need for transportation improvements to accommodate more automobiles, reduced congestion and emissions, and health care savings. The cumulative effect of the benefits of increased bicycling would serve to increase the overall quality of life and would far exceed the costs associated with bicycle facility improvements. However, before this shift can occur, and the associated benefits fully realized, a bicycle-friendly transportation infrastructure must be developed on a regional basis to not only meet existing demands, but also to encourage and facilitate bicycling as a viable means of transportation in the Roanoke Valley.

Establishing a Regional Bicycling Network

In developing a regionally significant bicycling network, the Roanoke Valley shares many of these opportunities and constraints with other regions throughout the state and nation. Building on the opportunities and overcoming the constraints, however, will require addressing the specific characteristics of the Roanoke Valley. If successful, the region will be able to take advantage of bicycling as a useful and environmentally sensitive form of transportation and recreation.

Development of a bicycling network will require coordination and cooperation among all stakeholders in the study area. As a geographic region composed of several jurisdictions, Roanoke Valley governments should coordinate bicycle facility improvements to ensure that travel corridors are consistent in and between jurisdictions in the study area. The goal of the *Regional Bicycle Suitability Study* is to facilitate the planning process by providing planning level data and tools for use in developing a bicycling network. End products will assist stakeholders in establishing consistency and connectivity along travel corridors, developing crucial linkages with the greenway system and public transit, and developing other components of a regional bicycling network.

Bicycle Safety

In developing a regional bicycling network and encouraging bicycling as a viable means of transportation, bicycle safety should be given proper attention and consideration. Unsafe bicyclist behavior, in addition to unsafe driver behavior, can contribute to bicycling accidents. Numerous examples of unsafe bicyclists behavior were noted in the study area. Such behavior may be the result of bicyclists not being aware of, or understanding, bicycling and traffic laws and bicycle safety precautions relating to bicycling. Education and safety training are often effective in addressing bicycle safety concerns. Education and safety training can assist in reducing bicyclist and pedestrian injuries, reducing conflict between the various transportation modes, facilitate understanding, obeying, and enforcement of traffic and bicycling laws, and ensure that facilities are properly designed and built. Education and safety training should be comprehensive include components for cyclists, pedestrians, motorists, police officers, and engineers and planners. Bicycle safety material, developed by the FHWA, is available Online at http://www.fhwa.dot.gov/safety/pedbike/univcourse/swintro.htm.

Bicyclist riding on sidewalk along Church Street in downtown Roanoke.

Bicyclist riding against the flow of traffic.

Table 1.1 lists the total reported accidents involving a bicycle in the study area from 1997-2001. During this four-year period a total of eight (8) accidents involving a bicycle were reported. Figure 1.2 shows the distribution of these accidents with the study area. All accidents occurred along portions of US 460 and US 11. It should be noted that three of the accidents occurred during darkness, and another at dawn, indicating that lack of light possibly contributed, in part, to these accidents.

Table 1.1
Reported Accidents Involving a Bicycle in the Study Area from 1997-2001

Accident Number *	Route Name	Jurisdiction	Number of Lanes	Configuration	Weather Conditions	Pavement Conditions	Lighting	Collision Type
1	US 460	Roanoke	3	Two-way, non-divided	Clear	Dry	Darkness - Street or Highway Lighted	Angle
2	US 460	Roanoke	3	Two-way, non-divided	Cloudy	Dry	Darkness - Street or Highway Lighted	Angle
3	US 460	Roanoke	4	Divided, no control of access	Cloudy	Wet	Daylight	Sideswipe - Same direction of travel
4	US 11	Roanoke	4	Divided, no control of access	Cloudy	Dry	Dawn	Angle
5	US 11	Botetourt	2	Two-way, non-divided	Clear	Dry	Daylight	Sideswipe - Same direction of travel
6	US 11	Roanoke	4	Two-way, non-divided	Clear	Dry	Darkness - Street or Highway Lighted	Angle
7	US 11	Botetourt	4	Two-way, non-divided	Clear	Dry	Daylight	Angle
8	US 460	Roanoke	3	Two-way, non-divided	Cloudy	Other	Daylight	Angle

*Corresponds to accident number on Figure 1.2
Source: Virginia Department of Transportation

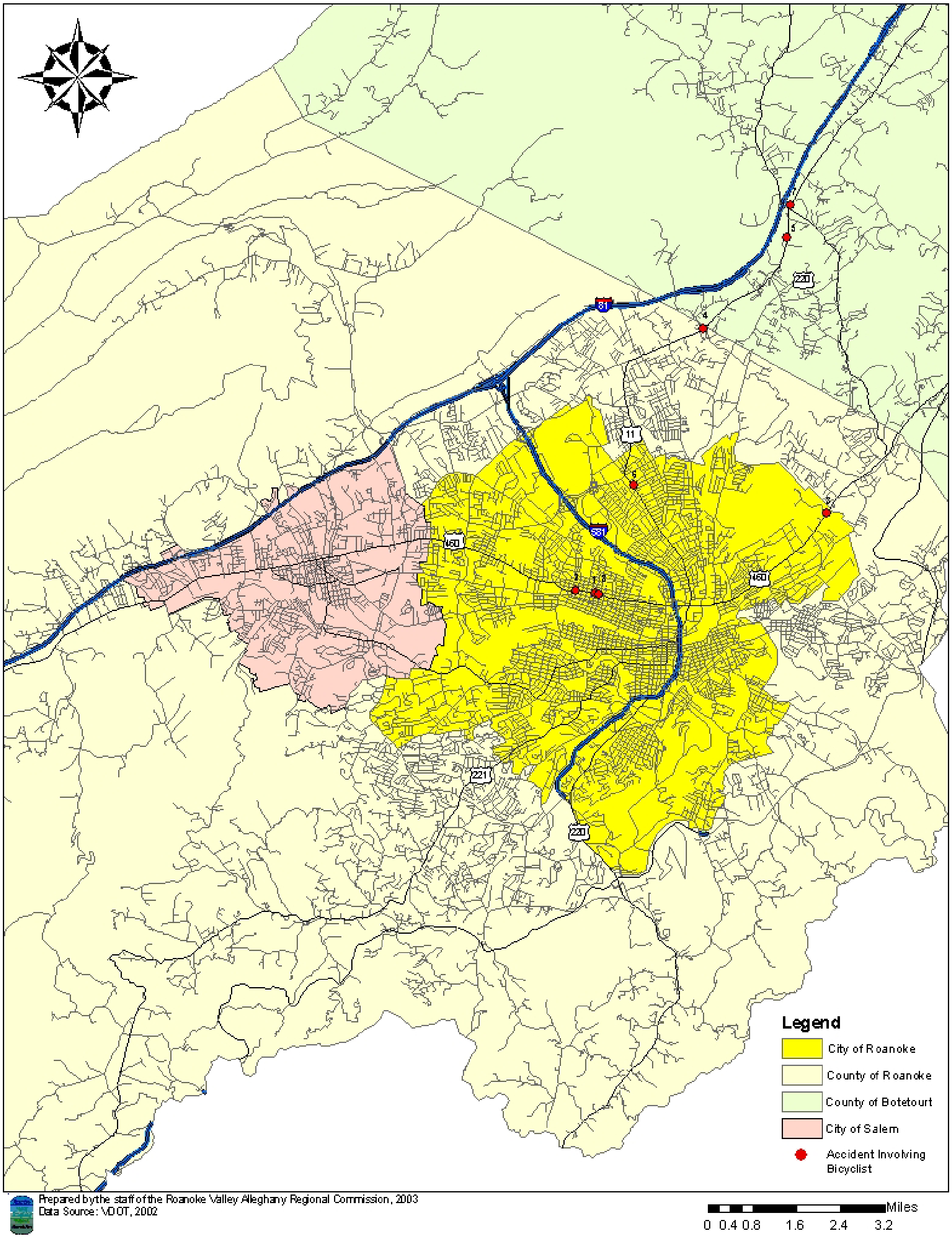


Figure: 1.2: Accidents Involving a Bicycle in the Study Area, 1997-2001

The *Fiscal Year 2003 Unified Planning Work Program* included a Bicycle Suitability Study element. As outlined in the project objective and description listed in the work program, the primary purpose of the study was to develop a methodology to evaluate the existing roadway network to determine what is considered user-friendly from the perspective of the bicyclist. Working from the objective and description, Regional Commission staff met with local governments to develop a project scope framework to accomplish this goal. The complete Project Scope for the *Regional Bicycle Suitability Study* is provided in Appendix A.

> ***Objective and Description:*** The primary goal of the RVAMPO bike plan is to develop or improve roadways for shared use by both motor vehicles and bicycles. To develop or improve roadways for shared use by these two modes of transportation, one must begin by evaluating existing roadways and determining what is considered user-friendly from the perspective of the bicyclist. In this task, an evaluation of the existing regional roadway network will be made in an effort to identify current and future problems facing the bicycling public. In doing so, the evaluation will also be able to be used to determine possible improvements and to determine operational and geometric requirements for new facilities. Most likely, this effort will involve the use of existing methodologies developed by FHWA to accomplish its goals.

Project Assistance

Toole Design Group of Laurel, Maryland, a consulting firm specializing in bicycle and pedestrian facility design, was contracted to assist Regional Commission staff with development and completion of various components of the study. Assistance included:

- Project development
- Data collection training seminar
- Bicycle facility design workshop
- Follow-up consultation during data collection and modeling process

Data Sources and Collection

Data regarding various cycling-related issues relevant to the study were gathered by a combination of primary and secondary data collection methods. In the data collection process, Regional Commission staff collected, compiled and analyzed primary data from several sources, including:

- A bicycling survey distributed and made available to selected groups;
- Fieldwork to collect data needed for level of service calculations in the initial study network; and
- Planning Committee input.

Secondary data sources included a wide variety of local, state, and federal data sets, publications, and online resources. These data were located, reviewed and incorporated, when appropriate, in the development and completion of the Regional Bicycle Suitability Study. Secondary data sources included:

- Census Transportation Planning Package (CTPP)
- US Census Bureau
- State Highway Planning System (SHiPS)
- Local comprehensive plans
- Regional plans
- State and federal publications
- Online resources and documents
- Consultants

Bicycling Survey

To gain a better understanding of the effectiveness of the bicycle network and the needs of cyclists, RVAMPO staff solicited public comments about cycling in the area via a survey conducted through March and April of 2003. The bicycling survey contained 25 questions that can be grouped, as follows, based on the information they were design to solicit:

- Questions to better understand the cycling characteristics and habits of bicyclist in the study area;
- Questions to better understand the relationship between bicycling, the greenway system, and the public transit system; and
- Questions to delineate the initial study network to be modeled in Phase I.

Chapter 6 presents a detailed analysis of the survey responses and a copy of the survey is included in Appendix B.

- **Distribution of Survey to Target Groups**

Based on the project scope, length of survey, analysis limitations, associated costs and other factors, distribution of surveys was not based on a random sampling of the MPO population. Focus groups were selected based on the data requirements needed to develop the study network. Regional Commission staff selected focus groups likely to have the most relevant information about bicycling conditions and needs in the region. Focus groups included the Blue Ridge Bicycling Club, Greenway Commission, Pathfinders, local planning, recreation, and traffic engineering departments, other bicycling clubs, organizations and advocacy groups.

Given that many questions in the survey required a certain level of familiarity with the existing network, the largest focus group consulted was the bicycling community. To solicit input from a large portion of this community, material explaining the study was distributed to members of the Blue Ridge Bicycling Club (BRBC), via a mailing list supplied by the BRBC. This material included a cover letter, a bicycling survey, and a self-addressed, stamped envelope to encourage survey returns. Surveys were also distributed to all area bicycle shops and, when possible, surveys were distributed to individual cyclists in the area. Surveys were advertised through several mediums including the BRBC newsletter and the Bike Virginia and East Coasters listserves. Additionally, the survey is available to all members of the general public on the *Regional Bicycle Suitability Study* homepage (www.rvarc.org/bike/home.htm) in an on-line form.

Other stakeholder groups also had opportunities to provide input. The survey was distributed to all members of the Roanoke Valley Greenway Commission and Pathfinders for Greenways members, a greenways advocacy group, for completion. In an effort to facilitate coordination with the regional greenway plan, several of the Greenway Commission members also serve on the *Regional Bicycle Suitability Study* Planning Committee. Surveys were sent to all local planning, traffic engineering, and recreation departments for completion and distribution to interested parties.

As previously referenced, an online version of the survey is posted on the Regional Commission's web page. This version can be completed and submitted online by any interested party. Additionally, an effort was made to distribute a survey to any person seen cycling in the area that may not be affiliated with a bicycling club or organization. It is hoped that these combined efforts offered all stakeholders sufficient opportunity to provide input concerning bicycling in the Roanoke Valley.

Data Collection Training

A major source of primary data was roadway operational and geometric measurements obtained through fieldwork. The Regional Commission hosted a training seminar to provide instruction on data requirements and collection methods needed for both the BCI and BLOS models. Following completion of the training seminar, staff collected data required for both the BCI and BLOS models for the initial study network. Material from the data collection training seminar is included in Appendix D.

Review of Relevant Material

In completing this study numerous publication and data sources were utilized. A major part of the methodology involved researching and reviewing literature, data sources and other information relevant to the various components of the study. Information from this review was especially useful in study preparation, and compilation of an inventory of existing and planned bicycle facilities the region. Additionally, information from a variety of sources is incorporated or referenced throughout the study. As part of the panning level data developed from this study, a complete listing of all reference documents is provided in the bibliography.

- **Level of Service (LOS) Models**

In developing a regional bicycling network, one of the first steps in the process is to evaluate the existing roadways in terms of bicycle-friendliness. An objective evaluation of the existing roadway network is useful in identifying current and future problems facing the bicycling public. Commission staff reviewed literature regarding existing bicycle level of service methodologies to assist in selecting the methodology most applicable to the study. Additionally, Toole Design Group provided summaries of the two models currently in use, the Bicycle Compatibility Index (BCI) model and the Bicycle Level of Service (BLOS) model, to the Planning Committee as part of the data collection training seminar. A detailed overview of the BCI and BLOS models is provided in Appendix C and on the *Regional Bicycle Suitability Study* homepage (www.rvarc.org/bike/home.htm).

- **Local and Regional Planning Documents**

Another step in developing a regional bicycling network is to conduct an inventory of existing resources and planned improvements. Commission staff reviewed all local and regional planning documents (e.g. comprehensive plans, MPO plans, bike plans, greenway plans, etc.) and noted any references to existing or future bicycle facilities, or related infrastructure. An overview of existing conditions is presented in Chapter 4 and a summary of bicycling related references from local comprehensive plans is provided in Appendix E.

- **State and Federal Data and Publications**

Commission staff also consulted numerous useful bicycle-related publications and data sets in completing this study. Many of these documents and data are maintained and housed as reference material in the Regional Commission library. Additionally, many of these and other publications are available on the Internet. Of special interest to this study is the memorandum concerning VDOT Policy Relative to Bicycle Facilities. This memorandum is included in Appendix F.

- **Online Resources and Documents**

A tremendous amount of bicycling information is available online and was a major source of secondary data utilized in the study. Information available at government and private websites was useful in development of this study and the data collection process. Additionally, Commission staff developed a *Regional Bicycle Suitability Study* homepage, containing information from the study and other resources. A detailed list of all data sources, and other online resources is included in the bibliography. Additionally, links to useful websites are provided on the study homepage.

Bicycle Facilities

The AASHTO *Guide for the Development of Bicycle Facilities* defines bicycle facilities as a general term denoting improvements and provisions made by public agencies to accommodate or encourage bicycling. This term encompasses a wide variety of potential improvements including bike lanes, shared roadways not specifically designated for bicycle use, and parking and storage facilities. Facility design will vary based on numerous considerations including the anticipated use of the facility, the environment in which it is to be built (e.g., on-street or off-street, urban or rural), and consideration of numerous local conditions and factor. This chapter provides a brief overview of bicycle facility design and the factors affecting bicycle accommodation on roadways. Dimensions listed in diagrams in this chapter are general minimum recommendation based on literature reviewed and referenced, and are intended for illustrative purposes only. Dimensions listed do not constitute design standards, specifications, regulations or recommendations to be applied to specific corridors or streets in the study area. AASHTO, VDOT, and other agencies and organization have developed reference material to assist planners, engineers, and bicycle advocates in developing and applying design criteria most applicable to local conditions and place-specific considerations. Individuals involved in the planning and design of bicycle facilities should consult the following publications for guidance and detailed information regarding bicycle facility design guidelines:

- *VDOT Road Design Manual*, Section A-5-Bicycle Facility Guidelines, 2001
- *Guide for the Development of Bicycle Facilities*, AASHTO, 1999

Other useful publications are also available and include the following:

- *Selecting Roadway Design Treatments to Accommodate Bicycles*, FHWA, 1994
- *Manual on Uniform Traffic Control Devices*, FHWA, 2000
- *Virginia Bicycle Facility Resource Guide,* VDOT, 2001

A full listing of all reference documents used in completing this study is listed in the bibliography. Additionally, links to many of those documents and other useful bicycling related websites are provided on the *Regional Bicycle Suitability Study* homepage (www.rvarc.org/bike/home.htm).

There are numerous variables to be considered in planning and developing a regionally significant bicycle network. These factors, in part, dictate the types of bicycle facilities needed in development of a bicycle network. Major factors to be considered in the planning process include:

- Environment
- User groups
- Bicycle facility types
- Ancillary facilities

Environment

The environment, or setting, is a major factor dictating the facility type(s) best suited for a particular location. Broadly, bicycling environments can be classified as urban, suburban, and rural. On the regional level, all of these settings may be present, necessitating the use of different facilities or treatments in developing of a regional bicycle network.

Bicycle facilities in an urban environment, with higher density and shorter distance between destinations, have the greatest potential for promoting bicycling as a means of transportation by creating a safe network of routes to activity centers. In suburban setting, with less density and greater distance between destinations, bicycle facilities should be developed to link residential areas and activity centers, as well as to provide recreational bicycling opportunities. Primarily recreational cyclists with significant cycling experience use rural roadways. As such, facilities in a rural environment should provide recreational opportunities on low-volume rural roadways.

User Groups

The target users of a bicycle facility are also important factors to consider in the planning and design of a regional bicycle network. To assist in determining the impact of different facility types and roadway conditions on bicyclists, user groups have been defined. American Association of State Highway and Transportation Officials (AASHTO) has developed the following definitions for each user group:

- Group A

Advanced or experienced riders generally using their bicycles as they would a motor vehicle. They are riding for convenience and speed and want direct access to destinations with a minimum of detour or delay. They are comfortable riding with motor vehicle traffic; however, they need sufficient operating space on the traveled way or shoulder to eliminate the need for either themselves or a passing motor vehicle to shift position.

- Group B

Basic or less confident adult riders using their bicycles for transportation, but prefer to avoid roads with fast and busy motor vehicle traffic unless there is ample roadway width to allow easy overtaking by faster motor vehicles. Thus, basic riders are comfortable riding on neighborhood streets and shared used paths and prefer designated on-road facilities such as bike lanes or wide shoulders.

- Group C

Children, riding on their own or with their parents, may not travel as fast as their adult counterparts but still require access to key destinations in the community, such as schools, libraries, parks, and recreational facilities. Residential streets with low motor vehicle speeds, linked with shared used paths and busier streets with well-defined pavement markings between bicycles and motor vehicles, can accommodate children without encouraging them to ride in the travel lane of major arterials.

Bicycle Facility Types

The choice of facility type is dependent upon several factors including an examination of the environment, the targeted user group, corridor conditions and facility cost. The two major bicycle facility categories are on-street and off-street. The *Guide for the Development of Bicycle Facilities*, developed by AASHTO provides detailed information on many of the common facility types and should serve as reference in facility design.

On-Street Bicycle Facilities

On road facilities are an important part of any bicycling network. *The Virginia Bicycle Facility Resource Guide* states:

> On-street bicycle facilities have the most potential in providing key connections in a bicycle network because of traditional development patterns most communities have undergone. Generally, the most critical variable affecting the ability of a roadway to accommodate bicycle traffic is width. Sufficient roadway width significantly dampens the impacts of adjacent traffic characteristics (i.e., traffic volumes, travel speeds, heavy vehicles) on the bicyclists. Adequate roadway width for bicycle travel may be achieved by providing paved shoulders, wide outside lanes, or bike lanes.

It is important to remember that on-road facilities are either shared with, or in close proximity to, vehicular traffic and therefore some facilities may not be suitable for all classes of cyclists. In certain cases, any increase in roadway width would benefit the cyclist by providing additional separation from passing motorists. Additionally, other geometric and operational design changes may be employed to decrease traffic speed (i.e., traffic calming, narrowing travel lanes), thereby increasing the comfort level of cyclists using certain corridors. These treatments are especially applicable in residential areas with low traffic volumes and urban areas with slower travel speeds. Any on-street treatment designed to better accommodate bicyclists should be applied based on location-specific analyses of roadway characteristics and geometric and operational design parameters.

- **Shared Roadway**

A shared roadway is a roadway that is open to both bicycle and motor vehicle travel. This may be an existing roadway with no bicycle accommodations, a street with wide curb lanes, or road with paved shoulders.

- **Wide Outside Lane** (Wide Curb Lane)

Wide outside lanes are outside vehicle travel lanes that provide adequate width for both motor vehicle and bicycle travel. Wide outside lanes have no stripes to delineate a separate lane for bicycles. Typical users on this type of treatment include Group A and B bicyclists. Wide outside lanes are best suited for urban and suburban environments.

The minimum recommended standard for wide outside lanes is 14 feet of usable lane width (Figure 3.1). Usable width is defined from edge stripe to lane stripe or from the longitudinal joint of the gutter pan to lane stripe. The gutter pan should not be included as usable width. The *Virginia Bicycle Facilities Resources Guide* suggests that a slightly wider outside lane width (i.e., 15 feet) may be necessary under the following conditions:

- on stretches of roadway with steep grades where bicyclists need more maneuvering space
- adjacent to on-street parking where hazardous conditions for passing bicyclists exist
- where drainage grates and raised reflectors reduce the effective width of the outside lane

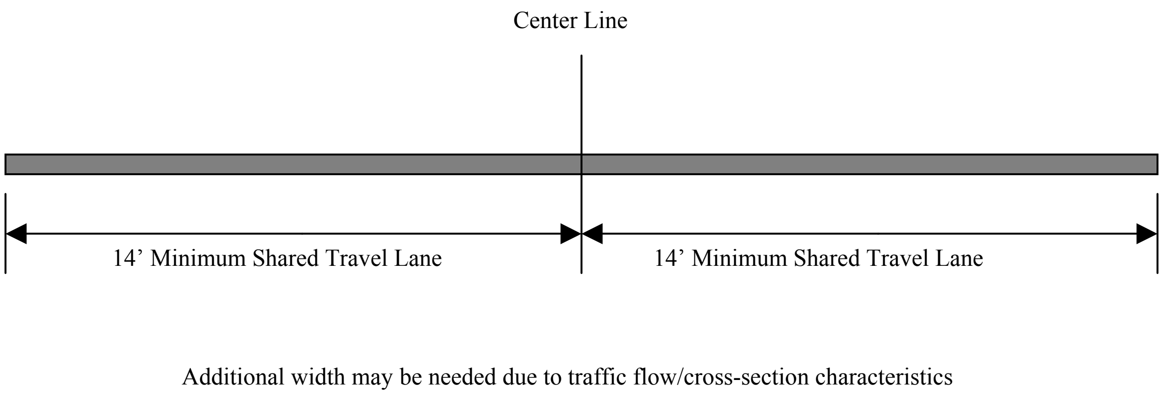


Figure 3.1: Wide Outside Travel Lane

- **Paved Shoulder** (Shoulder Improvements)

Shoulder improvements are often effective in accommodating bicycle travel on a shared roadway. However, in order for paved shoulders to be effective in accommodating bicyclists they need to be uniform, smooth, and well maintained. A shoulder with a minimum width of 4 feet is recommended for bicycle travel. However, in areas where side obstructions are present at the right side of the roadway, such as guardrails, barrier curbing, utility poles and other static obstructions a paved shoulder width of 5 feet is recommended. Additional shoulder width may also be appropriate under the following conditions:

- high bicycle usage is expected
- motor vehicle speeds exceed 50 mph
- steep grades are present (bicycles need additional width when traveling uphill)
- the percentage of trucks, buses, and recreational vehicles is high

Paved shoulders are best suited for Group A bicyclists in suburban and rural environments. Depending on adjacent traffic characteristics and the uniformity of the treatment, this improvement may accommodate Group B bicyclists as well. In cases where 4-foot widths cannot be achieved, any additional shoulder width is better than none at all. In addition to accommodating bicyclist, paved shoulders also provide additional maintenance and safety benefits such as pull over areas, recovery areas, and increased pavement structure durability.

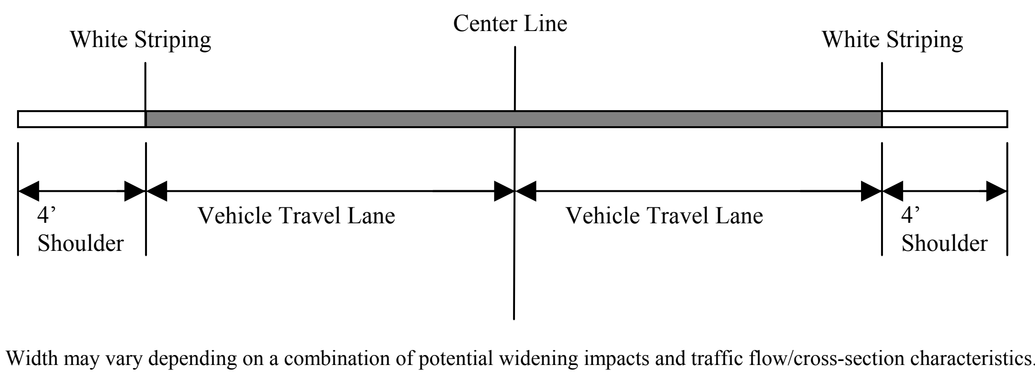


Figure 3.2: Paved Shoulder

- **Bike Lane**

A bike lane is a portion of a roadway, which has been designated by striping, signing and pavement markings, for the preferential or exclusive use of bicyclists. Given that bike lanes are part of the roadway, thus in close proximity to traffic flow, they are best suited for Group A and B users. However, under certain conditions, they may accommodate Group B/C bicyclists. Bike lanes are best suited for urban and suburban environments where there is significant bicycle demand.

The minimum recommended bike lane width is 4 feet (Figure 3.3). Certain edge conditions, such as on-street parking, curbing, guardrail, and longitudinal joints dictate additional bike lane width (Figure 3.4). The *Virginia Bicycle Facility Resource Guide* recommends the following minimum widths for bicycle lanes:

- 4-foot minimum for bike lanes on roadways with gutter pan and curb
- 5-foot minimum for bike lanes adjacent to barrier curb or other static side obstruction
- 5-foot minimum for bike lanes with adjacent on-street parking
- 6-foot bike lanes are desirable where substantial truck traffic is present or where motor vehicle speeds exceed 50 mph

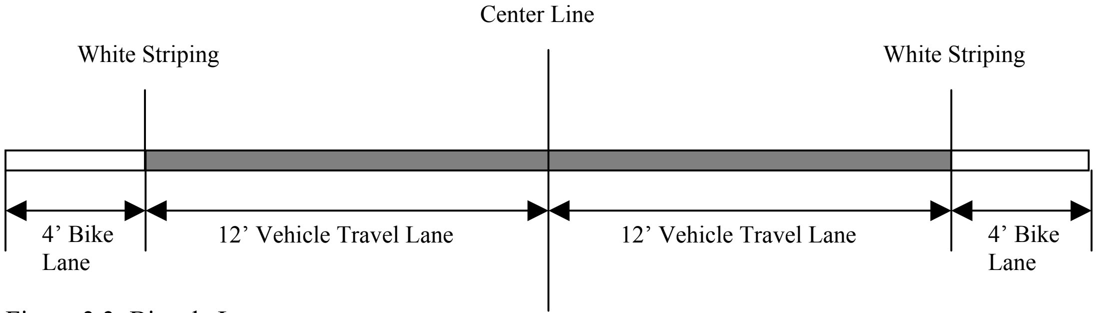


Figure 3.3: Bicycle Lane

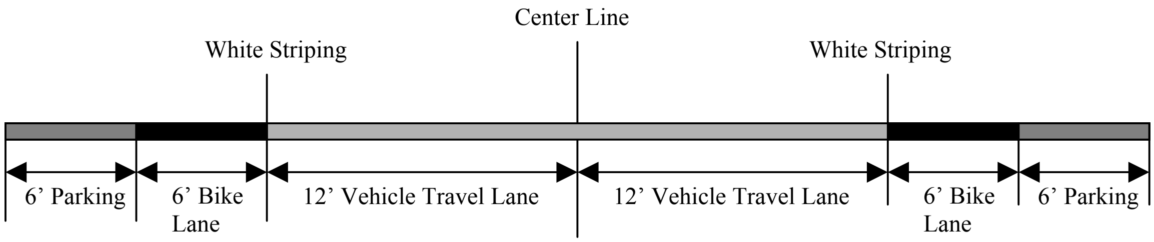


Figure 3.4: Bicycle Lane with Parking

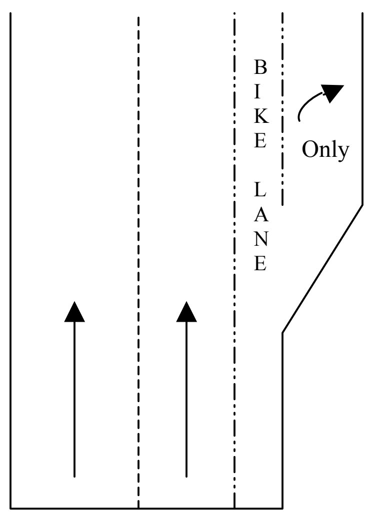


Figure 3.5: Right Turn Bike Lane

Because of their pavement markings, bike lanes, along with compatibility maps to be produced in Phase II of this study, can be an effective means of encouraging bicyclists to use particular corridors in lieu of others. Bike lanes may also increase bicycle usage by tapping into any latent demand among the general public.

Considerable debate exists over the effectiveness use of wide curb lanes (WCL) versus bike lanes (BL) in accommodating both bicyclists and motorists. *A Comparative Analysis of Bicycle Lanes Versus Wide Curb Lanes: Final Report*, developed by the FHWA, provides a summary of current research into the operation and safety of these two bicycle facility types. The final report states "the destination patterns of bicyclists traveling through the project sites led to maneuvers and conflicts that in many cases would have occurred whether the bicycle facility present was *either* a BL or WCL". The overall conclusion of this research is that *both* BL and WCL facilities can and should be used to improve riding conditions for bicyclists. However, the report also concludes that BLs are recommended, where there is adequate width, in that BLs are more likely to increase the amount of bicycling than WCLs. The complete guidebook is available online http://www.fhwa.dot.gov/tfhrc/safety/pubs/99034/99034.pdf.

- **Signed Shared Roadway** (Signed Bike Route)

A signed shared roadway is a corridor that has been designated, by signing, as a preferred route for bicycle use. The routes may or may not include a variety of different bicycle facilities including paved shoulders, wide outside lanes, and bike lanes. The *Virginia Bicycle Facility Resource Guide* lists several reasons for designating signed bike routes:

- the route provides continuity to other bicycle facilities such as bike lanes and shared use paths
- the road is a common route for bicyclists through a high demand corridor
- in rural areas the route is preferred for bicycling due to low motor vehicle traffic volume or paved shoulder availability
- the route extends along local neighborhood streets and collectors that lead to an internal neighborhood destination such as a park, school, or commercial district

Although these routes may offer advantages over other routes, signed shared routes may not represent ideal conditions for all bicyclists. The signage makes motorists more aware of potential bicycle activity along a particular roadway and heightens the overall presence of bicycling within the corridor.

Off-Street Facilities

- **Shared Use Path**

A shared use path is a bikeway physically separated from motorized vehicular traffic by an open space or barrier. Typical users include Group B and C bicyclists, pedestrians, skaters, wheelchair users, joggers, and other non-motorized users in urban, suburban, and rural environments. Shared use paths should have a minimum width of 10 feet (Figure 3.6). According to the *Virginia Bicycle Facility Resource Guide,* these facilities have been very successful in reintroducing communities to bicycling as a form of transportation and recreation. Shared use paths are often the catalysts for developing a bicycle network connecting a variety of attractions in the community (i.e., activity centers). These paths may serve as important linkages in the bicycling network providing increased connectivity and mobility.

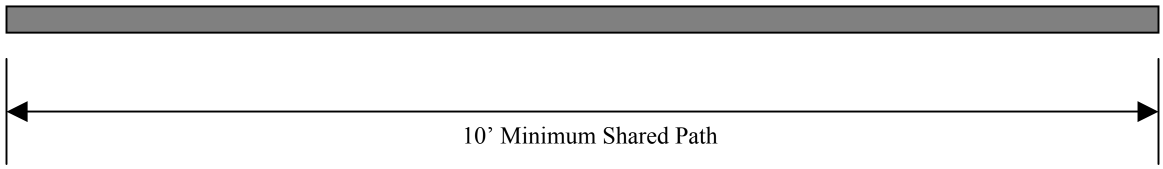


Figure 3.6: Shared Use Path

Ancillary Facilities

Ancillary facilities are the supporting facilities located at the bicyclists’ destination. They are also important components of a bicycle network and contribute directly to the overall success and usefulness of the bicycle system. Ancillary facilities include:

- Bicycle racks
- Bicycle lockers
- Shower facilities
- Water fountains
- Rest areas
- Benches

Existing Conditions

Chapter 3 discussed how the environment and rider skill level (user group), are important factors in determining the most appropriate facility type for a given area or corridor. In Chapter 3, the term environment referred primarily to the built environment, classified as urban, suburban, and rural. However, the decision to use a bicycle for transportation, as well as recreational, purposes can be influenced by numerous factors. These factors include climate/weather, topography, driver attitude toward cyclist, in additional to the existence of bicycle facilities along the network. The purpose of this chapter is to provide an overview of the physical and cultural (i.e., demographic) conditions of the study area and the relationships between the various factors and the decision to use a bicycle for transportation, as well as recreation. A better understanding of these relationships will assist not only in developing a regional bicycling network, but also in promoting bicycling as a safe, efficient, and viable means of transportation in the Roanoke Valley. Additionally, this chapter discusses and evaluates existing bicycle facilities and conditions in the study area.

Overview of the Study Area

The MPO study area covers portions of Botetourt and Roanoke Counties and all of the cities of Roanoke and Salem (Figure 1.1). The study area encompasses approximately 220 square miles. Table 4.1 gives the area of the current MPO study area and the urbanized area, as defined by the US Census Bureau (Figure 4.2). Roanoke County comprises the largest portion, 112 square miles, of the MPO study area. However, only 41 square miles of the county are in the urbanized area, representing less population density and development. This is also the case for Botetourt. Conversely, the cities of Roanoke and Salem, and the town of Vinton are entirely within the MPO study area and urbanized area, indicating higher population densities.

Table 4.1
Physical Area of Study Area by Locality

Area	Botetourt County	Roanoke City	Roanoke County*	Salem City	Vinton Town	Total Area
MPO Study Area – Current** (square miles)	48	43	112	14	3.2	220.2
2000 Census Urbanized Area (square miles)	12	43	41	14	3.2	125.2

Source: US Census Bureau, 2001
*Does not include Vinton
**The MPO study area includes a small portion of Bedford County, which is not included in the Regional Bicycle Suitability Study.

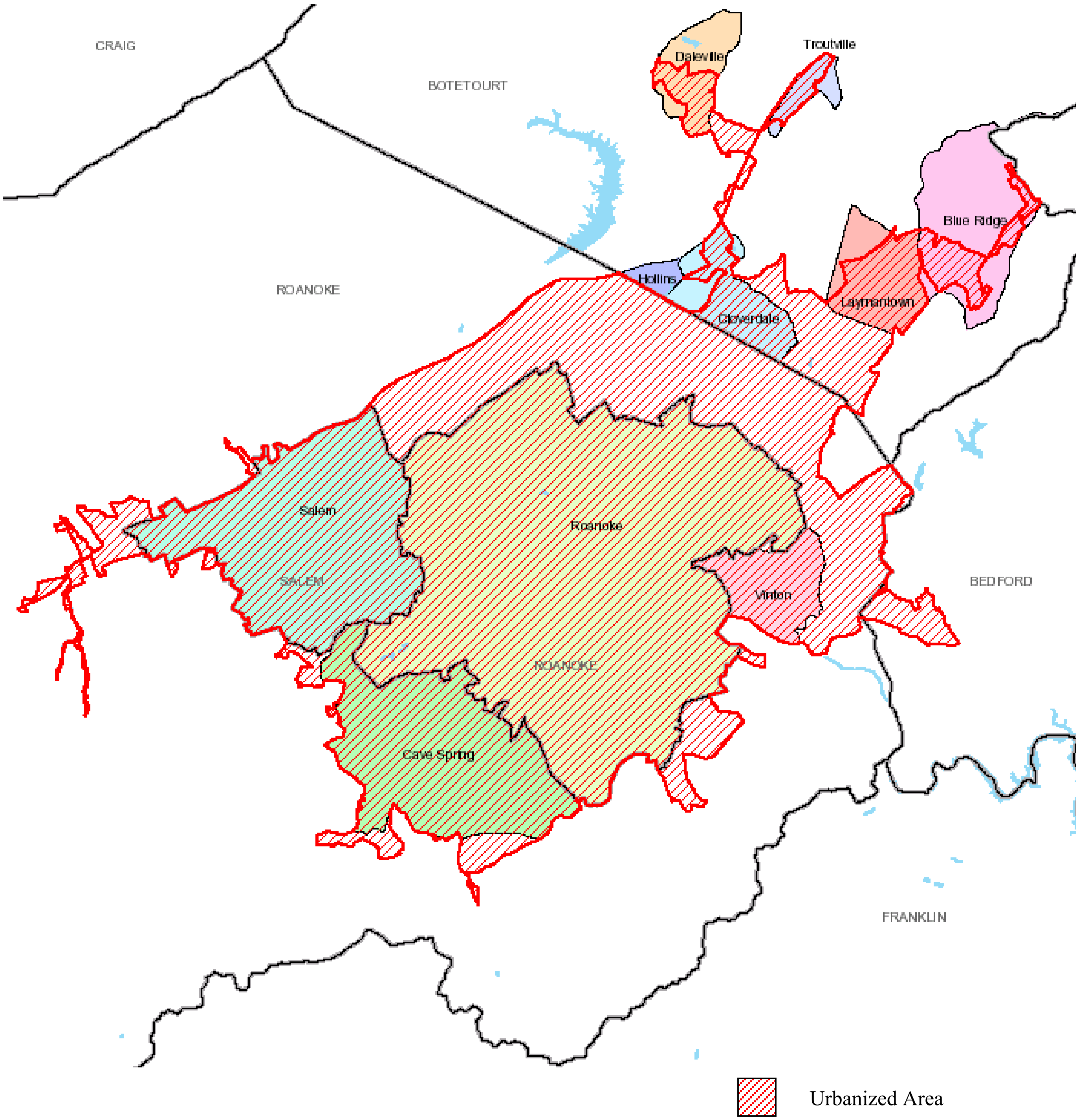


Figure 4.1. Roanoke, Virginia Urbanized Area

As shown in Table 4.2, the population for the study area is approximately 215,433. The urban core of the study area is centered on several population centers located primarily in the cities of Roanoke and Salem and portions of Roanoke County. While the population is still concentrated around these urban centers, it has expanded outward into traditionally rural areas in recent years. The southern end of Botetourt, which is the fastest growing portion of the MPO, is illustrative of this outward growth. Table 4.3 shows that the population of Botetourt and Roanoke County increased by 67.6 and 59.4 percent respectively, since 1970. During this same period, the population of the City of Roanoke declined by 10.2 percent. This represents a continued redistribution of population within the MPO and should be considered in planning efforts. However, the city of Roanoke continues to constitute the largest population and highest density areas of the study area. Given the demographic and socioeconomic characteristics of the study area, development or improvement of bicycle facilities in higher density, urban areas have the greatest potential to benefit the largest number of people. For a detailed discussion of this concept see Pucher and Renne's *Socioeconomics of Urban Travel: Evidence from the 2001 NHTS* available at http://policy.rutgers.edu/papers/14.pdf. Additional information on the National Household Transportation Survey is available at

While the historic areas of the urban core have high density and compact land uses that are relatively easy to serve with transit or bicycles, much of the study area is characterized by low-density land-use patterns. Recreational cyclists seeking to avoid high traffic volumes in the more urbanized portions of the study area often use these rural areas.

Table 4.2
Urbanized Area and MPO Study Area Populations

Area	Botetourt County	Roanoke City	Roanoke County*	Salem City	Vinton Town	Total Population
MPO Study Area – Current**	15,919	94,911	72,074	24,747	7,782	215,433
2000 Census Urbanized Area	9,995	94,911	59,142	24,747	7,782	196,577
1990 Census Urbanized Area	65	96,487	50,485	23,835	7,665	178,537

Source: US Census Bureau, 2000 and 1990
*Does not include Vinton
**The MPO study area includes a small portion of Bedford County, which is not included in the *Regional Bicycle Suitability Study.*

Table 4.3
Population Change for Localities in the Study Area

Area	2000 Total Population	1990 Total Population	1980 Total Population	1970 Total Population	1970-2000 Percent Change
Botetourt County	30,496	24,992	23,270	18,193	67.6%
Roanoke County*	85,778	79,278	72,945	53,817	59.4%
Roanoke City	94,911	96,487	100,220	105,637	-10.2%
Salem City	24,747	23,835	23,958	21,982	12.6%

*includes Vinton
Source: US Census Bureau, 2000 and 1990
* Includes Vinton

The geography of the study area includes mountains, rolling hills, and flat land along river valleys, creating a varied landscape and scenic beauty. While these features provide topographical diversity, it also its presents obstacles to accommodating bicyclists on the roadway system. Steep gradients slow cyclists' speed, and if sufficient passing width is not present, can creating unsafe conditions by causing motorists to encroach into the oncoming traffic lane to pass, or to pass too closely to the cyclists. Steep gradients also present potential safety hazards for inexperienced cyclists and children, by limiting sight distance and increased speed on down hill segments.

Due to its proximity to the Roanoke River and its tributaries, as well as the area's development as a railroad center, there are numerous bridges in the study area. Bridges often present obstacles to safely accommodating motorists and cyclists by creating pinch points and bottlenecks. These obstacles can disrupt traffic flow and present unsafe situations due to insufficient and inconsistent travel lane width created by bridges.

As discussed in Chapter 3, there are numerous treatments available to address steep gradients, insufficient lane width on bridges and other impediments to accommodating bicyclists and motorists. In many cases reconfiguring existing roadways to increase travel lane width is an effective means of better accommodating bicyclists and mitigating potential hazard.

Climatic and, more specifically, weather conditions that predominate in an area can influence bicycle usage for both transportation and recreation. Given the geographic location of the region the climate is classified as humid subtropical. The humid subtropical climate type is generally typified by ample precipitation distributed evenly throughout the year, generally mild temperatures and high humidity. However, the presences of mountains, hills, valleys, and rivers can create microclimates with considerable weather variations. Unlike many west coast climates that have a regular and pronounced dry season (i.e., Mediterranean), precipitation in humid subtropical climates occurs throughout all months, with peaks in summer (Figure 4.4). Additionally, there is a significant seasonal and diurnal range in temperatures (Figure 4.5) creating conditions that are not conducive to bicycle commuting. These weather variables, and associated inconveniences, often discourage bicycle usage as a means of transportation. According to the cycling survey conducted as part of this study, 15 percent of respondents listed 'weather' as a reason for not cycling more often.

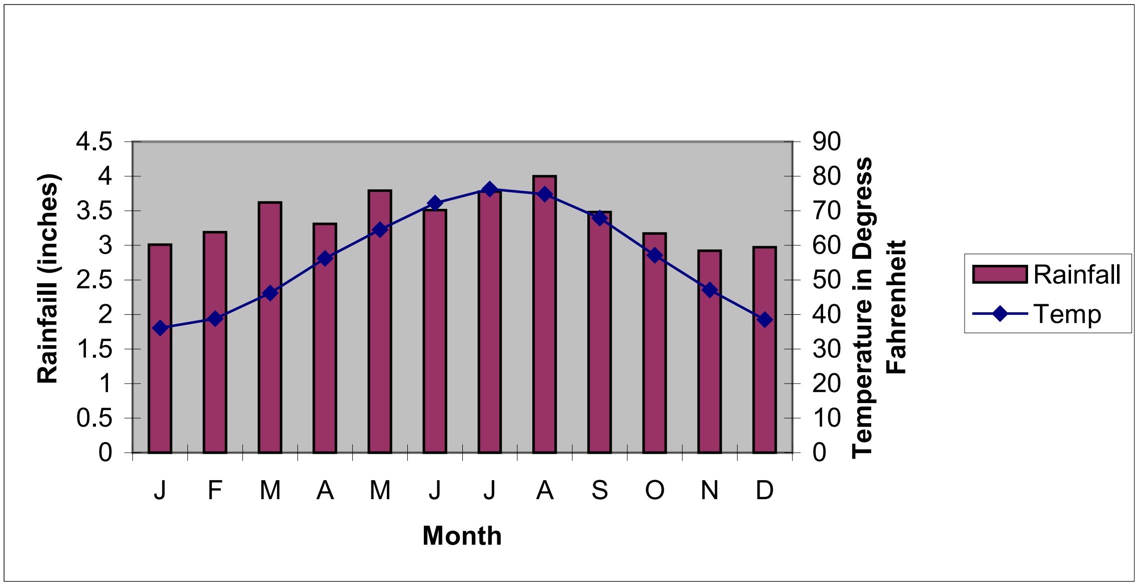
Although little can be done to change the topography and climate (and associated weather) of the study area, ancillary bicycle facilities can mitigate many inconveniences of bicycle commuting and inclement weather. Proper design, placement, and maintenance of these facilities will maximize their usefulness and convenience. As referenced in Chapter 3, ancillary facilities can include secure bicycle parking, bicycle lockers, and shower and locker facilities in the workplace and other destinations. These facilities are discussed in greater detail later in this chapter.

Other measures may also be employed to mitigate weather/climate-related inconveniences. Urban forestry practices can reduce the urban heat island effect, a phenomenon in which the air temperature in urban areas is considerably greater than the surrounding countryside. Urban heat islands form as vegetation is replaced by asphalt and concrete for roads, buildings, and other structures associated with the built environment. A report by NASA's Global Hydrology and Climate Center (Luvall and Quatttrochi, 1996) cites two important roles tree canopies play in mitigating the heat island effect:

- The forest canopy is very efficient in dissipating the solar energy received by transpiring water from leaf surfaces, which cools the air by taking "heat" from the air to evaporate the water.
- In shading surfaces like asphalt, roofs, and concrete parking lots, which prevents initial heating and storage of heat.

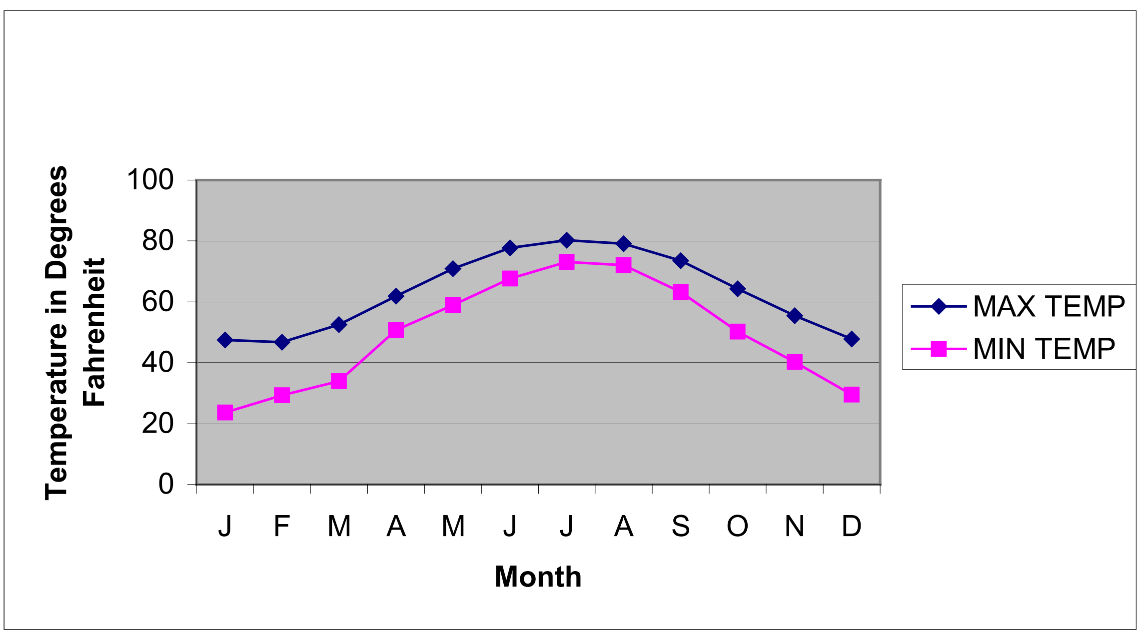
The City of Roanoke's *Urban Forestry Plan* (City of Roanoke, 2003), which serves as a guide for the city's efforts in managing its urban forest for maximum beneficial use, cites many benefits of trees. Trees provide benefits, such as improving air quality, reducing storm water runoff and energy savings. Additionally, trees can encourage alternative transportation by creating conditions more conducive to bicycle and pedestrian traffic. Trees planted along roadway corridors tend to slow traffic as well as making them more aesthetically pleasing. To fully realize these benefits, urban forestry practices and streetscape design should be considered and included in the discussion of bicycle facility design and promotion of alternative transportation.

Figure 4.2
Climograph for Roanoke, Virginia



Source: Southeast Regional Climate Center, Historical Climate Summaries for Virginia.
Period of Record: 8/ 1/1948 to 12/31/2001, Roanoke Airport

Figure 4.3
Average Maximum and Minimum Temperatures for the Roanoke Area



Source: Southeast Regional Climate Center, Historical Climate Summaries for Virginia.
Period of Record: 8/ 1/1948 to 12/31/2001.

Who Bicycles in the RVAMPO Study Area?

Bicycle usage in the Roanoke area is difficult to quantify. The U.S. Census “journey-to-work” data are available for 1990, and 2000. The “Journey-to-Work” data are a limited resource because it asked people (workers 16 years and over) for their *primary* means of transportation to work. Bicycling can often be a *secondary* or *linked* mode to transit. In addition, bicycle trips to schools are not counted in this data set, though they directly replace vehicle trips.

Table 4.6 presents a summary of the 1990 and 2000 data for each locality in the RVAMPO and the state of Virginia as a whole. The percentage of bicycle commuters rose only slightly from the 1990 census figures for Botetourt County, Roanoke City and Roanoke County. However, despite nominal increases, the data indicate that a very small percentage of workers in the area use a bicycle for the purpose of commuting to work. Roanoke City had highest number and percentage of bicycle commuters at 0.19 percent and 0.2 percent in 1990 and 2000, respectively. Although these percentages were comparable to that of Virginia as a whole, they still represent less than one-half of one percent of the total workers commuting to work. In the city of Salem and the state of Virginia fewer commuters chose bicycling in 2000 than in 1990.

Table 4.6
Workers 16 Years and Over Using Bicycle as Primary
Means of Commuting to Work, 1990 and 2000

	1990			2000		
Locality	**Total Workers Commuting to Work****	**Bicycle Commuters**	**Percent Bicycle Commuters**	**Total Workers Commuting to Work****	**Bicycle Commuters**	**Percent Bicycle Commuters**
Botetourt County*	12,943	0	0	15,040	12	0.08
Roanoke City	44,221	86	0.19	42,868	85	0.20
Roanoke County*	41,116	14	0.03	42,239	21	0.05
Salem City	11,734	49	0.42	11,998	5	0.04
Virginia	2,177,521	9,068	0.42	3,481,820	7,930	0.23

Source: 1990 and 2000 Census Bureau
* The MPO covers only the urbanized areas of these counties (Figure 4.1)
** Does not include those working at home

These numbers represent only bicycle commuting to work data and do not address trips on a bicycle for purposes other than trips to work. However, many more trips are made for recreation, fitness, and personal which are not counted in the “Journey-to-Work” data. Complete 2000 Census Transportation Planning Package (CTPP) data for the localities comprising the study area are included in Appendix E.

Other sources for evaluating bicycle usage in the RAMPO include a survey distributed as part of the *Regional Bicycle Suitability Study*, However, as stated in the Methodology Chapter, the survey was based on a limited sampling size, and was not intended to represent statistically valid indications of bicycle usage. Despite this caveat, survey responses do provide useful information on routes people choose and avoid and what factors influence people to ride their bicycles or not and with what frequency. Additionally, survey responses provide data regarding bicyclist habits, needs, and perceptions regarding bicycling in the area. A complete analysis of survey responses is presented in Chapter 5.

Existing Bicycle Facilities

Although formal bicycle facilities in the MPO are minimal, cyclists in the region still utilize the roadway network for bicycle commuting and recreational purposes. In the rural portions of the study area, were there are many popular and scenic rides, bicycle facilities are, for the most part, non-existent. However, significant pieces of a bicycling infrastructure do exist, primarily in the urbanized areas of the MPO. Additionally, and more importantly, interest and support for improving bicycle facilities is increasing. Already, several localities have made or are planning roadway improvements to better accommodate bicyclists on roadways in the area. In many cases, minimal improvements to the transportation infrastructure could result in a significant increase in the roadway networks ability to accommodate bicycles. This portion of the chapter provides a limited overview of the existing bicycle facilities and transportation infrastructure as related to bicycle travel in the study area. This overview explores existing assets, opportunities, and obstacles and how each impacts bicycle travel in the study area. However, it should be noted that it is not intended to be a comprehensive listing of all bicycle related infrastructure in the study area. Instead it is intended to provide a few examples of each type of facility for discussion purposes.

Table 4.7
Existing Bicycle Facilities by Locality

Locality	Shared Roadway	Wide Curb Lane	Paved Shoulder	Bike Lane	Signed Shared Roadway	Shared Use Path
Botetourt County	X		X			X
Roanoke County	X	X	X			X
City of Roanoke	X	X	X	X		X
City of Salem	X	X	X		X	X
Town of Vinton	X	X	X	X	X	X

Shared Roadways and Signed Shared Roadways

Shared roadways are the most common type of bicycle facility in the region. Although a few of the shared roadways have improvements to accommodate bicycle traffic, most of the roadways lack any bicycle-specific improvements. As a result many of roadways are not suitable for Group B and C users.

Proper signage is an integral part of any transportation system. This is no less true for a bicycling network. In the study area, there are several signed shared roadways or bike routes. Salem has an 11.2-mile bike route that meanders throughout the city. *Bike Route* signs placed periodically along the route assist users in staying on track. These bike routes designed primarily for recreation purposes and are often located in residential areas.

Bike Route sign in Salem. This is an example of a signed shared roadway.

Another common type of signage often found along shared roadways in the area is *Share the Road* signs. These signs are intended to serve as a reminder to automobile drivers to be aware of bicyclists. There are numerous *Share the Road* signs in place throughout the study area; however, there are significant variations in the design of the signs between localities. It is important to remember that few of the shared roadways in the area are accompanied by on-road facilities designed to accommodate bicyclists.

Share the Road sign along Brandon Avenue near Peters Creek Road.

Bike Lanes

Of the localities in the study area, currently the City of Roanoke and Vinton have formal bike lanes in place. Vinton has a bike lane along a 0.5-mile section of Hardy Road. This was the first bike lane in the Roanoke Valley.

Roanoke City also has a 0.5-mile bike lane along a section of Memorial Avenue/13th Street in the Grandin area, a village center designated in the City of Roanoke Vision 2020 Comprehensive Plan. The configuration of the corridor is different in each


Bike lane along Hardy Road in Vinton.

Bicyclists using the bike lane along Memorial Avenue in the City of Roanoke.

Wide outside lane along Peters Creek Extension in the City of Roanoke.

Wide lanes along Shenandoah Avenue, a direct corridor connecting the City Salem and the City of Roanoke.

travel direction, due to on street parking on the northbound travel lane. During level of service data collection, modeling, and mapping, configuration differences must be accounted for, as they will potentially impact the bicycle level of service of the corridor.

Applying the urban village concept, many of the neighborhood plans in the Vision 2020 include bicycle and pedestrian accommodations. Neighborhoods and village centers are also important components in a regional bicycle network. Connecting neighborhoods, activity centers, greenways and other points of interests by regional network would likely promote bicycling as viable means of transportation. Appendix F provides a listing of all references to bicycle facilities in local comprehensive plans.

Currently, Botetourt County, Roanoke County and the City of Salem have no designated bike lanes in place. However, Roanoke County approved a bike lane listed in the FY 2004 Six-Year Transportation Plan on Mountain View Drive. This bike lane will link the county portion of Route 24 to the Blue Ridge Parkway, a favorite corridor for many recreational cyclists. Other roads identified by Roanoke County for possible future bicycle facilities include Plantation Road, Hardy Road, Loch Haven Drive, Hollins Road, and Colonial Avenue.

Wide Outside Lanes

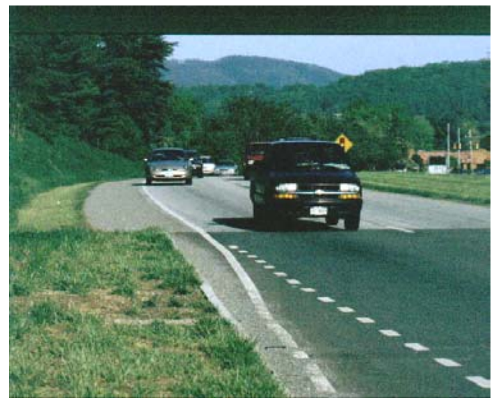
Many roads in the area have wide outside travel lanes designed to accommodate both motorists and bicyclist. As referenced in Chapter 3, the VDOT minimum recommended width for wide outside lanes is 14 feet of usable lane width. However, local conditions should dictate the minimum width

Peters Creek Extension has a 14-foot wide outside travel lane. Sections of Shenandoah Avenue, also has wide travel lanes. Between 24th and 30th street travel lanes in each direction are 17.5 foot wide, with no on-street parking. This configuration offers sufficient width for a variety of treatments to accommodate bicyclists. Facility improvements on Shenandoah would serve to connect Salem and the city of Roanoke's CBD.

There are numerous other examples of wide travel lanes in the study area, many of which are in close proximity to an activity centers, greenways, and other points of interest. Examples include portions of Brandon Avenue (Towers Shopping Center, Lakewood Park, Patrick Henry High School), Colonial Avenue (Towers, Virginia Western Community College), and Preston Avenue (Tinker Creek Greenway). Although wide travel lanes can serve to better accommodate bicyclist by creating more separation between bicyclist and motor vehicles, this treatment has the potential to increase motor vehicle speeds, thereby creating safety concerns and reducing compatibility between motor vehicle and bicyclist along these corridors. To address these concerns

Paved Shoulders

Currently, several roads in the study area have wide shoulders that are potentially sufficient for bicycle travel. The best example is Route 419, which connects the City of Roanoke, Roanoke County, and the City of Salem. This corridor has a 7-foot shoulder running along significant portions of its length from the Roanoke City/Roanoke County line to approximately the Salem City line. However, high traffic volumes, high speed, and inconsistencies in the shoulder width and pavement condition diminish the overall usefulness, quality, and safety of the shoulder for bicycle travel. Additionally, debris and other variables (i.e., intersections) along the shoulder present additional impediments to accommodating bicyclists. Although these conditions diminish the corridors ability to accommodate bicyclist, it has significant potential as a major travel corridor for use by bicycle commuters and recreation cyclists.



Inconsistent shoulder width along 419 in Roanoke County. Note the abrupt shoulder change at the beginning of a right turning lane.

The City of Salem also has another improved shoulder located in a residential area. The bike lane is located at the based of a steep gradient in a residential neighborhood. This treatment was designed to accommodate cyclists whose speed was slowed by the steep gradient. As such, the lane is only on the uphill travel direction lane.

Bike racks at the Williamson Road parking garage. Note that two racks are available – one located outside of the garage and one located inside of the garage protected from the elements.

Many of the corridors referenced in this Chapter are part of the initial study area discussed in Chapter 6. Regional Commission staff conducted level of service calculations for corridors in the study area using both the BCI and BLOS models. Level of service calculations are presented and discussed in Chapter 7.

Ancillary Facilities

Ancillary facilities are integral components of the bicycling and alternative transportation infrastructure. These facilities, along with other improvements, can greatly enhance the overall effectiveness and convenience of bicycle commuting and multimodalism in a variety of ways, and should be considered in developing the regional bicycling network. Major activity centers, transit stops and greenways should be proper

Bike rack and benches at the Cave Springs Corners shopping center in Roanoke County.

As with on-street bicycle facilities, the provisions of ancillary facilities in the study area are somewhat limited. By far, bike racks are the most common, and primarily the only, type of ancillary facility available to bicyclists at destinations in the study area. However, often even these facilities are not present at many of the destinations and activity centers in the area. Few malls, shopping centers, and other commercial establishments have bike racks available for use by patrons or employees. However, Cave Springs Corner shopping center in Roanoke County, not only has a bike rack, but also several benches for public use. None of the larger commercial centers, such as the Valley View, Tanglewood, or Towers malls, have bike racks available. Moreover, most public buildings also lack ancillary facilities.

Bicycle secured to a guardrail near Noel C. Taylor building.

Several localities do have limited ancillary facilities in place, primarily bike racks. The cities of Roanoke and Salem have bike racks at the main library branches, both of which are major activity centers in the respective localities. The City of Roanoke also has several bike racks located in parking garages

Bicycle chained to a No Parking near the Center in the Square in downtown Roanoke.

throughout the downtown area city. The Williamson Road parking garage has two bike racks, one located outside of the garage and one located inside the structure, providing storage protected from the elements. However, in many parts of the central business district (i.e., Center in the Square) and public buildings, bike racks were not available or easily visible. Commission staff regularly observed and noted an abundance of bicycles secured to fixed objects throughout the city. These observations may be indicative of a need for more visible placement of bike racks to serve the downtown area.

Bicycling and Public Transit

Although Valley Metro buses are not equipped with bike racks, cyclists are allowed to bring their bikes on the bus. This arrangement has the potential to facilitate multimodalism in the area. However, this policy is not well advertised, nor are any special bicycle facilities or accommodations provided on the buses or at the transit stops to encourage multimodalism. These conditions, along with limited routes and inconvenient schedules, may actually discourage the use of alternative transportation. Employing the practice of multimodalism, a bicycle commuter could potentially cycle from a rural residence to a transit stop, connect to any other part of the region served by the public transit network, and then use the bicycle to complete the trip after disembarking the transit system (Figure 4.5 shows all Valley Metro routes). However, before high levels of multimodalism can be achieved, improvements need to be made in not only to the bicycle infrastructure, but in the public transits infrastructure as well. Impediments to multimodalism may included lack of bike lanes or other on-street bicycle facilities leading to transit stops, lack of covered waiting facilities, bicycle parking and secured storage at transit stops, and limited service to portions of the study area. The addition of ancillary facilities and improvements to public transit services may promote bicycling as a component of multimodalism in the study area. For more information on multimodalism refer to VDOT's Statewide Multimodal Long-Range Transportation Plan (*Vtrans 2025*), which encourages connectivity among all modes of transportation – air, bicycle/pedestrian, highways, passenger rail, freight, ports, ferry and transit.

Shared Use Paths

The Roanoke Valley Greenway system offers an extensive network of shared use paths. The *Greenway Conceptual Plan,* provided in Figure 4.6, shows all proposed greenway routes. Currently, certain greenways in the area are used primarily for recreation purposes, serving Group B and C cyclists and children. However, as referenced earlier, greenways have significant potential as integral components of a regional bicycling network by providing linkages between corridors, activity centers, and transit, thereby increasing the connectivity and usefulness of the network. Increasingly, more cities and towns are incorporating greenways into transportation planning. The availability of TEA-21 funding for greenways, as components of alternative transportation systems, facilitates these efforts. Greenways are often very well-suited for short personal trips, such as running errands and visiting friends. Even when it is not pratical or possible to use a greenway for the entire trip, it may serve to bypass, or connect to, certain areas, corridors or activity centers. Already, the Lick Run, Tinker Creek, and Wiley Drive greenways are utilized by many residents for transportation purposes. As additonal greenways are constructed, linkages established, and connectivity increased, the Roanoke Valley Greenway system will likely play an increasingly important role in the bicycling and alternative transportation network in the area.

The development of a regional bicycling network could also benefit the greenway system by connecting various greenways, creating greater continuity within the system as a whole. However, there are considerations to be adddressed if greenways are to be incorparted into the bicycling network, and by extention the transportation network. The surface of some greenways is not suitable for all bicycles, especially road bikes with thin tires. Currently, the discontinuity of the greenway system discourages many experienced cyclists from using the greenway system for recrational or transportation purposes. The Roanoke Valley Greenway system is a valuable recreational resource for area residents, and increasingly so, a significant alternative transportation component. As such, the symbiotic relationship between greenways, bicycling and alternative transportation should be explored, and the greenway system incorporated, where practical, in developing a regional bicycle network.

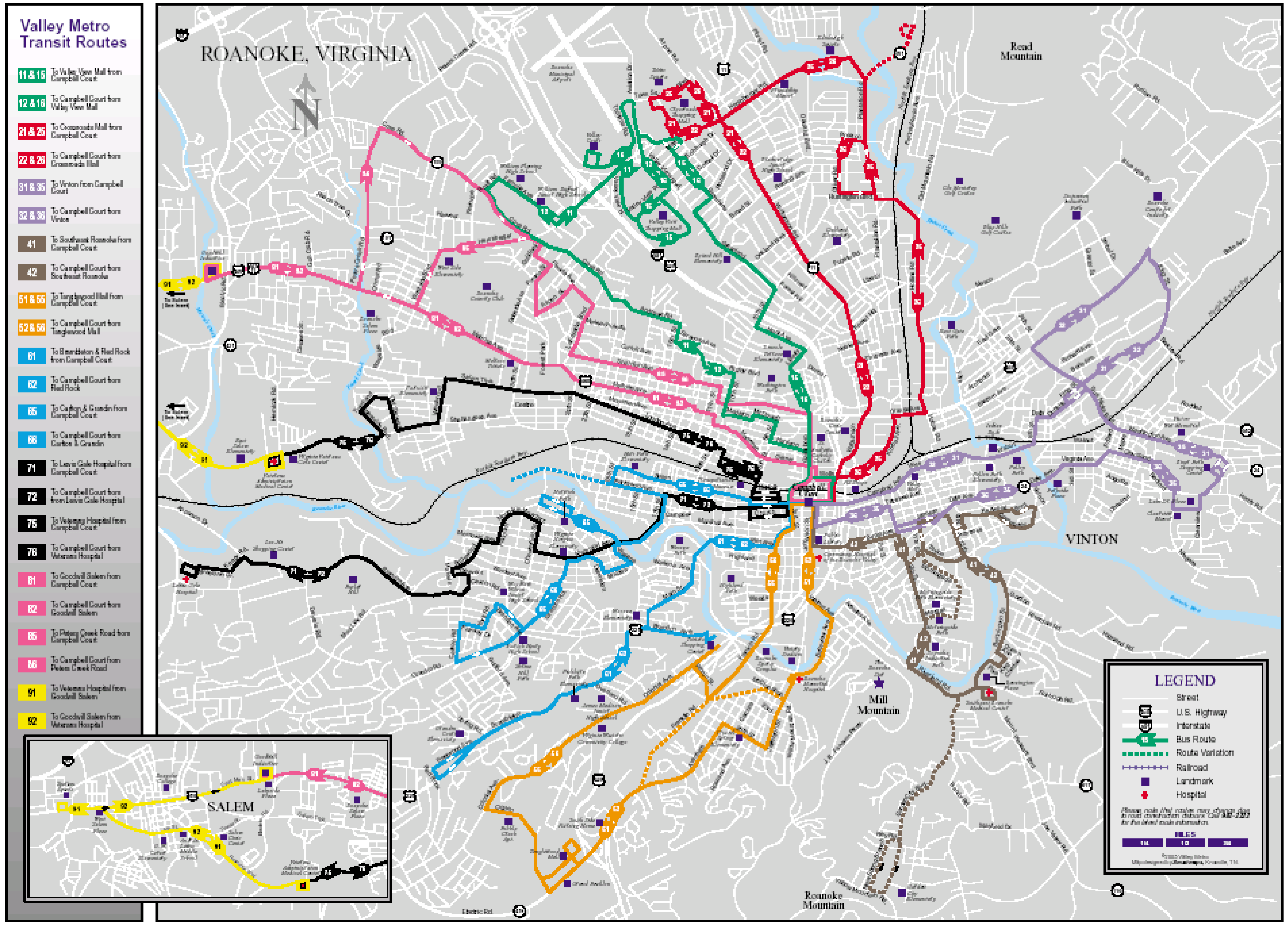


Figure 4.4 Valley Metro Routes   Source: http://www.valleymetro.com/VAInt.pdf

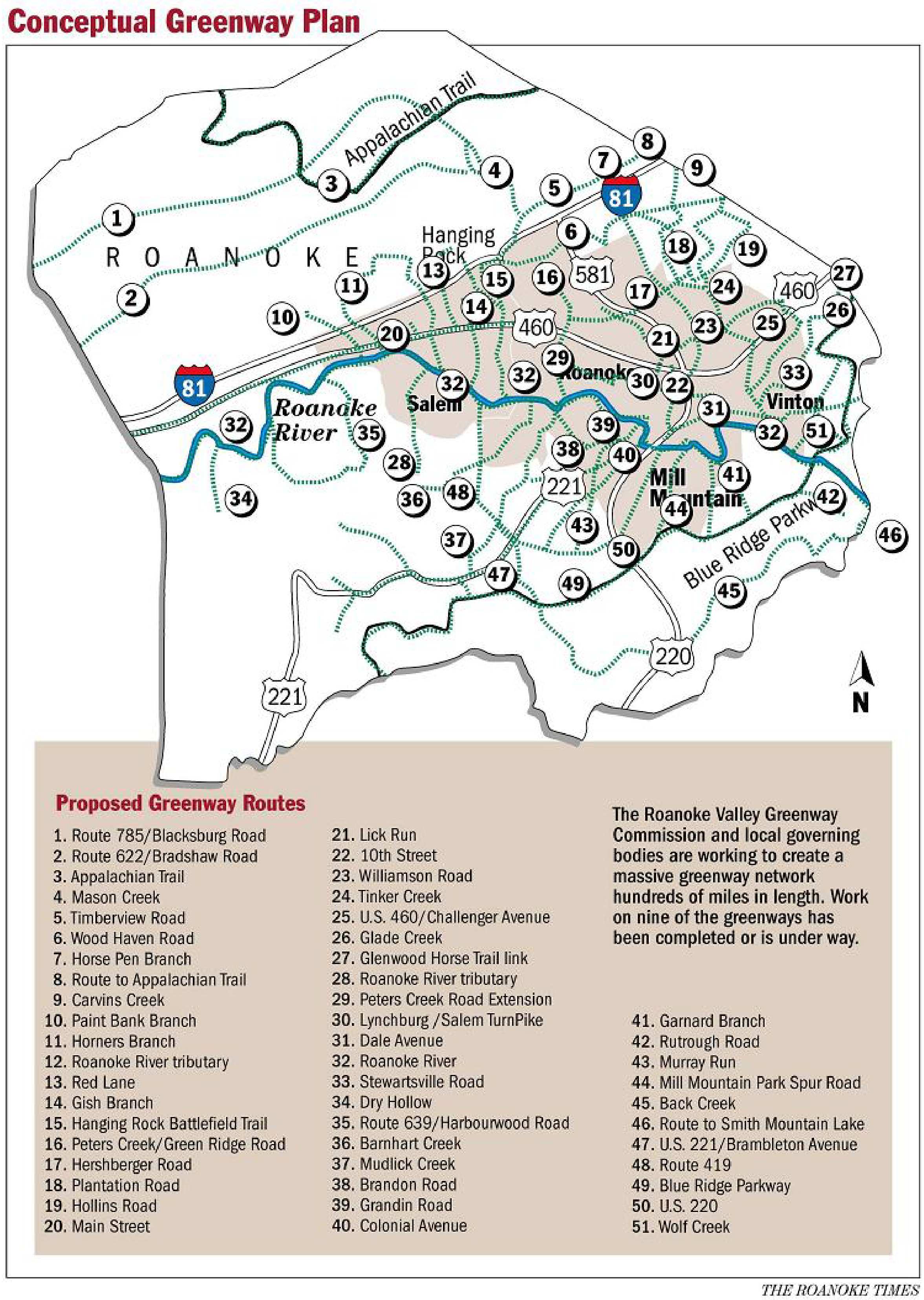


Figure 4.5: Conceptual Greenway Plan Source: http://www.greenways.org/concept.html

Analysis of Survey Responses

As summarized in Chapter 2, the survey was designed to solicit information on a variety of bicycling related topics consistent with the project scope. The RVAMPO collected over 130 completed surveys. This chapter presents a complete analysis of the survey responses.

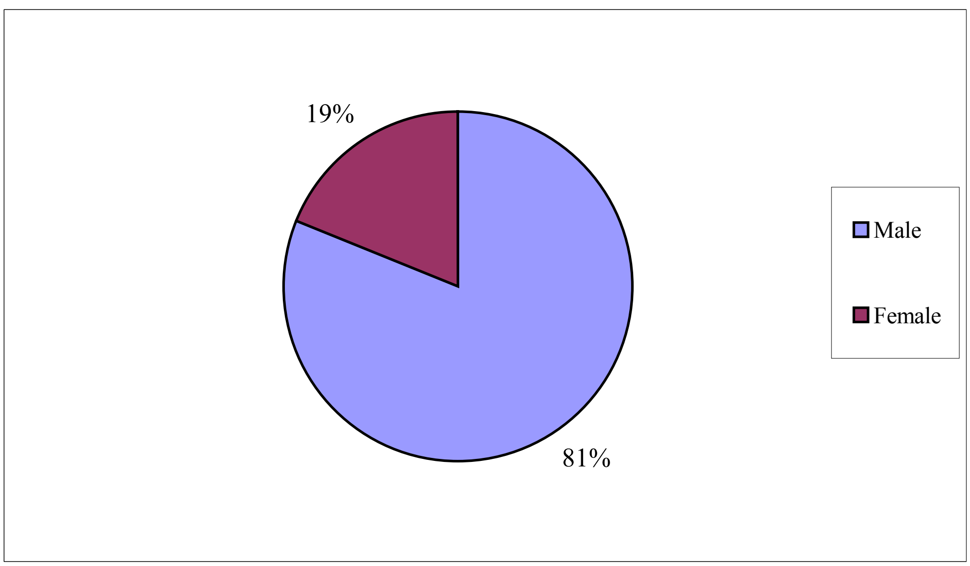
To better understand the characteristics and habits of bicyclist in the area, respondents were asked several questions regarding bicycle usage. Respondents provided information on cycling habits, characteristics, perceptions, and preferences. In an effort to determine linkages with the Roanoke Valley Greenway system and public transit, as discussed in Chapter 4, respondents also answered questions about their use of greenways for cycling and transit alternatives that incorporate bicycling.

Cyclists Profile

To determine the characteristics of cyclists responding to this survey, respondents were asked to indicate their age, gender and miles ridden on a bicycle in an average week.

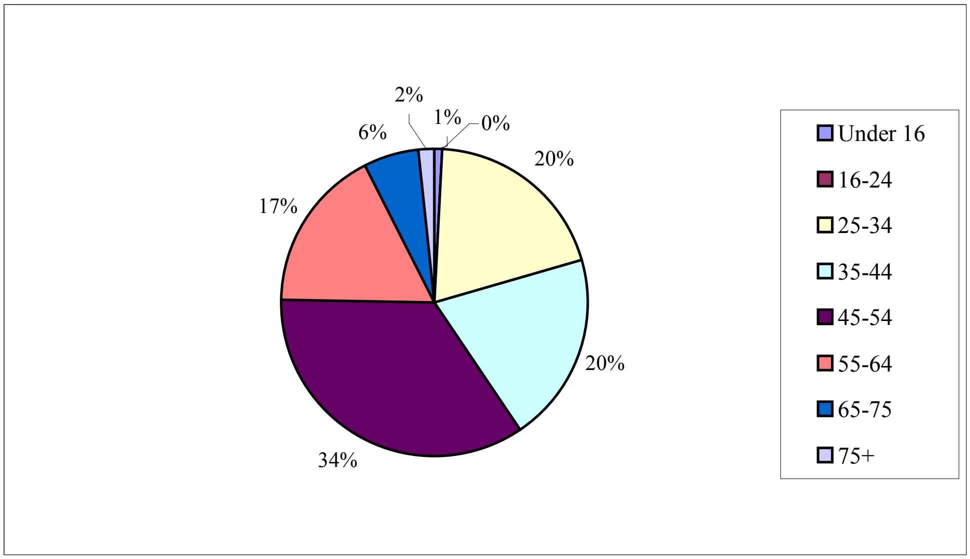
Respondents were given the option to indicate their gender on the survey. As shown in Figure 5.1, 81 percent of respondents answering this question were male, compared to 19 percent female.

Figure 5.1. Respondent Gender Profile



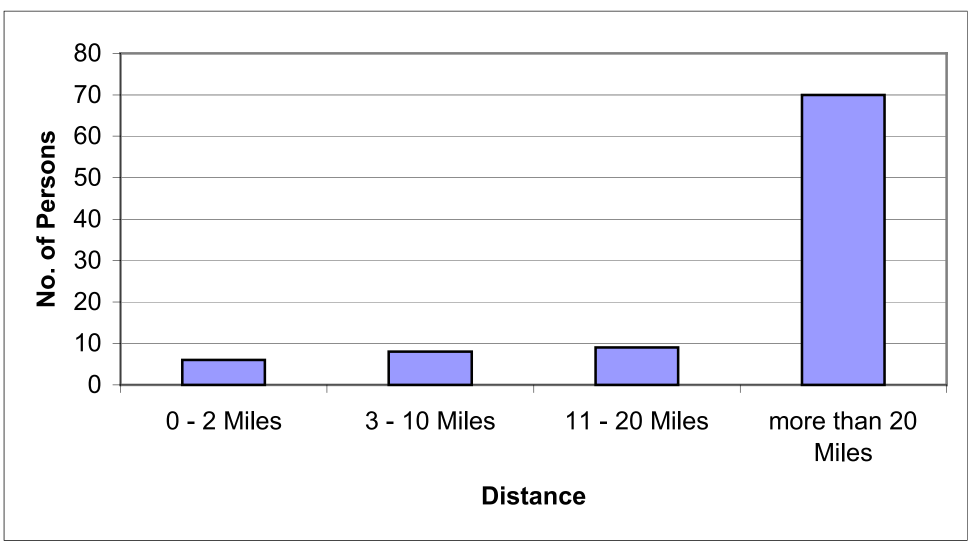
Respondents were also given the option of indicating their age by selecting one of several age groups. As indicated in Figure 5.2, 34 percent of respondents who elected to answer this question were within the 45-54 range. Additionally, 74 percent of respondents were between the ages of 25 and 54.

Figure 5.2. Respondent Age Profile



Respondents were asked to indicate the number of miles ridden on a bicycle in an average week by selecting a distance range. More than 50 percent of the respondents indicated that they ride more than 20 miles per week. This suggests that many respondents are experienced cyclists (Group A), riding mainly for fitness/recreation.

Figure 5.3. Cyclists' Responses to "How many miles do you ride your bicycle in an average week?"



Frequency of Bicycle Use by Trip Purpose

To better understand their cycling characteristics, respondents were asked to indicate how often they use their bicycle for purposes such as commuting to work, commuting to school, personal trips, fitness/recreation, and commuting to a public transit facility. The following scale was used in denoting frequency: Almost Daily (4-5 days per week); Often (1-3 days per week); and Rarely (1-2 days per month).

Figure 5.4 shows that many respondents 'often' bicycle for fitness/recreation purposes. Commuting to a public transit facility is the least likely purpose for cycling. Figures 5.5-5.9 provide a more detailed analysis of responses to this question.

Figure 5.4: Cyclists' Responses to "How often do you cycle for the following purposes?"

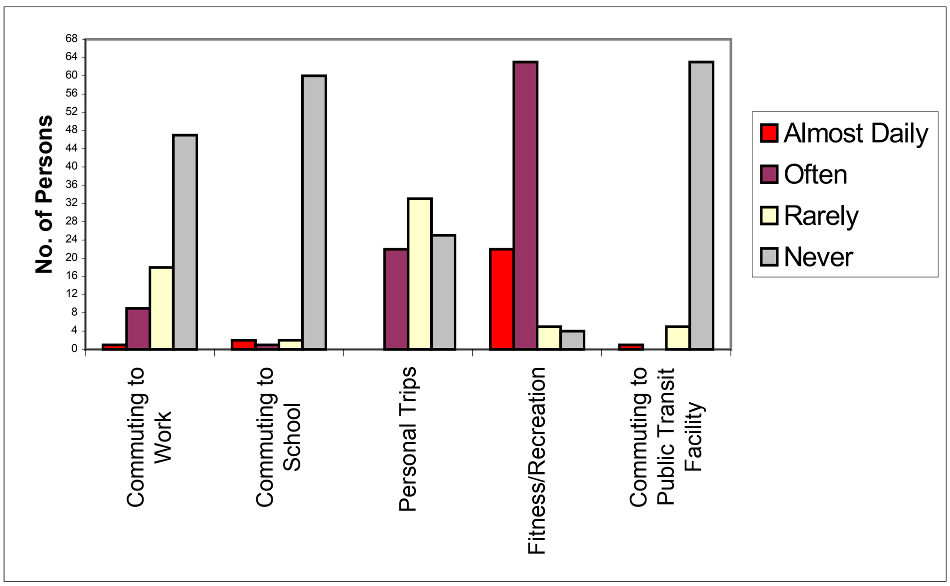


Figure 5.5 shows that 13 percent of respondents commute to work either 'almost daily' or 'often.' However, 87 percent of respondents indicated that they 'rarely' or 'never' commute to work by bicycle.

Figure 5.5: Commute to Work by Bicycle

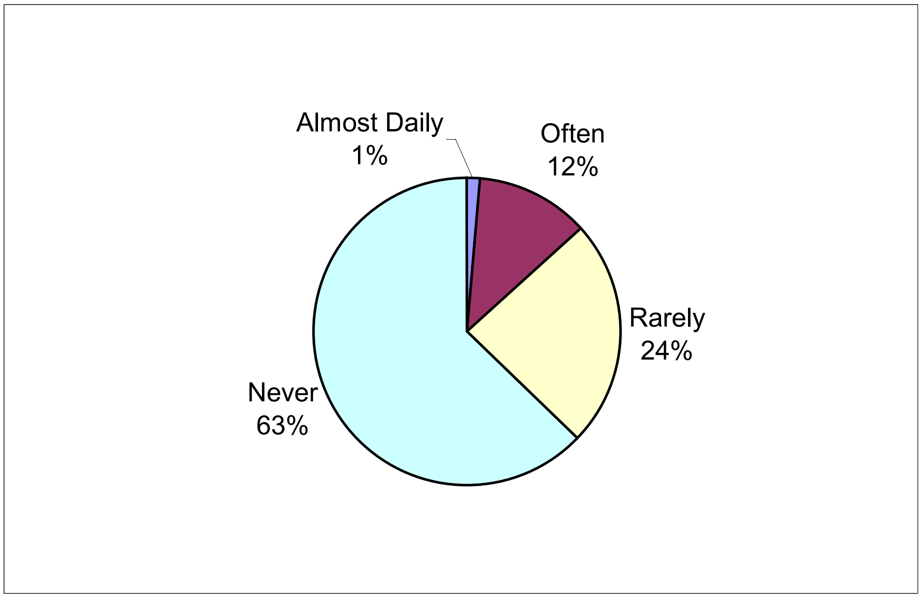
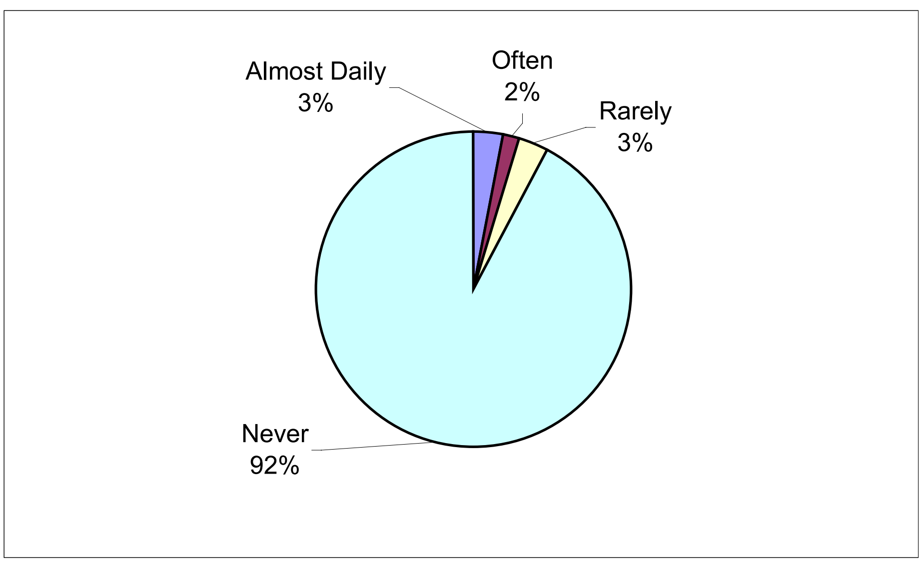


Figure 5.6 represents the percentage of respondents that commute to school by bicycle. This figure indicts that 92 percent of respondents 'never' use a bicycle to commute to school. However, following analysis of responses to this question, staff concluded that given the demographics of groups completing the survey were not consistent with traditional student demographics. This suggests that the majority of respondents had already completed their formal education, resulting in a large percentage who do not commute to school by bicycle. This assumption is also supported by Figure 5.2, which shows that 74 percent of respondents were between the ages of 25 and 54.

Figure 5.6: Commute to School by Bicycle



Additionally, based on information provided by area school superintendents' offices, very few public school students use a bicycle as their primary means of transportation to school. In many cases, students are discouraged from riding a bicycle to school by officials. For example, many schools are located in urban and high-traffic areas, making commuting by bicycle dangerous.

Twenty-eight percent of respondents indicated that they 'often' use a bicycle for personal trips, which may include running errands, visiting friends and any other trips of a personal nature. However, 31 percent indicated that they 'never' use a bicycle for personal trips. Using a bicycle for personal trips likely holds the greatest potential for increasing bicycle usage in lieu of a motor vehicle. Many personal trips are to destinations within distances that can be easily traveled on a bicycle.

Figure 5.7: Use Bicycle for Personal Trips

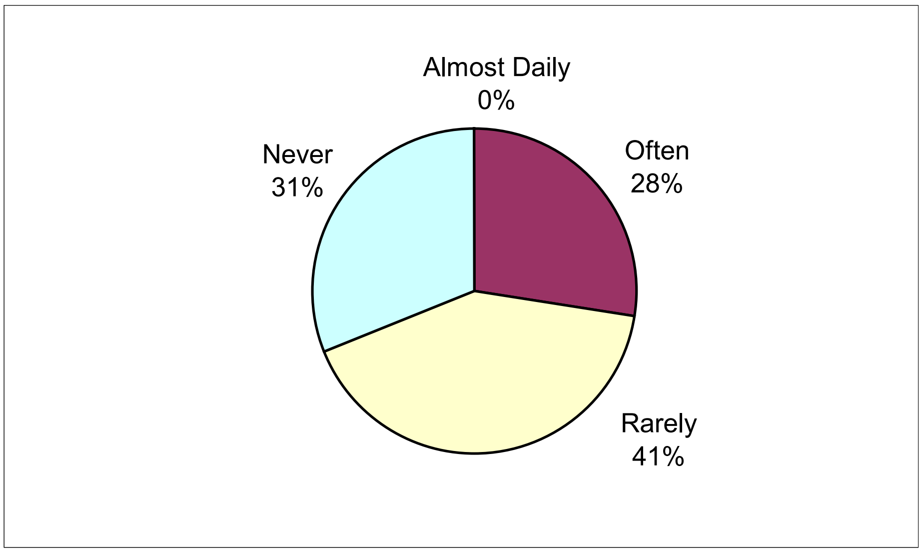


Figure 5.8 indicates that 'fitness/recreation' was, by far, the most common reason for using a bicycle. Ninety-one percent of respondents indicated that they use a bicycle for 'fitness/recreation' either 'almost daily' or 'often.' Many area cyclists use rural roads with lower traffic volumes, as well as scenic beauty, for group rides. Anecdotally, on any given day, numerous recreational cyclists can be seen throughout the area.

Figure 5.8: Use Bicycle for Fitness/Recreation

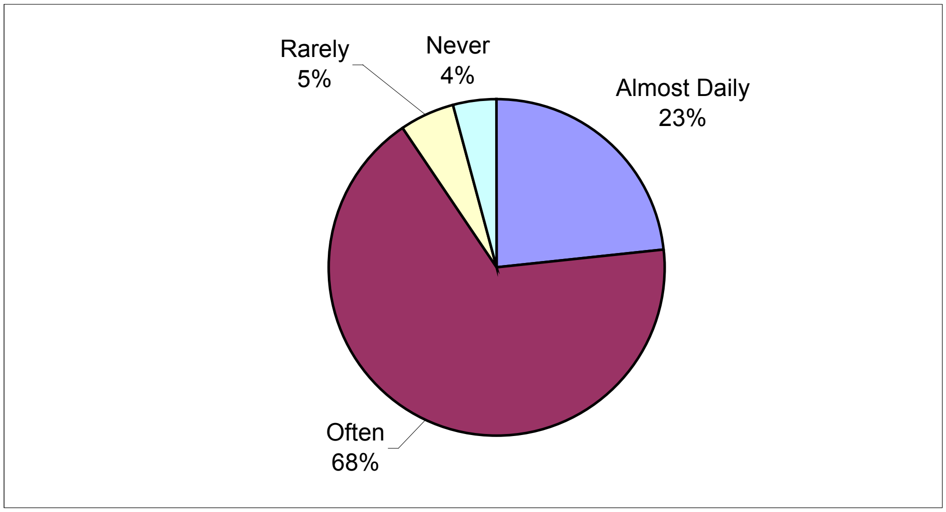
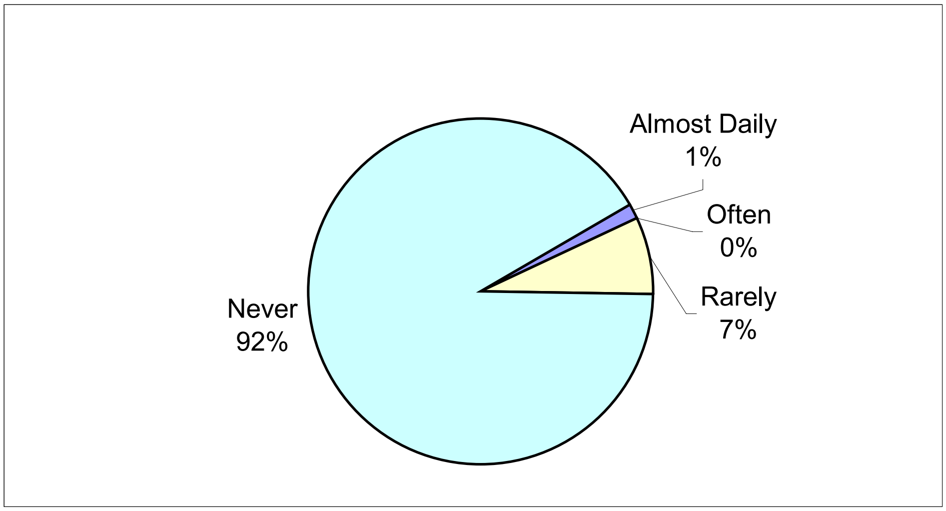


Figure 5.9 shows that 92 percent of respondents indicated they ‘never’ use a bicycle to commute to a public transit facility.

Figure 5.9: Commute to Public Transit Facility



Public Transit and Bicycling

A key instrument for encouraging higher levels of bicycling is a public transportation system that accommodates bicyclists’ needs. To better understand the factors influencing respondents public transit use, additional, transit related, questions were included in the survey. Responses to these questions are presented in Figures 5.10-5.12. Overall, responses to the transit related questions indicated very low public transit use among respondents.

Respondents were asked to indicated how far they live from the nearest public transit facility. Figure 5.10 shows that a large number of respondents live more than one mile from a public transit stop. However, collectively, the largest number of respondents indicated living less that one mile from the nearest transit facility, a distance easily traveled on a bicycle.

Figure 5.10: Cyclists' responses to "How far do you live from the nearest public transit facility (i.e., Valley Metro stop)?"

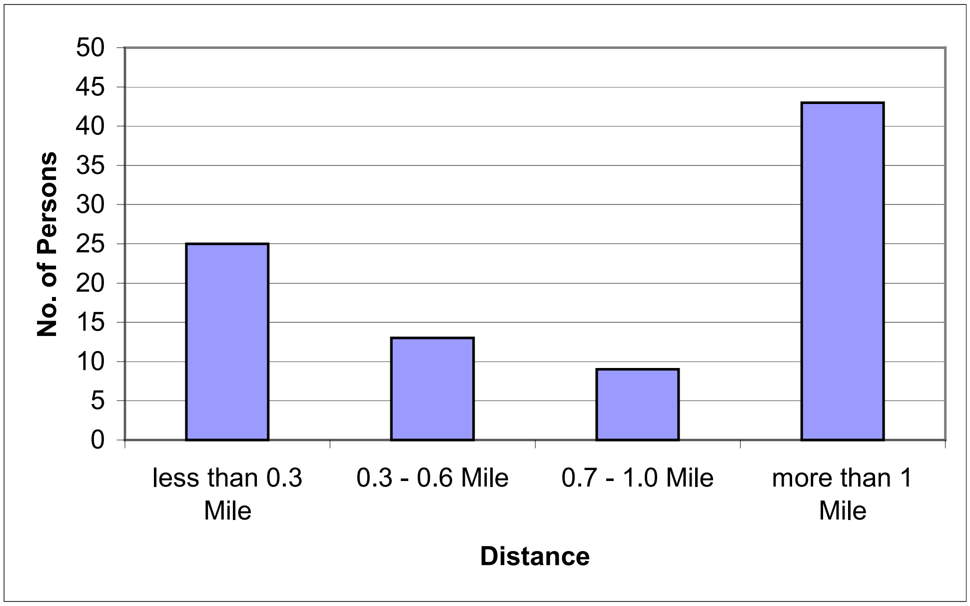
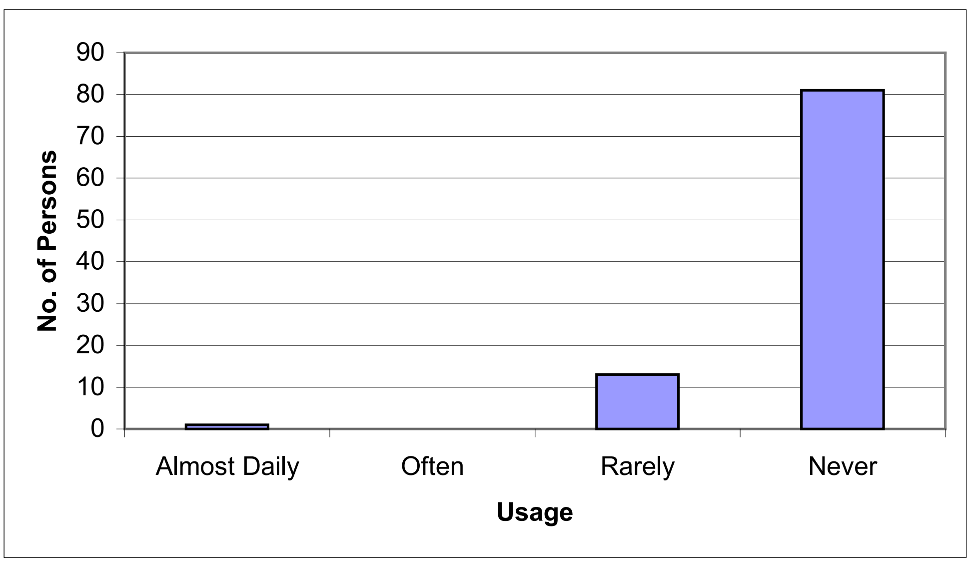


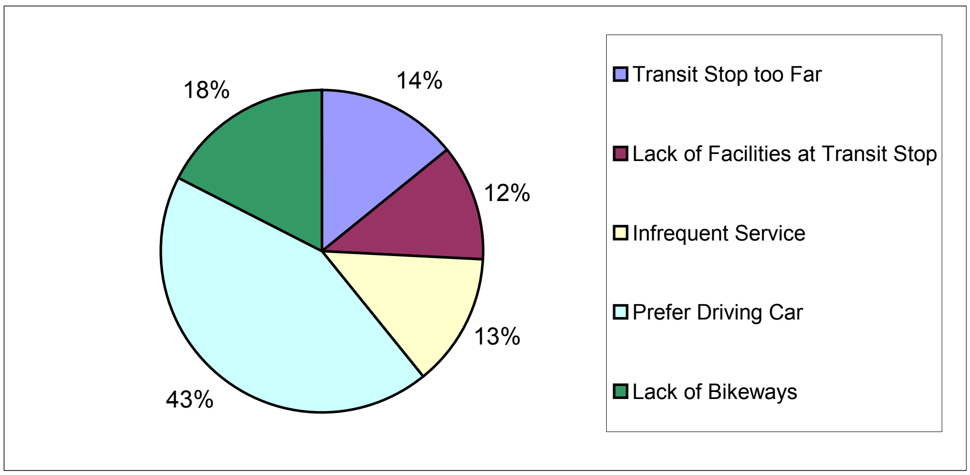
Figure 5.11 indicates that very few respondents use public transit. By far the largest number of respondents indicated 'never' using public transit, with the second largest group indicting they 'rarely' use public transit.

Figure 5.11: Cyclists' Responses to "How often do you use public transit?"



Respondents who indicated 'rarely' or 'never' using public transit were asked to provide reasons for not doing so. For this question, respondents could select more that one reason for not using public transit. Figure 5.12 shows that 43 percent of those who responded cited 'prefer driving car' as the reason for not using public transit. Additionally, 18 percent of respondents cited 'lack of bikeway to the transit stops' as reason for not using public transit. The addition of on-street and ancillary facilities at transit stops could be effective in promoting greater integration of bicycling and public transit. Therefore, the role of transit should be considered in developing a regional bicycle system.

Figure 5.12 Cyclists' responses to "If you rarely or never use public transit, what are the reasons for the same?"



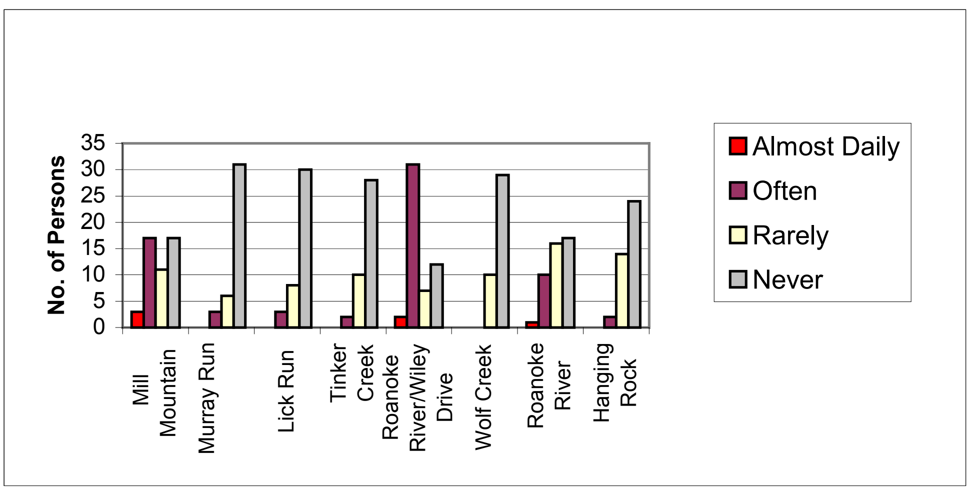
Roanoke Valley Greenway System and Bicycling

To better understand the relationship between the Roanoke Valley Greenway system and bicycling, several greenway-related questions were included in the survey. By establishing these relationships, the greenway system can be better incorporated into the bicycling network.

Figure 5.13 indicates that most residents live within 0-5 miles of the nearest greenway. However, given the proximity of a large number of respondents to an area greenway, overall the use of greenways for bicycling was relatively low. As indicated in 5.14, certain greenways are used more than others for bicycling. The greenway used most often for bicycling is the Roanoke River Greenway along Wiley Drive. It should be noted that based on previous questions, many survey respondents are experienced cyclist comfortable riding in all traffic conditions. Conversely, bicyclists using the greenway system are likely less experienced cyclists or children (i.e., Group C). However, the greenway system is an important recreational resource in the area, and as the system is further developed its potential as a major component of a regional bicycling network will also increase. Therefore, as stated earlier, the Roanoke Valley Greenway system should be considered in discussion of a regional bicycling network and incorporated where feasible and logical.

Figure 5.13 Cyclists' Responses to "How far do you live from the nearest Roanoke Valley Greenway?"

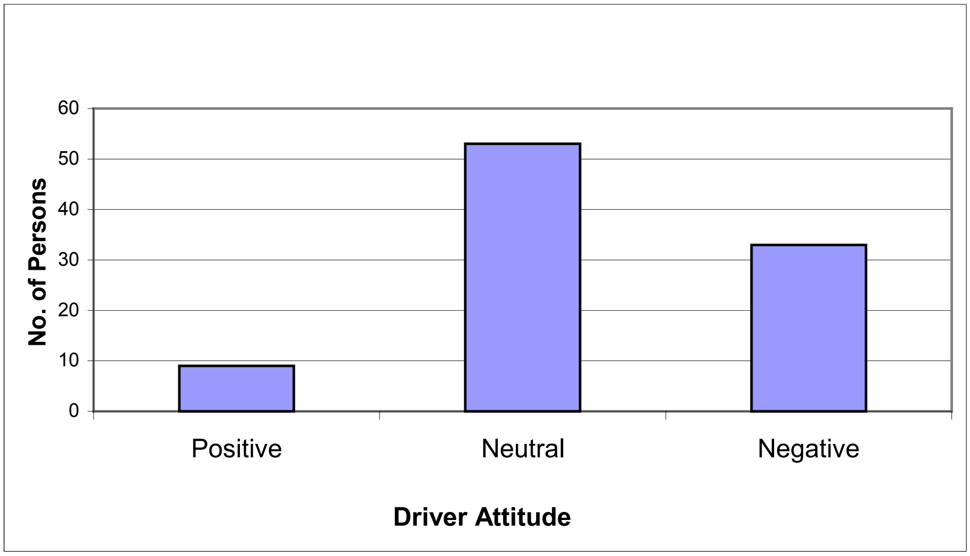
Figure 5.14 Cyclists' Responses to "How often do you use the following Roanoke Valley Greenways for cycling?"



As discussed in Chapter 4, numerous factors influence bicycle use. These factors include 'driver behavior or attitude toward cyclists' and the roadway networks ability to accommodate both motorists and cyclists. To better understand this relationship, respondents were asked to rate how they perceived the attitude of motorists toward cyclists. As indicated in Figure 5.15, most respondents rated driver attitude as 'neutral'.

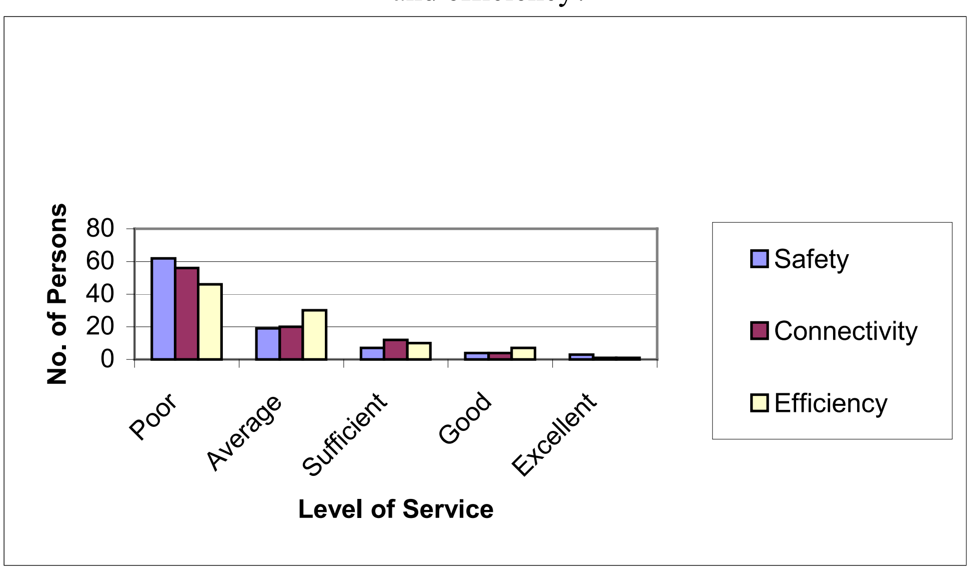
A statistically significant number of respondents perceived driver attitude as 'negative,' while only a small number rated driver attitude as positive.

Figure 5.15 Cyclists' Responses to "How would you rate the attitude/behavior of motorists toward cyclists in the Roanoke Valley?



To better understand respondents' perception of the overall level of service provided by the existing roadway network, cyclists were asked to rate the network in terms of safety, connectivity, and efficiency. Table 5.16 represents respondents' ratings of the system for each of the criteria: safety, connectively, and efficiency. Overall, the most common rating for the network was 'poor' with smaller numbers giving an average, sufficient, good or excellent rating.

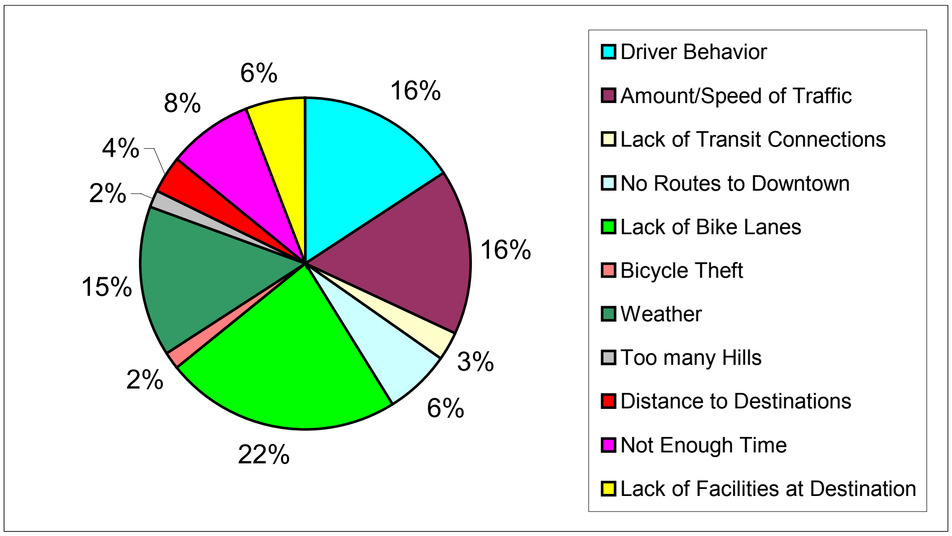
Figure 5.16: Cyclists' Responses to "How would you rate the overall level of service provided to the cyclists by the existing roadway network in terms of safety, connectivity, and efficiency?"



Factors That Discourage Respondents from Cycling More Often

Respondents were asked what discouraged them from cycling more often. For this question cyclists could check 'all factors that apply,' resulting in many listing more than one factor. As indicated in Figure 5.17, the most common factors that discourage cyclists from doing so more often were lack of bike lanes (23%), driver behavior (16%), amount/speed of traffic (16%), and weather (15%).

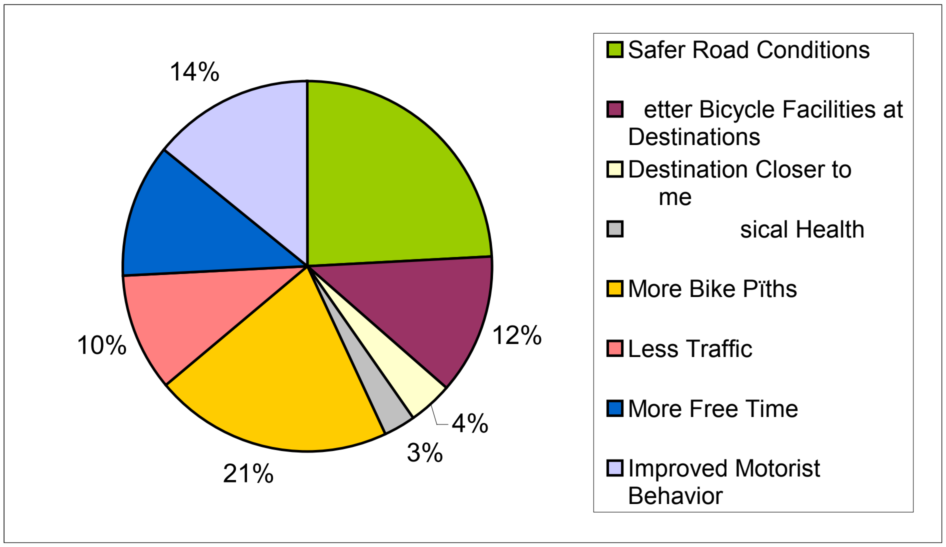
Figure 5.17: Cyclists' Responses to "What discourages you from cycling more often?"



Factors That Could Increase Bicycle Usage

Respondents were asked what factors could increase their likelihood of bicycling more often. Again, in responding to this question cyclist could to check 'all factors that apply', resulting in many respondents listing multiple factors. As listed in Figure 5.18, the most common responses were 'safer road conditions' (23%), and 'more bike paths' (21%). 'Improved motorist behavior' and 'better bicycle facilities at destinations' had the same response rate of 12 percent.

Figure 5.18: Cyclists' Responses to "What factors could increase the likelihood of your using a bicycle more often?"



Facilities Available at Respondent's Destination

To achieve a better understanding of the end-of-trip facilities available to cyclists, respondents were asked to indicate what facilities were available for them to use at common destinations (i.e., activity centers). Table 5.1 shows that 46 percent of respondents indicated that no facilities were available to respondents' at their destinations, making this the most common response. Only 13 percent of respondents cited an availability of a bike rack at their destination. As cited in Chapter 4, few of the activity centers in the area have bike racks available.

Table 5.1: Cyclists' Responses to "When you arrive at your most common destination(s) on your bicycle, what facilities are available for you to use?"

Facility	Number	Percent
None	55	46%
Bike rack	13	11%
Change room	8	7%
Secured storage	8	7%
Restroom	6	5%
Shower	3	3%
Water	1	1%

Facilities Respondents Would Like to Have Available at Their Destination

As a follow-up to the previous question, respondents were asked to indicate what (ancillary) facilities they would like to have available at their most common destination(s). Table 5.2 shows that 48 percent of respondents listed 'bike rack' as the facility they would like to have available upon reaching their destination. Other common responses were ‘secured storage’ (24%) and ‘change room’ (15%).

Table 5.2: Cyclists’ responses to “What facilities would you like to have available at your most common destination(s)?

Facility	Number	Percent
Bike rack	58	48%
Secured storage	29	24%
Change room	18	15%
Restrooms	9	7%
Shower	8	7%
Water	5	4%
Shelter	3	3%
Bicycle carriage on transit vehicles	2	2%
Covered bike rack	2	2%
Picnic table	2	2%
Refreshment	2	2%

Development of the Initial Study Network

To assist in developing a regional bicycling network, a series of questions network-related were included in the survey. Responses to these questions are presented in Tables 5.3 – 5.8. Additionally, responses will be used to assist in developing the initial ‘study network’ to be evaluated using both the BCI and BLOS models for comparison purposes. The development of the initial study network is discussed in detail in Chapter 6.

Cyclists were asked to list the five destinations they would most like to see connected via a bicycling network. Table 5.3 lists the most common responses to this question. Forty-three percent of respondents cited downtown Roanoke as a destination to be connected via a bicycling network. Other common responses included Salem (28%), the Blue Ridge Parkway (20%), Explore Park (19%), and Carvins Cove (15%). These destinations, with the exception of downtown Roanoke and Salem are likely a reflection of the high percentage of respondents who indicated ‘fitness/recreation’ as the primary reason for using a bicycle. However, other activity centers more closely related to personal trips, including Tanglewood and Valley View, were also cited as common destinations. Connecting common destinations or activity centers by a bicycling network could enable more bicycle trips and encourage bicycling as a viable form of transportation.

Table 5.3: Cyclists' Responses to "List five destinations you would like to see connected via a bicycling network."

Destination	Number	Percent
Downtown	52	43%
Salem	28	23%
Blue Ridge Parkway	20	17%
Explore Park	19	16%
Carvins Cove	15	13%
Mill Mountain	15	13%
Tanglewood	13	11%
Valley View/Airport	13	11%
Green Hill Park	11	9%
Vinton	11	9%

To help determine where to focus future bicycle network development, cyclists were asked indicate the best corridors to ride in the Roanoke Valley in terms of scenery, popularity, or recreational value. Responses are provided in Table 5.4. The Blue Ridge Parkway was by far the most common response, being cited by 58 percent of respondents. Other corridors included Bradshaw Road (17%), Mill Mountain (15%), 311 (13%) and Wiley Drive (11%). These corridors are primarily rural or suburban in nature with relatively low traffic volumes, thus are often favored by experienced recreational cyclists looking to avoid high traffic volumes.

Table 5.4: Cyclists' Responses to "List the five best corridors to ride in the Roanoke Valley in terms of scenery, popularity, or recreational value".

Corridor/Road	Number	Percent
Blue Ridge Parkway	70	58%
Bradshaw Rd.	20	17%
Mill Mountain	18	15%
311	15	13%
Wiley Dr.	13	11%
12 o'clock Knob	10	8%
Greenway System	8	7%
River Rd.	8	7%
Carvins Cove	7	6%
Harborwood Rd.	7	6%

Respondents were asked to list the five corridors in the Roanoke Valley that are currently the best to ride in terms of bicycle-friendly conditions. Table 5.5 shows that the Blue Ridge Parkway (27%) was perceived to be the most bicycle-friendly corridor in the study area, followed by Route 11 (16%). Thirteen percent of respondents cited 'none' in response to this question, indicating a generally low level of satisfaction with the bicycle-friendliness of the current roadway network.

Table 5.5: Cyclists' Responses to "List the five corridors that are currently the best roads to ride in the Roanoke Valley in terms of bicycle friendly road conditions."

Corridor/Road	Number	Percent
Blue Ridge Parkway	32	27%
11	19	16%
None	16	13%
Wiley Dr.	14	12%
Bradshaw Rd.	9	8%
Mill Mountain	9	8%
419	8	7%
Riverside Dr.	6	5%
Grandin Rd.	5	4%
Peter's Creek Extension	5	4%

In an effort to identify problem areas, (i.e., area that do not sufficiently accommodate bicycle traffic) respondents were asked to list the five worst roads, corridors, intersections, or other areas to ride in the Roanoke Valley in terms of bicycle-friendly roadway conditions. As indicted in Table 5.6, the top response to this question was Route 419 (37%) followed by 460, 211, 311, and Williamson Road.

Table 5.6: Cyclists' Responses to "List the five worst roads, corridors, intersections, or areas to ride in the Roanoke Valley in terms of bicycle friendly roadway conditions."

Corridor/Road	Number	Percent
419	44	37%
460	26	22%
221	25	21%
311	24	20%
Williamson Rd.	19	16%
220	19	16%
Franklin Rd.	16	13%
Colonial Ave.	15	13%
11	14	12%
Brambleton Ave.	13	11%

To further assist in developing a regional bicycling network, respondents were asked to list the top five corridors that should be upgraded in some way to better accommodate bicycles. As indicted in Table 5.7, responses to this question were similar to responses in Table 5.6. Again, Route 419 was the top response with 43 percent of respondents listing it as a corridor in need of improvements to better accommodate cyclists. Other corridors included 11, 311, 460, and 221.

Table 5.7: Cyclists' Responses to "List the top five corridors that should be upgraded in some way to better accommodate bicyclists."

Corridor/Road	Number	Percent
419	40	33%
11	26	22%
311	25	21%
460	21	18%
221	17	14%
Williamson Rd.	17	14%
Franklin Rd.	16	13%
Colonial Ave.	15	13%
Blue Ridge Parkway	14	12%
220	12	10%

To provide a last opportunity for respondents to offer input regarding bicycling-related issues not already addressed in previous questions, respondents were given the opportunity to list any other problem areas they have noticed in the Roanoke Valley and what needs to be done to improve them. Responses to this question are provided in Table 5.8.

Table 5.8: Cyclists' Responses to "List any other problem areas you have noticed in the Roanoke Valley and what needs to be done to improve them."

Problem Area/Improvement	Number	Percent
Lack of Wide Shoulder	11	9%
Dangerous Motorist Attitude	9	8%
Need for Public Education	9	8%
Bikes have difficulty with auto-sensing traffic lights	4	3%
Lack of Share Road Signs	4	3%
Debris on Shoulder	3	3%
Greenways Need Connection	3	3%
Need for Public Education	3	3%
Dangerous Motorist Attitude	2	2%
Need for Speed Limit Enforcement	2	2%
Wonju and Franklin Intersection	1	1%

Initial Study Network Development

The initial study network consists of selected roads and corridors in the Roanoke Valley. This network was developed to provide a limited and manageable number of roads to evaluate using both the BCI and BLOS models during Phase I of the study. This network also served as sample training corridors for Regional Commission staff and planning committee members for level of service data collection and modeling. As such, development of this network was based on several factors selected to ensure inclusion of corridors containing varying design and operational configurations. An attempt was made to include roadways in urban, suburban, and rural environments. Special attention was also given corridors in the study area that, with minimal improvements, could better accommodate bicyclists. Figure 6.1 shows the location of each of the corridors in the initial study network. The network can be grouped as follows:

Existing bicycle facilities

- Bike lane on Hardy Road in Vinton
- Bike lane on Memorial Avenue/13th near Grandin

Survey results

- Route 419
- US 460 (Salem)
- Route 311

Areas that with minimal improvements could better accommodate bicyclists

- Route 419
- Shenandoah Avenue

Figure 6.1 shows the location of each corridor modeled during Phase I. Levels of service calculations (BCI and BLOS) for each of these corridors are provided in Chapter 7. This study network will be expanded, and additional corridors evaluated, in Phase II of the study.

Development of a Regional Bicycling Network

The development of a regional bikeway network in the Roanoke Valley should be oriented toward utilitarian, as well as recreational, bicycle trips and emphasize regional connectivity and connections to the greenway and transit systems. As discussed in Chapter 4, several localities in the study area already have bike lanes in place. As facilities developed in the localities will form the foundation of a regional network, these facilities should be coordinated and integrated, along with greenways and transit, into a regional network. In developing both local and regional networks, the following objectives should be considered when applicable:

- Provide greater connection to and between activity centers and other area attractions such as universities, hospitals, parks, athletic venues, tourist attractions, and commercial centers;
- Provide access to the major central business districts of the region (e.g., downtown Roanoke and Salem);
- Provide greater connection to the Roanoke Valley Greenway System, and existing and proposed open space;
- Provide greater connection to the transit system; and
- Provide easy access to, and safe riding conditions along, scenic or popular corridors

The survey conducted as part of this study provided considerable information for use in developing a regional bicycling network. Survey results, proposed bicycle facilities, local comprehensive plans, study planning committee, and other data sources should also be consulted. Development of a regional network, and recommendations on how to best use work products developed from this study, are discussed in Chapter 8.

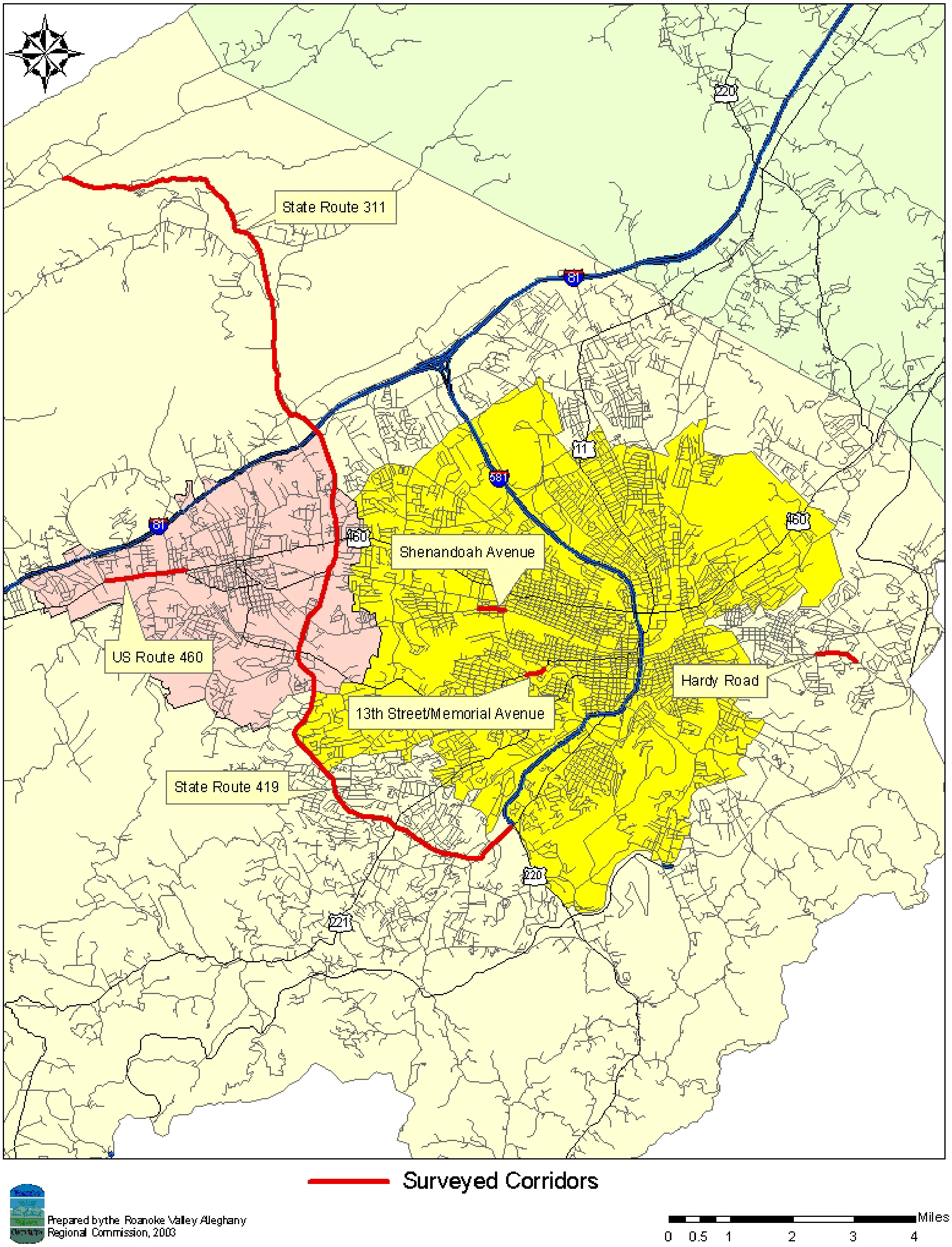


Figure 6.1: Initial Study Network

Overview of LOS Calculations

As referenced in Chapter 6, each corridor comprising the initial study network was evaluated using both the BCI and BLOS models. By applying both models to the same corridor, Regional Commission staff and the planning committee hope to achieve the following outcomes:

- Better understand the similarities and differences between the BCI and BLOS models (e.g., data requirements and collection techniques)
- Compare and contrast level of service results produced by each model
- Better understand the variables and factors that most heavily impact the level of service score given by each model

For each corridor, or segment thereof, Regional Commission staff conducted fieldwork to collect all data required of both models. It should be noted that the field data collection sheet developed by Toole Design Group (Appendix D), contains columns for not only the data required by both models, but also additional design and operational parameters affecting the roadways' ability to accommodate bicyclists. This information will be available for use in planning future bicycle facilities in the region. It should also be noted that for each corridor evaluated, the BCI model uses three spreadsheets – the data entry, intermediate calculations, and the Bicycle Compatibility Index (BCI) and Level of Service Computations spreadsheets. As the intermediate calculations sheets are not necessary for an explanation of the calculations, they are not included in this Chapter. An explanation of the models, and data requirements and collection methods is provided in Appendix C and D, respectively.

Annual Average Daily Traffic (AADT) utilized in each model were taken from the 2001 *Average Daily Traffic Volumes with Vehicle Classification Data on Interstate, Arterial, and Primary Routes* report developed by the VDOT Mobility Management Division. This document is available online at http://www.virginiadot.org/projects/resources/AADT_PrimaryInterstate_2001.pdf. The Bicycle Level of Service and Bicycle Compatibility Index Model Data Needs section of the study (Appendix D), characterizes a heavy vehicle is any large truck with six or more tires. As such, heavy vehicle percentages (HV%) were calculated, by totaling the percentages of the following VDOT vehicle classifications:

- 3+Axle Truck: Percentage of the traffic volume made up of single unit trucks with three or more axles.
- 1Trail Truck: Percentage of the traffic volume made up of units with a single trailer.
- 2Trail Truck: Percentage of the traffic volume made up of units with more than one trailer.

Hardy Road Bike Lane

As discussed in Chapter 5, the bike lane along a 0.5-mile section of Hardy Road was the first bike lane in the Roanoke Valley. This section of Hardy Road has total of four travel lanes, and a shared turning median. Additionally, the road has a 3-foot bike lane, 2-foot gutter pan, and is paralleled by a sidewalk. As shown in Table 7.1 shows that the BCI and BLOS models gave this bike lane a level of service grade of A indicating a high level of bicycle compatibility. The data entry and compilation spreadsheets for each model are provided in Tables 7.2 –7.4.

Table 7.1
Level of Service Comparisons
Hardy Road Bike Lane

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
Hardy Road bike lane	A	A

Table 7.2
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
Hardy Road Bike Lane

Data Entry														
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Data			
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)	Time Limit (minutes)
Hardy Road/ 624	2	45.5	3	3	N	35	44	10000	1.00	5.00	N	0.00	0.00

Table 7.3
Bicycle Compatibility Index (BCI) and Level of Service Computations
Hardy Road Bike Lane

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
Hardy Road/ 624	1	3.0	45.5	275	275	44	0	0	0.6	-1.79	A	Extremely High

Table 7.4
Bicycle Level of Service (BLOS) Calculations
Hardy Road Bike Lane

Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Lanes (L) Con.	Traffic Data Vol. (ADT) (vpd)	Traffic Data Pct. (HV) (%)	Post. Spd. (SPp) mph	Width of Pavement (Wt) (ft)	Width of Pavement (Wl) (ft)	Width of Pavement (Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)	Bicycle LOS Score	Bicycle LOS Grade (A..F)
Hardy Road	length of bike lane	length of bike lane	0.50	N	4	U	10,000	1	35	15.5	3.0	0.0	0	0	N	4.5	4.5	0.32	A

Memorial Avenue Bike Lane

The City of Roanoke has placed a bike lane along a 0.5-mile long portion of Memorial Avenue/13th Street between Campbell Avenue and Grandin Road. Given the differences in the road configuration for each travel direction, this segment had to be divided based on its configuration to be properly evaluated. In this case, the northbound travel lane has on-street parking, while the southbound travel lane has no on-street parking.

As shown in Table 7.5 both models graded the segment similarly. However, the differences previously referenced produce a slightly different level of service grades for the different travel directions using the BLOS model. The data entry and compilation spreadsheets for each model are provided in Tables 7.6 –7.8.

Table 7.5
Level of Service Comparisons
Memorial Avenue/13th Street Bike Lane

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
Memorial Avenue Northbound	C	B
Memorial Avenue Southbound	C	C

Table 7.6
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
Memorial Avenue Bike Lane

Data Entry														
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Data			
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number,	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)	Time Limit (minutes)
Memorial Drive Northbound	1	12	5	12	y	30	39	12000	0.00	2.00	Y	5.00	0.00
Memorial Drive Southbound	1	12	5	5	y	30	39	12000	0.00	2.00	N	0.00	0.00

Table 7.7
Bicycle Compatibility Index (BCI) Level of Service Computations
Memorial Avenue Bike Lane

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
Memorial Drive Northbound	1	5.0	12.0	660	0	39	1	1	0.1	3.28	C	Moderately High
Memorial Drive Southbound	1	5.0	12.0	660	0	39	0	1	0.1	2.78	C	Moderately High

Table 7.8
Bicycle Level of Service (BLOS) Calculations
Memorial Avenue Bike Lane

Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Lanes (L) Con.	Traffic Data Vol. (ADT) (vpd)	Traffic Data Pct. (HV) (%)	Post. Spd. (SPp) mph	Width of Pavement (Wt) (ft)	Width of Pavement (Wl) (ft)	Width of Pavement (Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)	Bicycle LOS Score	Bicycle LOS Grade (A..F)
US 11/Memorial Drive	Grandin Rd.	Campbell Ave.	0.84	N	2	U	12,000	0	30	24.0	12.0	7.0	25	25	N	4.0	4.0	2.05	B
US 11/Memorial Drive	Grandin Rd.	Campbell Ave.	0.84	S	2	U	12,000	0	30	16.0	5.0	0.0	0	0	N	4.0	4.0	3.09	C

Route 419

Route 419 was included in the study network based on several factors. First, as discussed in Chapter 5, Route 419 was cited several times in the bicycling survey conducted as part of this study. As was shown in Tables 5.6 and 5.7, Route 419 was listed as the top response to the following survey directives:

- List the five worst roads, corridors, intersections, or areas to ride in the Roanoke Valley in terms of bicycle friendly roadway conditions; and
- List the top five corridors that should be upgraded in some way to better accommodate bicyclists.

Additionally, Route 419 was identified as one of the corridors that with minimal improvements could potentially be made to better accommodate bicyclist.

As discussed in Chapter 4, Route 419 is a 4-lane (two lanes in each travel direction), divided roadway that connects parts of the City of Roanoke, Roanoke County, and the City of Salem. Segments of Route 419 that were evaluated collectively cover 11.17 miles. Route 419 has a twenty-foot median and a seven-foot paved shoulder running most of its length. In places (i.e., intersections) part of the median width is used to provide a separate left turning lane. Additionally, at most right turn areas, the paved shoulder width is increased for use as a separate right turning lane. To evaluate the level of service for segments of 419, Regional Commission staff collected all requisite data for each segment of the corridor.

As presented in Table 7.9, there was considerable variation in the grade given to each segment by the different models.

Table 7.9
Level of Service Comparisons
Route 419

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
Franklin Road to Ronaoke County line (0.7)	E	C
Roanoke County line to Starkey Road (0.77)	D	A
Starkey Road to Brambleton/US 221 (1.44)	D	A
Brambleton to Salem City line (3.16)	D	A
Salem City line to Apperson/US 11 (0.69)	F	D
Apperson/US 11 to Roanoke Blvd. (0.58)	E	D
Roanoke Blvd. to Alt US 60/Texas Street (0.89)	E	D
Alt US 60/Texas Street to US 460/E.Main (0.53)	E	D
US 460/E.Main to RCL (0.88)	E	D
RCL to I-81 (0.96)	E	D
I-81 to 311/Catawba Valley Drive (0.57)	E	D

The BCI Data Entry Sheet and Level of Service Computations are presented in Tables 7.10 and 7.11, and the BLOS calculations spreadsheet is presented in Table 7.12. Based on BCI model calculations (Table 7.11), all segments along this corridor scored a low level of bicycle compatibility. Of the 11 segments evaluated, three scored a level of service grade of D, seven scored an E, and one segment scored an F (Table 7.12). The BLOS model, when applied to the same Route 419 segments, scored the segments differently. As shown in Table 7., the BLOS model gave three segments a level of service grade of A, one segment a C, and seven segments received a grade of E.

Table 7.10
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
Route 419

Data Entry														
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Data		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)	Time Limit (minutes)
Franklin Road to Ronaoke County line (0.7)	2	12	0	7	n	35	35	50000	0.00	20.00	n	0.00	0.00
Roanoke County line to Starkey Road (0.77)	2	12	0	11	n	35	35	50000	0.00	20.00	n	0.00	0.00
Starkey Road to Brambleton/US 221 (1.44)	2	12	0	7	n	45	45	27000	0.00	10.00	n	0.00	0.00
Brambleton to Salem City line (3.16)	2	12	0	7	n	45	45	35000	0.00	5.00	n	0.00	0.00
Salem City line to Apperson/US 11 (0.69)	2	12	0	0	n	45	45	32000	0.00	5.00	n	0.00	0.00
Apperson/US 11 to Roanoke Blvd. (0.58)	2	12	0	0	n	35	35	28000	0.00	5.00	n	0.00	0.00
Roanoke Blvd. to Alt US 60/Texas Street (0.89)	2	12	0	0	n	35	35	19000	3.00	5.00	n	0.00	0.00
Alt US 60/Texas Street to US 460/E.Main (0.53)	2	12	0	0	n	35	35	20000	4.00	8.00	n	0.00	0.00
US 460/E.Main to RCL (0.88)	2	12	0	0	n	45	45	13000	4.00	5.00	n	0.00	0.00
RCL to I-81 (0.96)	2	12	0	0	n	45	45	14000	4.00	2.00	n	0.00	0.00
I-81 to 311/Catawba Valley Drive (0.57)	1	12	0	0	n	45	45	9700	1.00	0.00	n	0.00	0.00

Table 7.11
Bicycle Compatibility Index (BCI) and Level of Service Computations
Route 419

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
Franklin Road to Ronaoke County line (0.7)	1	7.0	12.0	1375	1375	35	0	0	0.1	4.63	E	Very Low
Roanoke County line to Starkey Road (0.77)	1	11.0	12.0	1375	1375	35	0	0	0.1	4.13	D	Moderately Low
Starkey Road to Brambleton/US 221 (1.44)	1	7.0	12.0	743	743	45	0	0	0.1	3.46	D	Moderately Low
Brambleton to Salem City line (3.16)	1	7.0	12.0	963	963	45	0	0	0.1	3.99	D	Moderately Low
Salem City line to Apperson/US 11 (0.69)	0	0.0	12.0	880	880	45	0	0	0.1	5.63	F	Extremely Low
Apperson/US 11 to Roanoke Blvd. (0.58)	0	0.0	12.0	770	770	35	0	0	0.1	5.02	E	Very Low
Roanoke Blvd. to Alt US 60/Texas Street (0.89)	0	0.0	12.0	523	523	35	0	0	0.6	4.93	E	Very Low
Alt US 60/Texas Street to US 460/E.Main (0.53)	0	0.0	12.0	550	550	35	0	0	0.6	4.99	E	Very Low
US 460/E.Main to RCL (0.88)	0	0.0	12.0	358	358	45	0	0	0.6	4.88	E	Very Low
RCL to I-81 (0.96)	0	0.0	12.0	385	385	45	0	0	0.6	4.95	E	Very Low
I-81 to 311/Catawba Valley Drive (0.57)	0	0.0	12.0	534	0	45	0	0	0.5	4.99	E	Very Low

Table 7.12
Bicycle Level of Service (BLOS) Calculations
Route 419

Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Con.	Traffic Data Vol. (ADT) (vpd)	Pct. (HV) (%)	Post. Spd. (SPp) mph	Width of Pavement (Wt) (ft)	(Wl) (ft)	(Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)
419	Franklin Road	Ronaoke County line	0.70	WB	4	D	50000	0.00	35	12.0	7.0	0.0	0	0	n	4.0	4.0
419	Roanoke County line	Starkey Road	0.77	WB	4	D	50000	0.00	35	19.0	7.0	0.0	0	0	n	4.0	4.0
419	Starkey Road	Brambleton/US 221	1.44	WB	4	D	27000	0.00	45	19.0	7.0	0.0	0	0	n	4.0	4.0
419	Brambleton	Salem City line	3.16	WB	4	D	35000	0.00	45	19.0	7.0	0.0	0	0	n	4.0	4.0
419	Salem City line	Apperson/US 11	0.69	WB	4	D	32000	0.00	45	12.0	0.0	0.0	0	0	n	4.0	4.0
419	Apperson/US 11	Roanoke Blvd.	0.58	WB	4	D	28000	0.00	35	12.0	0.0	0.0	0	0	n	4.0	4.0
419	Roanoke Blvd.	Alt US 60/Texas Street	0.89	WB	4	D	19000	3.00	35	12.0	0.0	0.0	0	0	n	4.0	4.0
419	Alt US 60/Texas Street	US 460/E.Main	0.53	WB	4	D	20000	4.00	35	12.0	0.0	0.0	0	0	n	4.0	4.0
419	to US 460/E.Main	RCL	0.88	WB	4	D	13000	4.00	45	12.0	0.0	0.0	0	0	n	4.0	4.0
419	RCL	I-81	0.96	WB	4	D	14000	4.00	45	12.0	0.0	0.0	0	0	n	4.0	4.0
419	I-81	311/Catawba Valley Drive	0.57	WB	4	D	9700	1.00	45	12.0	0.0	0.0	0	0	n	4.0	4.0

Route 311

Route 311 was included in the study network base primarily on its being cited as one of the top responses for several survey questions (Table 5.6 and 5.7). The segment evaluated, a 6.7 segment from 419 Electric Road to Catawba Creek Road, is best described as a rural residential. This two-lane section of the 311 has recently been repaved. However, the shoulder is not paved and is composed of gravel. Route 311 is of special interest in that it is not only a popular route for recreational cyclists, it also provides a connection to many popular mountain bike trails and open space surrounding the Carvins Cove reservoir.

Table 7.13 shows that this segment scored very low on both models, with each giving the segment a level of service grade of E. This is primarily due to the high speed limit (55) and the lack of a paved shoulder to better accommodate bicyclists.

Table 7.13
Level of Service Comparisons
Route 311

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
419 Electric Rd. to Catawba Creek Rd. (6.70)	E	E

Table 7.14
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
Route 311

Data Entry														
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Data		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)	Time Limit (minutes)
419 Electric Rd. to Catawba Creek Rd. (6.70)	1	12	0	0	Y	55	55	10000	4.00	25.00	n	0.00	0.00

Table 7.15
Bicycle Compatibility Index (BCI) and Level of Service Computations
Route 311

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
419 Electric Rd. to Catawba Creek Rd. (6.70)	0	0.0	12.0	550	0	55	0	1	0.6	5.21	E	Very Low

Table 7.16
Bicycle Level of Service (BLOS) Calculations
Route 311

Seg_ID	Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Lanes (L) Con.	Traffic Data Vol. (ADT) (vpd)	Traffic Data Pct. (HV) (%)	Post. Spd. (SPp) mph	Width of Pavement (Wt) (ft)	Width of Pavement (Wl) (ft)	Width of Pavement (Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)	Bicycle LOS Score	Bicycle LOS Grade (A..F)
1.0	311	419	Catawba Creek Rd.	6.70	N	2	U	10,000	4	55	12.0	0.0	0.0	0	0	n	5.0	0.0	4.63	E

US 460 (Wildwood Road to 4th Street, Salem)

Regional Commission staff evaluated the section of US 460 between Wildwood Road and 4th Street (460 Alt.). Within this 1.31-mile segment the outside travel lane is 12.5 feet wide, which is less that the minimum recommended width for a shared travel lane. This section of 460 serves not only as a major thoroughfare, but also provides access to a major commercial area of the City of Salem. As such, this segment of Route 460 has a very high AADT and right turn percentage, both of which negatively impact bicycle compatibility.

Table 7.13 provides level of service comparisons for this segment of 460. Both models gave a low compatibility and level of service score for this section of 460. The BCI gave a score of E, and the BLOS gave it a D.

Table 7.17
Level of Service Comparisons
US 460 (Wildwood Road to 4th Street, Salem)

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
Wildwod Road to 460 Alt./4th Street, Salem	E	D

Table 7.18
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
US 460

Data Entry													
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Da		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)
SR 112 to ALT US 460, 4th St. (1.31)	2	12.5	0	0	N	35	35	25000	2.00	25.00	N	0.00

Table 7.19
Bicycle Compatibility Index (BCI) and Level of Service Computations
US 460

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
SR 112 to ALT US 460, 4th St. (1.31)	0	0.0	12.5	688	688	35	0	0	0.6	5.25	E	Very Low

Table 7.20
Bicycle Level of Service (BLOS) Calculations
US 460

Seg_ID	Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Lanes (L) Con.	Traffic Data Vol. (ADT) (vpd)	Traffic Data Pct. (HV) (%)	Post. Spd. (SPp) mph	Width of Pavement (Wt) (ft)	Width of Pavement (Wl) (ft)	Width of Pavement (Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)	Bicycle LOS Score	Bicycle LOS Grade (A..F)
1.0	460	SR112	ALT US 460, 4th St.	1.31	W	4	U	25,000	2	35	12.5	0.0	0.0	0	0	N	5.0	0.0	**3.89**	**D**

Shenandoah Avenue

Shenandoah Avenue is an example of a corridor that, with minimal improvements, could better accommodate bicyclists. This segment of Shenandoah Avenue is a two-lane road that serves as a connection between the cities of Salem and Roanoke. Many segments of this corridor have travel lanes sufficiently wide (17.5-feet) to accommodate a bike lane or other on-road facilities. However, it should be noted that lane and shoulder width along this corridor are not consistent, thereby presenting obstacles to accommodating bicyclists along certain sections.

As shown in Table 7.21 both models scored the section similarly, with the BCI model providing a grade of D and the BLOS model provided a grade of C. Table

Table 7.21
Level of Service Comparisons
Shenandoah Avenue

Road/Segment	BCI Level of Service Grade	BLOS Level of Service Grade
30th Street to 24th Street	D	C

Table 7.22
Bicycle Compatibility Index (BCI) Data Entry Spreadsheet
Shenandoah Avenue

Data Entry														
Location	Geometric & Roadside Data					Traffic Operations Data					Parking Data		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number,	No. of Lanes (one direction)	Curb Lane Width (ft)	Bicycle Lane Width (ft)	Paved Shoulder Width (ft)	Residential Development (y/n)	Speed Limit (mi/h)	85th %tile Speed (mi/h)	AADT	Large Truck % (HV)	Right Turn % (R)	Parking Lane (y/n)	Occupancy (%)	Time Limit (minutes)
30th Street to 24th Street	1	17.5	0	0	N	35	35	8000	2.00	0.00	N	0.00	0

Table 7.23
Bicycle Compatibility Index (BCI) and Level of Service Computations
Shenandoah Avenue

Bicycle Compatibility Index and Level of Service Computations												
Location	BCI Model Variables									Results		
Midblock Identifier (Route/Intersecting Streets, Segment Number, Link Number, Etc.)	BL	BLW	CLW	CLV	OLV	SPD	PKG	AREA	AF	BCI	Level of Service	Bicycle Compatibility Level
30th Street to 24th Street	0	0.0	17.5	440	0	35	0	0	0.5	3.62	D	Moderately Low

Table 7.24
Bicycle Level of Service (BLOS) Calculations
Shenandoah Avenue

Route Name	From	To	Len. (Ls) (Mi)	Dir. of Sur.	Lanes (L) Th #	Lanes (L) Con.	Vol. (ADT) (vpd)	Pct. (HV) (%)	Spd. (SPp) mph	Width of Pavement (Wt) (ft)	Width of Pavement (Wl) (ft)	Width of Pavement (Wps) (ft)	Occu. Park. N/E (%)	Occu. Park. S/W (%)	Rumb. Stps. (Y/N)	Pvmt Cond Lane (5..1)	Pvmt Cond Shdr (5..1)	Bicycle LOS Score	Bicycle LOS Grade (A..F)
Shenandoah	30th Street	24th Street	0.50	E	2	U	8,000	0	35	17.5	0.0	0.0	0	0	N	4.0	4.0	2.72	C

Study Summary

The *Regional Bicycle Suitability Study* is intended to serve as a resource document to facilitate development of a regionally significant bikeway network in the RVAMPO service area. The primary purpose of the *Regional Bicycle Suitability Study* is to develop ***planning level data and tools*** to assess the current level of service (LOS) offered by the existing roadway network in regards to bicycle travel in the region. Data and tools developed as part of the study are useful in identifying current and future problems facing the bicycling public, facilitating the planning and design of a bicycle-friendly transportation system, and determining possible options regarding operational and design requirements for new facilities.

Work products developed from Phase I of the *Study* will be available for planners, transportation engineers, bicycle coordinators and enthusiasts, and citizens, to assist in developing facilities and other accommodations to enhance safe bicycle travel within the MPO. Additionally, Phase I work products will be further expanded and implemented in Phase II of the *Regional Bicycle Suitability Study* as outlined in the *FY 2003-2004 Unified Transportation Work Program* and the *FY 2004 Rural Transportation Planning Program*. A complete list of work products developed in Phase I of the study is provided in Chapter 1.

Recommendations

Phase I recommendations were developed by the Study Planning Committee and Regional Commission staff. These recommendations will serve as the “next steps” in the planning process. As such, they are intended to be general in nature and will be further developed and implemented in Phase II of the study.

- **Continue to work with the** *Regional Bicycle Suitability Study* **Planning Committee to effectively utilize Phase I work products and guide Phase II activities.**

The *Regional Bicycle Suitability Study* Planning Committee is composed of a cross-section of stakeholders including Regional Commission staff, local planning and traffic engineering staff, Greenway representatives, VDOT representatives, bicycling advocates, and citizens. The planning committee was established, as part of Phase I, to serve in an advisory capacity and assist in guiding various aspects of the study. The committee will continue to serve in this capacity throughout the completion of Phase II. Major tasks will include guiding effective utilization and application of work products developed in Phase I and development of a detailed project scope for Phase II.

- **Develop a regional bicycling network for LOS calculations and mapping**

This network should emphasize both transportation and recreation routes and corridors. Development of the regional bicycling network will draw from a wide variety of documents and other sources including, but not limited to:

Study Planning Committee
Long Range Transportation Plan
Local Comprehensive Plans
Bikeway Plan for the Roanoke Valley Area (1997)
Conceptual Greenway Plan
Bicycle advocates
Bicycling survey
Valley Metro Ride Guide

- **Apply both the BCI and BLOS models in evaluating the level of service offered by the regional bicycling network and proposed bicycle facilities in the MPO.**

As referenced in Chapter 7, by applying both models to the same corridor, Regional Commission staff and the planning committee hope to achieve the following outcomes:

- Better understand the similarities and differences between the BCI and BLOS models (e.g., data requirements and collection techniques)
- Compare and contrast level of service results produced by each model
- Better understand the variables and factors that most heavily impact the level of service score given by each model

Upon completion of the modeling process, results produced by each model will be compared and evaluated to determine the model that most accurately reflects the conditions of the study area. Results will be utilized to produce compatibility maps for use by area cyclist in route selection and making design recommendations.

- **Facilitate incorporation of the Roanoke Valley Greenways system and the public transit systems as integral components of the bicycling and alternative transportation systems**

The federal Transportation Equity Act for the 21st Century (TEA-21), enacted in 1998, calls for integrating all modes of transportation - cars, buses, trains, trucks, walking and biking - into a single, multi-modal, efficient transportation system. Greenways and public transit are integral components of this alternative transportation and should be considered when planning and developing the regional bicycling network.

- **Facilitate coordination of each locality's street resurfacing schedules and consideration of bicycle accommodations**

Coordination of resurfacing and consideration of bicycle accommodations can be a cost-effective means of increasing the LOS with minimal improvements to the existing corridors. The BCI and BLOS can assist in making recommendations for accommodations prior to resurfacing.

- **Expand and maintain the** *Regional Bicycle Suitability Study* **website as a public outreach tool for use by all interested stakeholders**

By expanding the *Regional Bicycle Suitability Study* website it can better serve as a public outreach tool for the MPO. The website can be an effective way to make available to the public work products from the study and other useful bicycling information. The website will offer:

- downloadable BCI and BLOS worksheets for level of service calculations
- Phase I and Phase II work products
- compatibility and route maps
- useful links
- photo gallery
- bicycling related news, legislation and other information
- discussion forum for bicycling related topics

Appendix A

Roanoke Valley Area Metropolitan Planning Organization
Regional Bicycle Suitability Study
Project Scope

Study Purpose

The purpose of this study is to provide a preliminary assessment of the current level of service offered by the existing transportation and recreation infrastructure from the perspective of the bicyclist. This preliminary assessment will provide planning level data needed to identify current and future problems facing the bicycling public, facilitate the planning and design of a bicycle-friendly transportation system, and determine possible improvements regarding operational and geometric requirements for new facilities. Attention will be given to linkages/connectivity between the Roanoke Valley Greenway system, the public transportation infrastructure (i.e., Valley Metro), activity centers/destinations (e.g., village centers, commercial centers, schools, and parks) and notably scenic corridors in the Roanoke Valley. Study findings and end products will be available for use by localities in the region, and can be easily incorporated into local plans.

Study Area

The study encompasses the Roanoke Valley Area Metropolitan Planning Organization service area to include the counties of Botetourt and Roanoke, the cities of Roanoke and Salem, and the town of Vinton.

End Products

The goal of the study is to provide planners, transportation engineers, bicycle coordinators and enthusiasts, and others, planning level data and tools for use in guidance in the development of facilities and other accommodations to enhance safe bicycle travel within the MPO. Planning level data and tools will include:

- Model for level of service calculations
- Planning committee to facilitate effective application and use of study end products in future bicycle facilities planning and design
- Detailed analysis and summary of survey responses
- Prioritized lists of routes, corridors, destinations, and activity centers to be connected via a significant regional bicycling network
- Maps of existing and proposed bicycle facilities, and other spatial data relevant to the study
- Review of existing conditions, opportunities, and obstacles
- Overview of local, regional, state, and national bicycle facility planning efforts
- Bicycle facilities design workshop
- Trained data collectors to assist BCI modeling
- Database of operational and design parameters for roads in the 'study network'
- *Regional Bicycle Suitability Study* website

Task I. Study Preparation

A. Review literature regarding existing bicycle level of service methodologies and select the methodology most applicable to the study.
B. Develop a planning committee, composed of a cross-section of interested stakeholders, to assist in various aspects of the study as needed.
C. Using surveys, and other data collection techniques as needed, solicit information from focus groups regarding various cycling related issues relevant to the study.
D. Contract with a consultant to 1) provide up-front consultation in the development of a bicycle study network; 2) deliver a one-day training course on bicycle facility design and data collection methods in order to collect the necessary data for model from Task I.A ; 3) provide additional consultation during the data collection and modeling phases.

Task II. Inventory of Existing Resource

A. Review existing local plans (e.g. comprehensive plans, bike plans, greenway plan, etc.) to note any references to future bicycle and/or pedestrian networks, facilities, or related infrastructure
B. Using data collected in Tasks I.C and II.A, work with planning committee to develop a prioritized list and map of bicycle routes and corridors to serve as the 'study network' for level of service calculations
C. Using Regional Commission staff and trained data collectors as outlined in Task I.D, compile a database of operational and geometric attributes, as required by the model selected in Task I.A, for selected corridors in the 'study network' developed in Task II.B.

Task III. Identify Activity Centers, Linkages, and Problem Areas

A. Using data collected from Task 1.C, identify activity centers respondents would like to reach via bicycle, provided a sufficient level of service, safety, connectivity, and efficiency (note: activity centers may include but are not limited to village centers, schools, commercial centers, the Roanoke Valley Greenway system, sports venues, the public transportation infrastructure (i.e., Valley Metro), and notably scenic or enjoyable corridors in the Roanoke Valley).
B. Identify potential corridors and links to utilize in increasing connectivity between activity centers noted in Task III.A with special emphasis on the Greenway and public transportation systems.
C. Using data collected from Tasks 1.C and 1.E, identify and map the 'problem' or 'isolated' areas of the MPO not having viable access to corridors or routes with sufficient levels of service
D. Identify obstacles and impediments to bicycle travel in areas identified in Task III.C suggested improvements to make these areas more 'bicycle friendly.'

Task IV. Analysis of Planning Level Data

A. Using model selected in Task I.A and data collected in Task II.B, calculate the level of service for corridors in the 'study network' developed in Task II.A.
B. Produce a series of maps to display the following spatial data:
    - compatibility maps
    - existing routes and facilities (i.e., often used bicycle routes and corridors)
    - potential new routes
    - destinations and activity centers

- problem or isolated areas, and impediments
- geo-coded map of the survey respondents (for those that provide optional address information)
- other spatial data as needed

Task V. Conclusion and Recommendations

A. Draft a final report summarizing the study findings and end products
B. Continue working with the study planning committee, local governments, and cycling enthusiasts to effectively use study findings and to facilitate improvements to the regional bicycle network. Possible activities include, but are not limited to:
    - modeling additional corridors
    - bike lane designation and signage
    - seeking funding through various federal, state, local, and private sources
    - route mapping
    - develop non-binding guidelines for design criteria for the regional cycling network
    - working with other stakeholders, use data to develop a *Regional Bicycling Guide*
    - other uses to be determined

Appendix B

Roanoke Valley Alleghany Regional Commission

Roanoke Valley Area Metropolitan Planning Organization
Regional Bicycle Suitability Study
Cycling Survey

1. How often do you cycle for the following purposes?

	Almost Daily (4-5 days per week)	Often (1-3 days per week)	Rarely (1-2 days per month)	Never
commuting to work	☐	☐	☐	☐
commuting to school	☐	☐	☐	☐
personal trips (e.g., to a store, to a friends house)	☐	☐	☐	☐
fitness/recreation	☐	☐	☐	☐
commuting to a public transit facility	☐	☐	☐	☐
other ___________________________	☐	☐	☐	☐

2. How many miles do you ride your bicycle in a average week?

0-2 miles ☐ 3-10 miles ☐
11-20 miles ☐ more than 20 miles ☐

3. How far do you live from your place of work?

0-2 miles ☐ 3-5 miles ☐
6-8 miles ☐ more than 8 miles ☐

4. How far do you live from the nearest public transit facility (i.e., Valley Metro stop)?

less than 0.3 miles ☐ 0.3-0.6 miles ☐
0.7-1.0 mile ☐ more than 1.0 mile ☐

5. How often do you use public transit?

Almost Daily ☐ Often ☐ Rarely ☐ Never ☐

6. If you rarely or never use public transit, what are the reasons for the same?

transit stop is too far from home ☐ prefer driving car ☐

lack of bicycle facilities at transit stop (e.g., bike racks, change rooms, etc.) ☐ lack of bikeways or sidewalks to transit stop ☐

infrequent service ☐ other ______________________ ☐

7. How far do you live from the nearest Roanoke Valley Greenway? (see list in question 8)

0-2 miles ☐	3-5 miles ☐
6-8 miles ☐	more than 8 miles ☐

8. How often do you use the following Roanoke Valley Greenways for cycling?

	Almost Daily	Often	Rarely	Never
Mill Mountain Greenway	☐	☐	☐	☐
Murray Run Greenway	☐	☐	☐	☐
Lick Run Greenway	☐	☐	☐	☐
Tinker Creek Greenway	☐	☐	☐	☐
Roanoke River Greenway along Wiley Dr.	☐	☐	☐	☐
Wolf Creek Greenway	☐	☐	☐	☐
Hanging Rock Battlefield Trail	☐	☐	☐	☐
Roanoke River Greenway	☐	☐	☐	☐
Hanging Rock Battlefield Trail	☐	☐	☐	☐

9. Do you have school-aged children in your household that ride bicycles on the roadway network?

yes ☐ no ☐

10. How would you rate the attitude/behavior of motorists toward cyclists in the Roanoke Valley?

positive ☐ neutral ☐ negative ☐

11. How would you rate the <u>overall</u> level of service provided to the cyclists by the existing roadway network in terms of safety, connectivity, and efficiency?

	poor	average	sufficient	good	excellent
safety	☐	☐	☐	☐	☐
connectivity	☐	☐	☐	☐	☐
efficiency	☐	☐	☐	☐	☐

12. What discourages you from cycling more often (check all that apply)?

driver behavior ☐	lack of bike lanes ☐	distance to destinations ☐
amount/speed of traffic ☐	bicycle theft ☐	not enough time ☐
lack of transit connections ☐	weather ☐	lack of facilities at destination(s) ☐
no routes to downtown ☐	too many hills ☐	other ______________________ ☐

13. What factors could increase the likelihood of your using a bicycle more often (check all that apply)?

safer road conditions	☐	better physical health	☐	more free time	☐
more/better bicycle facilities at destinations	☐	more bike paths or wider shoulders	☐	improved driver behavior/attitude toward cyclists	☐
destinations closer to home	☐	less traffic	☐	other ________________________	☐

14. What type of bicycle infrastructure would you prefer? (Please rank in order of preference)

no special provisions (e.g., bike lanes or separated paths)	___________
major streets with wide lanes or shoulders	___________
bike lanes on major streets	___________
bike routes on side streets (i.e., signage only, no bike lanes)	___________
separated bicycle paths (i.e., paved path at side of roadway separated by curb or median)	___________
other facilities or combination of facilities above (please list): ____________________	___________

15. As a cyclist, what aspects of the existing recreation and roadway network do you like?

16. List where you generally cycle from, your destination, and the route taken.

Starting Point (i.e., near the intersection of Third and Luck	**Destination**	**Description of Route**

17. When you arrive at your most common destination(s) on your bicycle, what facilities are available for you to use? (e.g., bike racks, secured storage, change rooms, etc.)

18. What facilities would you like to have available at your most common destination(s)? (e.g., bike racks, secured storage, change rooms, etc.)

19. List five destinations you would like to see connected via a bicycling network (e.g., village centers, commercial centers, recreational areas, or other points of interest).

1.
2.
3.
4.
5.

20. List the five corridors that are currently the best roads to ride in the Roanoke Valley in terms of bicycle friendly road conditions (list starting and ending points i.e., Route 419 between Colonial Avenue and Apperson Drive).

1.
2.
3.
4.
5.

21. List the five best five corridors to ride in the Roanoke Valley in terms of scenery, popularity, or recreational value?

1.
2.
3.
4.
5.

22. List the five worst roads, corridors, intersections, or areas to ride in the Roanoke Valley in terms of bicycle friendly roadway conditions.

1.
2.
3.
4.
5.

23. List the top five corridors that should be upgraded in some way to better accommodate bicycles.

1.
2.
3.
4.
5.

24. List any other problem areas you have noticed in the Roanoke Valley and what needs to be done to improve them. (use the back of this survey if necessary)

25. Other comments? (use the back of this survey if necessary)

OPTIONAL DEMOGRAPHIC INFORMATION

26. Please indicate your age group and gender:

under 16	☐	45-54	☐	Female	☐
16-24	☐	55-64	☐	Male	☐
25-34	☐	65-75	☐		
35-44	☐	75+	☐		

Thank you for taking the time to complete this survey. Although optional, to assist the Regional Commission in developing a spatial database of survey respondents, please provide the following information:

Street address	Apartment # (if applicable)	City	State	5-digit Zip code

Using the enclosed self-addressed, stamped envelope, please return the survey to the Roanoke Valley-Alleghany Regional Commission by <u>April 30, 2003.</u> If you have any questions concerning the survey or the *Regional Bicycle Suitability Study*, please contact the Regional Commission at (540) 343-4417.

Appendix C

A Summary of the
Bicycle Compatibility Index

Prepared for the

Roanoke Valley-Alleghany Regional Commission
Bicycle Suitability Analysis Training

May 2003

The Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual

Federal Highway Administration

FHWA-RD-98-095

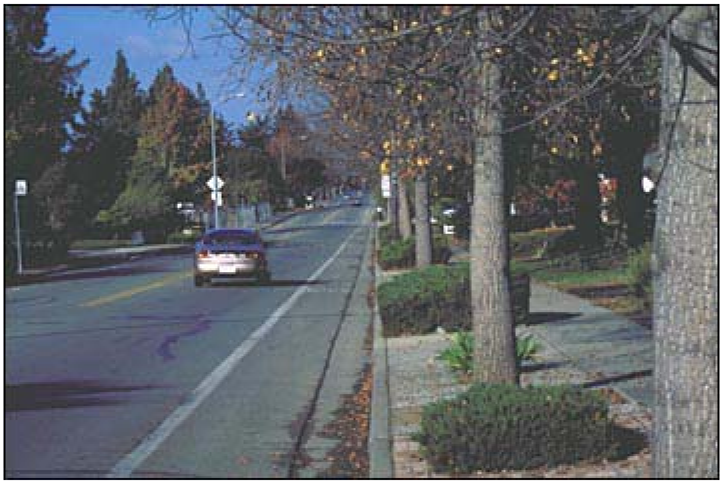
Excerpt taken from http://www.hsrc.unc.edu/research/pedbike/98095/index.html

Introduction

The goals of the United States Department of Transportation (USDOT) as stated in the *National Bicycling and Walking Study* are: 1) to double the number of trips made by bicycling and walking, and 2) to simultaneously reduce by 10 percent the number of pedestrians and bicyclists killed or injured in traffic crashes.[1] Meeting the first of these goals will require a substantial increase in the number of trips made by bicyclists using on-road or shared facilities. This increased exposure could, in turn, jeopardize the second goal of improved safety unless careful consideration is given to the needs of both bicyclists and motor vehicle operators in the enhancement of existing roadways or development of new roadways. To develop or improve roadways for shared use by these two modes of transportation, one must begin by evaluating existing roadways and determining what is considered user-friendly from the perspective of the bicyclist.

Currently, no methodology is widely accepted by engineers, planners, or bicycle coordinators that will allow them to determine how compatible a roadway is for allowing efficient operation of both bicycles and motor vehicles. Determining how existing traffic operations and geometric conditions impact a bicyclist's decision to use or not use a specific roadway is the first step in determining the bicycle compatibility of the roadway.

The primary objective of the current study was to develop a methodology for deriving a ***bicycle compatibility index (BCI)*** that could be used by bicycle coordinators, transportation planners, traffic engineers, and others to evaluate the capability of specific roadways to accommodate both motorists and bicyclists (see figure 1). This research effort expanded upon the stress level work of Sorton and Walsh[2] and the Geelong Bikeplan Team[3] to produce a practical instrument that can be used by practitioners to predict bicyclists' perceptions of a specific roadway environment and ultimately determine the level of bicycle compatibility that exists on roadways within their jurisdictions. *(For a more complete discussion of these and other efforts that have been undertaken in recent years to develop a systematic means of measuring the suitability of roadways for bicycling, refer to the final report for this study.[4])*



Streets with marked bicycle lanes

Streets with Standard or Wide-Curb Lanes

Streets with Parking

Figure 1. The bicycle compatibility index (BCI) allows practitioners to evaluate the capability of a variety of roadways to accommodate both motorists and bicyclists using geometric and operational characteristics such as lane widths, speed, and volume.

The BCI methodology was developed for urban and suburban roadway segments (i.e., midblock locations that are exclusive of major intersections) and incorporated those variables that bicyclists typically use to assess the "bicycle friendliness" of a roadway (e.g., curb lane width, traffic volume, and vehicle speeds). The BCI model developed and the subsequent level of service (LOS) designations provide practitioners the capability to assess their roadways with respect to compatibility for shared-use operations by motorists and bicyclists and to plan for and design roadways that are bicycle compatible. Specifically, the BCI model can be used for the following applications:

· Operational Evaluation - Existing roadways can be evaluated using the BCI model to determine the bicycle LOS present on all segments. This type of evaluation may be useful in several ways. First, a bicycle compatibility map can be produced for the bicycling public to indicate the LOS they can expect on each roadway segment. Second, roadway segments or "links" being considered for inclusion in the bicycle network system can be evaluated to determine which segments are the most compatible for bicyclists. In addition, "weak links" in the bicycle network system can be determined, and prioritization of sites needing improvements can be established on the basis of the index values. Finally, alternative treatments (e.g., addition of a bicycle lane vs. removal of parking) for improving the bicycle compatibility of a roadway can be evaluated using the BCI model.

· Design - New roadways or roadways that are being re-designed or retrofitted can be assessed to determine if they are bicycle compatible. The planned geometric parameters and predicted or known operational parameters can be used as inputs to the model to produce the BCI value and determine the bicycle LOS and compatibility level that can be expected on the roadway. If the roadway does not meet the desired LOS, the model can be used to evaluate changes in the design necessary to improve the bicycle LOS.

· Planning - Data from long-range planning forecasts can be used to assess the bicycle compatibility of roadways in the future using projected volumes and planned roadway improvements. The model provides the user with a mechanism to quantitatively define and assess long-range bicycle transportation plans.

This report provides practical information on using the BCI model in real-world applications. Included in the report is a brief summary of the model development, data requirements for using the model, a description of the workbook or spreadsheet developed to facilitate its use, and practical examples illustrating a variety of applications. For more details regarding the research and development of the model, refer to the companion document *Development of the Bicycle Compatibility Index: A Level of Service Concept, Final Report.*[4]

Model Development

The approach used in developing the BCI was to obtain the perspectives of bicyclists by having them view numerous roadway segments captured on videotape and rate these segments with respect to how comfortable they would be riding there under the geometric and operational conditions shown. The reliability of the results obtained using this video technique of data collection with respect to reflecting on-street comfort levels was validated in a pilot study. The procedure offered several advantages over other forms of data collection, including minimizing the risk to bicyclists, maximizing the range of roadway conditions to which the bicyclists could be exposed, and controlling the variables evaluated by the bicyclists.

It is important to note again that the BCI model developed is for midblock street segments only and is primarily intended for use on "through" streets. In other words, the ratings do not account for major intersections along the route where the bicyclist may encounter a stop sign or traffic signal. Within the research study, the video technique described above was piloted for a limited number of intersection sites. The results proved that this technique can be used in developing an intersection BCI, but further research is needed to fully develop such an index and incorporate that index with the segment BCI discussed in this manual. *(See the Final Report for a more complete discussion of the intersection index results.[4])*

Table 1. Bicycle Compatibility Index (BCI) model, variable definitions, and adjustment factors

$$BCI = 3.67 - 0.966\mathbf{BL} - 0.410\mathbf{BLW} - 0.498\mathbf{CLW} + 0.002\mathbf{CLV} + 0.0004\mathbf{OLV} + 0.022\mathbf{SPD} + 0.506\mathbf{PKG} - 0.264\mathbf{AREA} + \mathbf{AF}$$

where:

BL = presence of a bicycle lane or paved shoulder ≥ 0.9 m
no = 0
yes = 1

BLW = bicycle lane (or paved shoulder) width
m (to the nearest tenth)

CLW = curb lane width
m (to the nearest tenth)

CLV = curb lane volume
vph in one direction

OLV = other lane(s) volume - same direction
vph

SPD = 85th percentile speed of traffic
km/h

PKG = presence of a parking lane with more than 30 percent occupancy
no = 0
yes = 1

AREA = type of roadside development
residential = 1
other type = 0

AF = $f_t + f_p + f_{rt}$

where:

f_t = adjustment factor for truck volumes (*see below*)

f_p = adjustment factor for parking turnover (*see below*)

f_{rt} = adjustment factor for right-turn volumes (*see below*)

Adjustment Factors

Hourly Curb Lane Large Truck Volume[1]	f_t	Parking Time Limit (min)	f_p
≥ 120	0.5	≤ 15	0.6
60 - 119	0.4	16 - 30	0.5
30 - 59	0.3	31 - 60	0.4
20 - 29	0.2	61 - 120	0.3
10 - 19	0.1	121 - 240	0.2
< 10	0.0	241- 480	0.1
		> 480	0.0

Hourly Right-Turn Volume[2]	f_{rt}
≥ 270	0.1
< 270	0.0

[1] Large trucks are defined as all vehicles with six or more tires.
[2] Includes total number of right turns into driveways or minor intersections along a roadway segment.

Using the perspectives of more than 200 study participants in three locations (Olympia, WA; Austin, TX; and Chapel Hill, NC), the BCI model was developed for all bicyclists as shown in table 1 (see appendix A for the English units version). The participants rated each of 67 sites included on a videotape with respect to how comfortable they would be riding there under the conditions shown. The ratings were made using a six-point scale where a ***one*** indicated that the individual would be "extremely comfortable" riding there while a ***six*** indicated that the individual would be "extremely uncomfortable" riding in those conditions. This model predicts the overall comfort level rating of a bicyclist using the eight significant (at p £ 0.01) variables shown and an adjustment factor (AF) to account for three additional operational characteristics. The basic model (excluding the adjustment factor) has an R^2-value of 0.89, indicating that 89 percent of the variance in the index or comfort level of the bicyclist is explained by the eight variables included in the model. In other words, the model is a reliable predictor of the expected comfort level of bicyclists on the basis of these eight variables describing the geometric and operational conditions of the roadway. The variable with the largest effect on the index is the presence or absence of a bicycle lane or paved shoulder (**BL**); the presence of a bicycle lane (paved shoulder) that is at least 0.9 m wide reduces the index by almost a full point, indicating an increased level of comfort for the bicyclist. Increasing the width of the bicycle lane or paved shoulder (**BLW**) or the curb lane (**CLW**) also reduces the index as does the presence of residential development along the roadside (**AREA**). On the other hand, an increase in traffic volume (**CLV** and **OLV**) or motor vehicle speeds (**SPD**) increases the index, indicating a lower level of comfort for the bicyclist. The presence of on-street parking (**PKG**) also increases the index.

In addition to the primary variables included in the BCI model, three additional variables defining specific operating conditions were also examined. These supplemental variables were identified during the pilot phase of the study as having a potential impact on the comfort level of bicyclists and included the presence of: 1) large trucks or buses, 2) vehicles turning right into driveways, and 3) vehicles pulling into or out of on-street parking spaces. An analysis of the overall comfort level ratings made when viewing video clips illustrating these conditions showed all three of these variables to significantly increase the index, thus indicating a lower level of comfort when these conditions were present. For all bicyclists, the overall mean rating increased by 0.50 when large trucks or buses were present. When there were vehicles pulling into or out of parking spaces, the average rating increased by 0.60. And finally, the presence of right-turning vehicles resulted in an increase in the mean rating of 0.10.

While the presence of these three specific operating conditions was not evaluated across all possible combinations of geometrics and operations, the results of the limited sample do indicate a need for adjustment to the BCI model when large trucks or buses are present, when there is a high number of vehicles pulling into or out of on-street parking spaces, or when there is a high volume of right-turning vehicles. Thus, a series of adjustment factors that can be added to the model have been developed for each of these scenarios (*see table 1*). These factors were developed based on the theory that the conditions shown to the survey participants represented worst-case scenarios and, subsequently, the increase in the overall mean comfort level rating represented the maximum adjustment that would be required.

It should be noted that one variable not included in the development of the BCI model was the grade of the roadway. Results from a preliminary effort showed that changes in grade of 2 percent or less were not distinguishable on the video. The advantages of using video, including not exposing bicyclists to high-risk conditions, incorporating a much larger sample of sites, and controlling specific variables to ensure all subjects were exposed to identical conditions, were believed to outweigh the absence of this one variable. It is also believed that the variables having the most significant effect on the bicycle compatibility of a roadway have been included in the BCI model. Specifically, the variables of width, speed, volume, and on-street parking were shown to have the greatest impact on the index. At this time, the impact of grade relative to these and the other significant variables included in the model is unknown but may be determined in future research efforts.

Once the BCI model was developed, bicycle level of service (LOS) criteria were established based on the results of applying the model to the sites included in this study. Currently, there are no bicycle LOS criteria provided in the *Highway Capacity Manual*.[5] However, the definition of LOS according to the manual is founded on the concept of users' perceptions of qualitative measures that characterize the operational conditions of the roadway. Two of the terms used in the manual to describe LOS are comfort/convenience and freedom to maneuver. Both of these terms are applicable to bicyclists and are directly reflected in the BCI since the rating scale used by the study participants was an indication of comfort level.

Table 2. Bicycle Compatibility Index (BCI) ranges associated with level of service (LOS) designations and compatibility level qualifiers.

LOS	BCI Range	Compatibility Level[1]
A	≤ 1.50	Extremely High
B	1.51 - 2.30	Very High
C	2.31 - 3.40	Moderately High
D	3.41 - 4.40	Moderately Low
E	4.41 - 5.30	Very Low
F	> 5.30	Extremely Low

[1] Qualifiers for compatibility level pertain to the average adult bicyclist.

Thus, using the distribution of BCI values produced from the representative set of locations included in this study, LOS designations were established for LOS A through LOS F as shown in table 2. LOS A (represented by an index £ 1.50) indicates that a roadway is extremely compatible (or comfortable) for the average adult bicyclist while LOS F (represented by an index > 5.30) is an indicator that the roadway is extremely incompatible (or uncomfortable) for the average adult bicyclist.

In developing the BCI model, several other issues were addressed, including the effect of bicycling experience level on perceived comfort levels. Using the results from a questionnaire completed by the participants, the bicyclists were stratified into three groups based on their riding habits, such as number of bicycle trips per week and types of facilities used (e.g., major roadways vs. bicycle paths). A comparison of the comfort level ratings of these three groups showed that **casual recreational** bicyclists were generally less comfortable across all sites than **experienced recreational** or **experienced commuter** bicyclists. As a result of these differences, separate BCI models were produced for each of the three groups in addition to the model for **all** bicyclists. However, in real-world applications, it is most likely that bicyclists of all experience levels will have the opportunity to ride on any given segment of roadway. Thus, it is recommended that the BCI model developed for all bicyclists and shown in table 1 be used without modification for most applications**. It is important to note that the LOS designations shown in table 2 were developed on the basis of this model, and thus are only applicable to results produced with the "all bicyclists" model.**

Notwithstanding, when the practitioner knows that the large majority of riders are indeed casual bicyclists, the approach that should be used to ensure that facilities meet the desired comfort levels of this group is to simply design for a higher level of service. The results of the research showed that the model developed for the **casual** bicyclist, on average, produced BCI values that were 0.14 to 0.38 greater than those produced by **all** bicyclists. The differences in BCI values between LOS designations are, on average, 1.0 (*see table 2*). By designing for a higher LOS (e.g., LOS B rather than LOS C) on a facility known to attract a high number of casual bicyclists, the necessary comfort level for this group of bicyclists can be achieved with the BCI model as it is currently developed. **Note that where casual bicyclists are expected, the facility should always be designed at LOS C or better.**

Table 3. Ranges of variables included in the regression model.

Variable	Description	Minimum	Maximum
CLW	Curb Lane Width	3.0 m	5.6 m
BLW	Bicycle Lane/Paved Shoulder Width	0.9 m	2.4 m
CLV	Curb Lane Volume	90 vph	900 vph
SPD	85th Percentile Speed	40km/h	89 km/h

Another issue addressed was that of possible regional differences in the perceptions of bicyclists. If bicyclists in different geographic regions of the country perceive comfort levels differently, then separate models would need to be developed to reflect these differences. An analysis of the comfort level ratings across subjects in the three survey cities showed no differences in the mean overall comfort levels for the four variables rated (speed, volume, width, and overall). This lack of differences indicates that the perceptions of individuals with respect to bicycle compatibility are the same in the three regions where the survey was conducted, and that the BCI model should be applicable across all regions of the country.

The range of conditions included in the development of the model should be representative of most urban and suburban roadway conditions. However, since the sites included in the development contained a limited range of widths, volumes, and speeds, the model should not be extrapolated beyond the values shown in table 3. For example, the model may only be appropriate for bicycle lane or paved shoulder widths between 0.9 and 2.4 m and curb lane widths between 3.0 and 5.6 m.

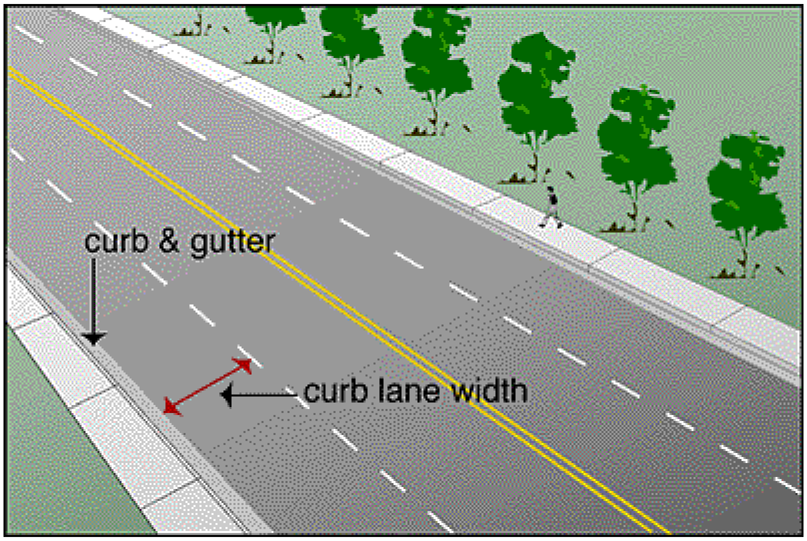
Data Requirements

The data needs for the BCI model are limited and, for the most part, include data that are traditionally collected by states and municipalities for other purposes. However, there will always be locations for which some of the data will not be available. In these cases, the practitioner must make judgments about appropriate values to use within the BCI model. It will also be the case that the available data are not in a form that can be directly input into the model. In that case, specific computations must be made to convert the data into the appropriate format. Described below are the variables required for the model and, where appropriate, computations and assumptions that can be used should the data be either not available or in the incorrect format. It should also be noted that the Microsoft Excel workbook on the enclosed diskette and described in the next section makes many of these computations for the user and incorporates some of the assumptions as default values.

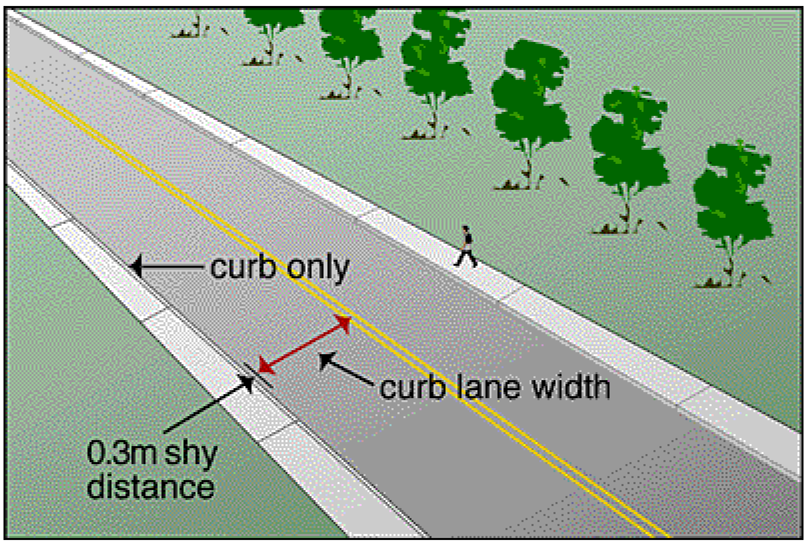
As with any applied model, the output is only as good as the input. Therefore, it is very important that the user of the BCI model understand the variable definitions and assumptions provided below, and that there will always be specific situations requiring their best judgment as to what would be most appropriate for the model. For example, one of the decisions that must be made by the user of the BCI model is which hour of the day to use for evaluating bicycling conditions. It has been assumed throughout this document that the peak hour will be the hour of choice. However, depending on the route being examined, the operational conditions may change with time of day. For example, while traffic volumes may be significantly greater during the peak hour compared with the rest of the day, travel speeds may be significantly lower due to the volumes. On other streets, on-street parking may be prohibited during the peak hour. Thus, the off-peak parking lane becomes the peak-hour curb lane for motor vehicle and bicycle travel. While in most cases the peak-hour analysis will be the "worst-case" scenario and will serve as a good measure of bicycle compatibility for a given roadway irrespective of time of day, the user of the model should be aware that differences in operating conditions such as those described here can significantly change the outcome and can result in different levels of compatibility on the same route. It is recommended that, for those routes or segments where dramatic changes in operating conditions are expected at different times of the day, the analysis be conducted for all scenarios that apply.

Defined below are the variables required for the BCI model:

· Lane Configuration - ***number of through motor vehicle lanes in one direction and the presence or absence of a bicycle lane or paved shoulder***. The number of lanes is used in the workbook to determine lane volumes from the average annual daily traffic (AADT).



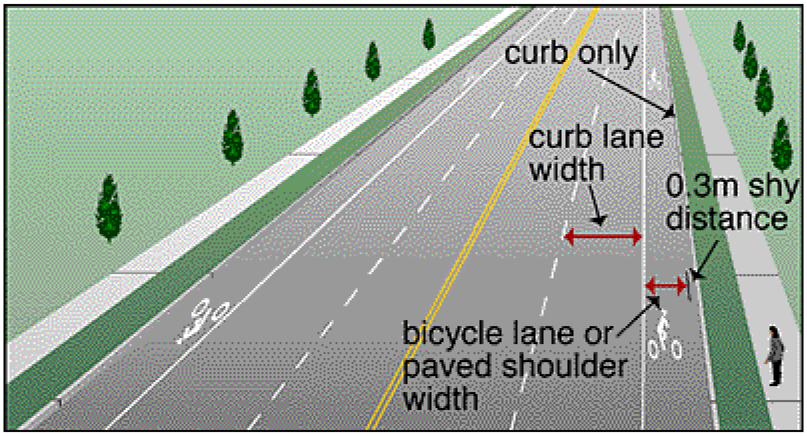
when gutter pan is present



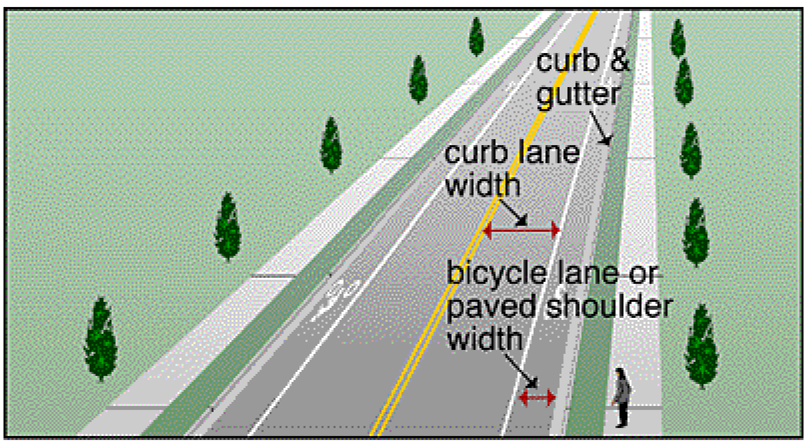
when no gutter pan is present

Figure 2. Curb lane width measurement when there is no bicycle lane, paved shoulder, or on-street parking lane.

· Curb lane width - ***width of the motor vehicle travel lane closest to the curb***, measured to the nearest tenth of a meter. If there is no bicycle lane, paved shoulder, or parking lane present, this distance is measured from the center of the lane line or center line to the joint or seam between the pavement edge and the gutter pan as shown in figure 2. If no gutter pan is present, the curb lane width is determined by measuring the distance from the center of the lane line or center line to the curb face and then subtracting 0.3 m from that distance. The 0.3-m value accounts for the space bicyclists will typically leave between themselves and a curb (i.e., the "shy" distance). This value also reflects the difference in bicycle lane design widths recommended by the American Association of State Highway and Transportation Officials (AASHTO), i.e., 1.5 m when no gutter pan is present versus 1.2 m when a gutter pan exists.[6] This scenario is also illustrated in figure 2.



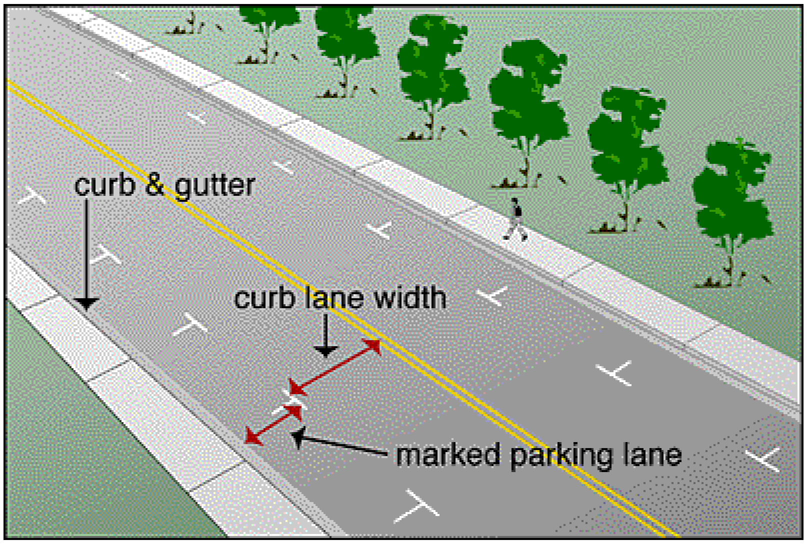
when no gutter pan is present



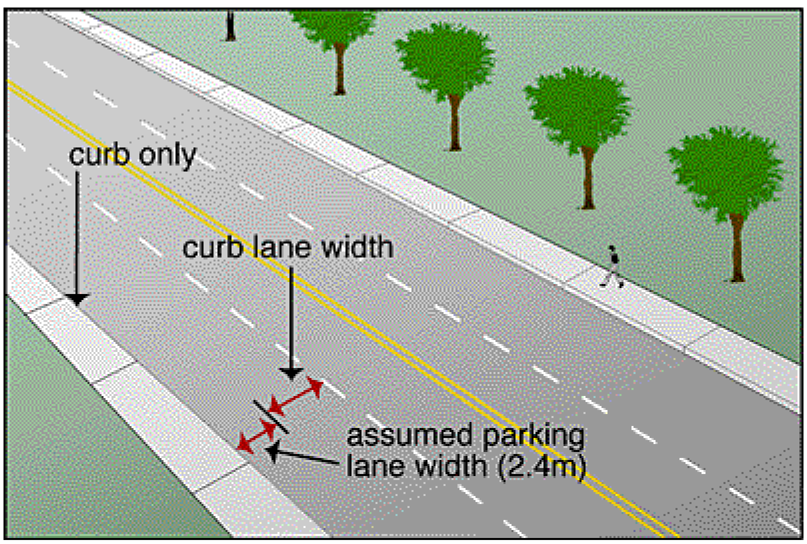
when gutter pan is present

Figure 3. Curb lane and bicycle lane (paved shoulder) width measurements when there is no on-street parking

When there is a bicycle lane or paved shoulder, the curb lane width is measured from the center of the lane line or center line to the center of the edge line as shown in figure 3. If there is a marked parking lane present, the curb lane width is measured in a similar manner as shown in figure 4. If the parking lane is unmarked, the curb lane width can be determined by measuring from the center of the lane line or center line to the curb face (including the gutter pan if present), and then subtracting 2.4 m from this distance (*see figure 4*). The 2.4-m value accounts for the fact that vehicles occupy, on average, approximately 2.1 m of space when parallel parking and typically park within 0.15 to 0.3 m of the curb.[7]



when parking lane is marked



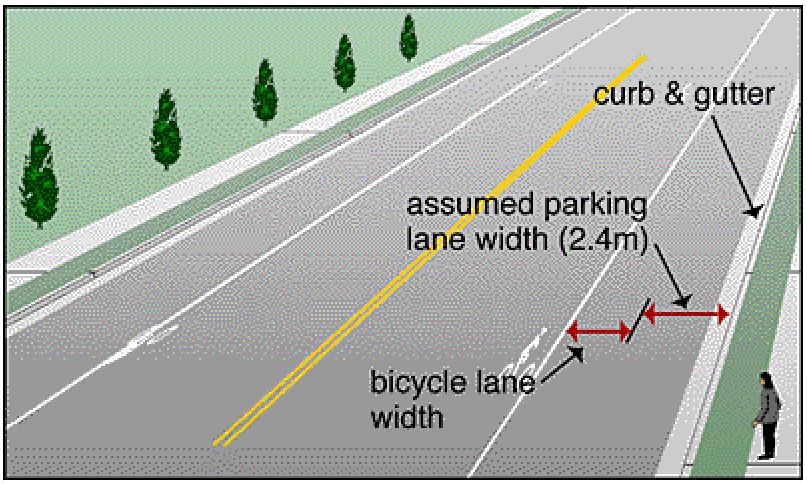
when parking lane is not marked

Figure 4. Curb lane width measurement when there is a parking lane present

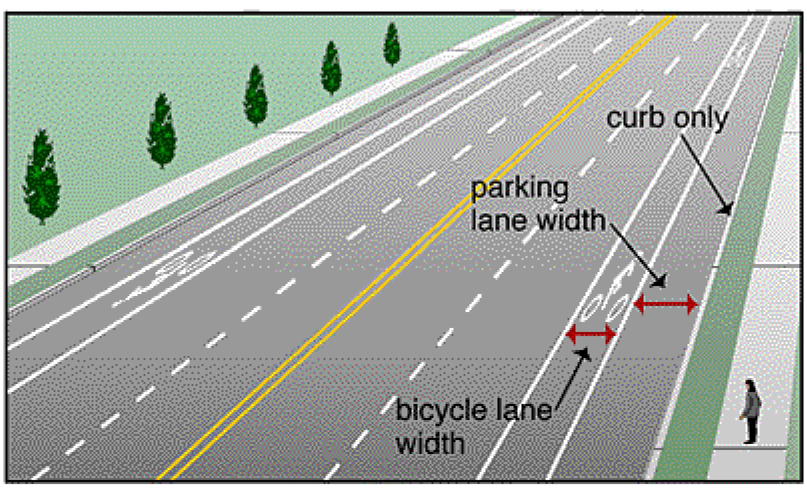
The other scenario common on residential streets is to have no lane markings at all. In this case, the total cross section width can be measured from curb to curb (or gutter pan seam to gutter pan seam) and divided by the number of lanes (typically two) to determine the curb lane width. If parking is also present on this type of unmarked street, the parking lane widths (usually 2.4 m) should be subtracted from the total cross-section width prior to dividing by the number of lanes.

· Bicycle lane (paved shoulder) width - ***width of the bicycle lane or paved shoulder (if present)***, measured to the nearest tenth of a meter. Note that a paved shoulder is treated the same as a bicycle lane in the BCI model since recent research has shown that these two types of facilities result in virtually identical operational behaviors by motorists and bicyclists.8 If there is no parking lane present, the bicycle lane (paved shoulder) width is measured from the center of the edge line separating the bicycle lane from the motor vehicle travel lane to the joint or seam between the pavement edge and the gutter pan as shown in figure 3. If no gutter pan is present, the distance is measured from the edge line to the curb face, and then 0.3 m is subtracted from that distance to account for the space bicyclists will typically leave between themselves and a curb (i.e., the "shy" distance). This scenario is also illustrated in figure 3.

If a marked parking lane is adjacent to the bicycle lane, the bicycle lane width is measured from the center of the edge line (separating the motor vehicle travel lane and bicycle lane) to the center of the parking lane line separating the bicycle lane and the parking lane as shown in figure 5. If the parking lane is not marked, as would be the case in a shared parking/bicycle lane, the bicycle lane width can be determined by measuring the distance from the center of the edge line to the curb face (including the gutter pan if present) and then subtracting 2.4 m from that distance to account for the width of the parking lane. This scenario is also illustrated in figure 5.



when parking lane is marked



when parking lane is not marked

Figure 5. Bicycle lane width measurements when there is a parking lane present

As noted in all of the possible configurations described above and shown in the figures, the curb lane width and bicycle lane (paved shoulder) width measurements either did not include gutter pan widths or included them but subtracted a value to account for the "shy distance" of the bicyclist. The BCI model was developed using sites that either had no gutter pan or had gutter pans ranging from 0.3 to 0.6 m in width. Many communities have gutter pans that are wider than 0.6 m and provide space that can be utilized by a bicyclist. In fact, some communities designate this space as a bicycle lane. In those cases, it is recommended that the practitioner determine if the extra wide gutter pan does indeed provide adequate space for the bicyclist to ride. If so, this space should be added to the curb lane width or bicycle lane width as appropriate.

· Motor vehicle speed - ***85th percentile speed of traffic***, in km/h. This value can be obtained from manual or automated speed data collection efforts; for more information on collecting speed data, refer to the Manual of Transportation Engineering Studies.9 However, if the data are unavailable or the resources to collect speed data do not exist, it is recommended that 15 km/h be added to the posted speed limit as a surrogate measure for the 85th percentile speed. Prior research has shown that 85th percentile speeds for vehicles traveling on many urban and suburban streets (including arterial, collector, and local classifications) generally exceed the speed limit by 10 to 23 km/h.10

· Traffic volume - ***hourly traffic volume by lane in one direction of travel.*** While hourly counts may be available in some locations, it is more likely that AADT counts (collected for continuous 24-hour periods) will be the source of traffic volume information. Converting these data into hourly counts requires knowing the percentage of daily traffic traveling on the roadway during the hour of interest. In most cases, the hour of interest will be the peak hour. This volume can be determined using the following equation:

$$PHV = AADT \times K \times D$$

where:

PHV = peak-hour directional volume,

AADT = average annual daily traffic (vehicles per day)

K = peak-hour factor (the proportion of vehicles traveling during the peak hour, expressed as a decimal), and

D = directional split factor (the proportion of vehicles traveling in the peak direction during the peak hour, expressed as a decimal).

The K- and D-factors are usually determined on the basis of regional or route-specific characteristics. Generally, the K-factor ranges from 0.07 to 0.15 while the D-factor ranges from 0.50 to 0.65 in urban and suburban areas.11 If these factors are unknown or cannot be easily determined, a default K-factor of 10 percent may be assumed (expressed as 0.10), and a default

D-factor of 55 percent may be used (expressed as 0.55). Note also that for one-way streets, the D-factor becomes 1.0 since 100 percent of the traffic is traveling in the same direction.

Once the directional hourly volume of traffic is determined using the above formula, it is necessary to assign traffic volumes to the curb lane and other travel lanes if it is a multilane facility. The lane distribution on non-freeway facilities depends on a variety of factors, including number and location of access points, the type of development, traffic composition, speed, volume, and local driving habits. These factors result in very little uniformity from site to site with respect to how volumes are distributed across lanes.5,11 If counts are available by lane, the percentage of vehicles traveling in each lane can be easily determined. If such counts are not available and considering the lack of consistency in this variable across sites, it is recommended that the hourly volume be distributed equally across all through lanes using the following equations:

CLV = PHV/N OLV = PHV – CLV

where:

CLV = hourly curb lane volume,

OLV = hourly volume in all through lanes except the curb lane,

PHV = peak-hour directional volume, and

N = number of through lanes in one direction.

· Presence and density of on-street parking - ***presence of an on-street parking lane and percentage of spaces occupied***. The simple presence of an on-street parking lane may not adversely impact the comfort level of the bicyclist. During the development of the BCI model, it was shown that at least 30 percent of the spaces had to be occupied before the parking lane impacted the bicyclists comfort level. Thus, it is necessary to collect occupancy data for the hour being evaluated to determine if this 30 percent occupancy threshold is being met.

· Type of development - ***type of development or land use adjacent to the roadway***. For purposes of the model, only two classifications are required, "residential" and "other." The residential development type proved to be significantly different from all other types of development and was shown to positively impact the comfort level of bicyclists.

· Large truck volume - ***hourly large truck volume in the curb lane***. For purposes of the BCI model, large trucks are simply defined as all vehicles having six or more tires. This definition captures most single unit trucks and all combination unit trucks and buses. Most vehicle counters used today provide vehicle classification, and thus the percentage of trucks in the traffic stream is readily available if traffic count data are available. The volume of large trucks in the curb lane can then be determined as follows:

CLTV = PHV x HV x T

where:

CLTV = curb lane truck volume,

PHV = peak-hour directional volume (all vehicles),

HV = the proportion of all vehicles in the traffic stream that can be defined as large trucks (expressed as a decimal), and

T = curb lane truck factor (proportion of large trucks traveling in the curb lane, expressed as a decimal).

On a two-lane roadway (one lane of travel in each direction), the T-factor, or proportion of large trucks traveling in the curb lane, is 1.0 since 100 percent of the trucks will be traveling in the curb lane. On a multilane roadway, however, the T-factor must be calculated or assumed. If traffic counts are collected by lane of travel, the T-factor can be directly determined. If such data are not available, it is recommended that a default value of 0.80 be used for this factor on multilane roadways, indicating that 80 percent of the large trucks on the roadway are traveling in the curb lane. This value is based on collected data for freeways showing that up to 89 percent of the trucks travel in the curb lane.5 While comparable statistics were not available for arterials and other types of surface streets, the distribution of large trucks by lane of travel is believed to be similar.

If classification counts are not available, the user will have to input a truck percentage value (HV) believed to be appropriate for the type of roadway. In general, many urban streets will have very little or no truck traffic because of travel restrictions placed on such vehicles. An analysis of the FHWA Highway Safety Information System (HSIS) confirmed this fact for certain functional classifications. For the States of Illinois, Utah, and North Carolina, the mean percentage of traffic that was classified as trucks on local streets was less than 1 percent. On collectors, the mean truck percentage ranged from 0.4 to 2.6 percent, while on minor arterials, the range of means was 0.5 to 3.9 percent. The largest percentage of trucks was found on non-freeway principal arterials where the means ranged from 1.4 to 5.4 percent.12 On the basis of this analysis, it is recommended that the truck percentages shown in table 4 be used for the various functional classifications when the practitioner does not have the appropriate data and is not able to adequately determine the actual truck percentage.

· Parking time limits - ***parking time limits for on-street spaces***. Vehicles pulling into or out of on-street parking spaces were shown to adversely impact the comfort level of bicyclists. Thus, as the parking turnover along a street increases, the comfort level for bicyclists decreases. Since most locations will not have parking turnover data or the resources to collect such data, a surrogate measure of parking time limit is recommended. It should be noted, however, that there may be cases where the time limit does not adequately reflect the level of parking turnover. For example, a street in front of a local post office may have 60-minute parking stalls, but the people using these spaces may generally be there no more than 15 minutes at a time. In that case, the value for a 15-minute limit parking stall may be more appropriate.

Right-turn volumes - ***hourly volume of vehicles turning right into all driveways and intersecting streets along the midblock segment being evaluated***. For the BCI model, the adjustment factor is only applied when the hourly number of right turns is 270 or more. Knowing this information will assist in accounting for high-volume driveways or minor streets. Once the peak-hour volume is calculated, determining the number of right-turning vehicles can be done as follows:

$$RTV = PHV \times R$$

where:

RTV = right-turn volume,

PHV = peak-hour directional volume,

R = proportion of vehicles in the traffic stream turning right into driveways or minor streets along the roadway segment, expressed as a decimal.

Knowledge of the proportion of vehicles turning right into driveways and minor intersection streets along a segment of roadway often may not exist. And since the adjustment factor in the BCI model and the relative impact on the overall bicycle LOS are small, it does not warrant spending resources to obtain this information. Instead, it is recommended that the practitioner use his/her judgment as to whether a specific midblock segment contains a high volume of right-turning traffic during the hour being evaluated. Examples of locations where right-turn volumes may be a factor during the peak hour include business and industrial entrances and minor streets used to cut through neighborhoods.

Table 4. Recommended truck percentages by functional classification for streets where such information is not available.

Functional Classification (Type of Street)	Recommended Truck Percentage (HV)
Principal Arterial (Non-Freeway)	3.5%
Minor Arterial	2.0%
Collector Street	1.5%
Local Street	0.0%

References

1. *The National Bicycling and Walking Study*, Report No. FHWA-PD-94-023, Federal Highway Administration, Washington, DC, 1994.

2. A. Sorton and T. Walsh, "Bicycle Stress Level as a Tool to Evaluate Urban and Suburban Bicycle Compatibility," *Transportation Research Record 1438*, Transportation Research Board, Washington, DC, 1994.

3. Geelong Planning Committee, *Geelong Bikeplan*, Geelong, Australia, 1978.

4. D.L. Harkey, D.W. Reinfurt, M. Knuiman, and A. Sorton, *Development of the Bicycle Compatibility Index: A Level of Service Concept, Final Report*, Report No. FHWA-RD-98-072, Federal Highway Administration, Washington, DC, August 1998.

5. *Highway Capacity Manual*, Special Report 209, Transportation Research Board, Washington, DC, 1994.

6. *Guide for the Development of Bicycle Facilities*, American Association of State Highway and Transportation Officials, Washington, DC, August 1991.

7. *A Policy on the Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials, Washington, DC, 1994.

8. D.L. Harkey and J.R. Stewart, "Evaluation of Shared-Use Facilities for Bicycles and Motor Vehicles," *Transportation Research Record 1578*, Transportation Research Board, Washington, DC, 1997.

9. H.D. Robertson (editor), *Manual of Transportation Engineering Studies*, Institute of Transportation Engineers, Washington, DC, 1994.

10. D.L. Harkey, H.D. Robertson, and S.E. Davis, "Assessment of Current Speed Zoning Criteria," *Transportation Research Record 1281*, Transportation Research Board, Washington, DC, 1990.

11. W.R. McShane and R.P. Roess, Traffic Engineering, Prentice Hall, Englewood Cliffs, NJ, 1990.

12. *Highway Safety Information System*, Internal Project Memorandum, Federal Highway Administration, Washington, DC, February 1998.

A Summary of the Bicycle Level of Service Model

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Bicycle Suitability Analysis Training

May 2003

Bicycle Level of Service Model

The *Bicycle Level of Service Model (Bicycle LOS Model)* is an evaluation of bicyclist perceived safety and comfort with respect to motor vehicle traffic while traveling in a roadway corridor. It identifies the quality of service for bicyclists or pedestrians that currently exists within the roadway environment.

The statistically calibrated mathematical equation entitled the *Bicycle LOS Model*[1] *(Version 2.0)* is used for the evaluation of bicycling conditions in shared roadway environments. It uses the same measurable traffic and roadway factors that transportation planners and engineers use for other travel modes. With statistical precision, the *Model* clearly reflects the effect on bicycling suitability or "compatibility" due to factors such as roadway width, bike lane widths and striping combinations, traffic volume, pavement surface condition, motor vehicle speed and type, and on-street parking.

The *Bicycle Level of Service Model* is based on the proven research documented in *Transportation Research Record 1578* published by the Transportation Research Board of the National Academy of Sciences. It was developed with a background of over 150,000 miles of evaluated urban, suburban, and rural roads and streets across North America. Many urban planning agencies and state highway departments are using this established method of evaluating their roadway networks. The Virginia Department of Transportation is using the *Bicycle LOS Model* in both the Richmond and Northern Virginia regions. The model has also been applied in Anchorage AK, Baltimore MD, Birmingham AL, Buffalo NY, Gainesville FL, Houston TX, Lexington KY, Philadelphia PA, Sacramento CA, Springfield MA, Tampa FL, Washington, DC, and by the Delaware Department of Transportation (DelDOT), Florida Department of Transportation (FDOT), New York State Department of Transportation (NYDOT), Maryland Department of Transportation (MDOT) and many others.

Widespread application of the original form of the *Bicycle LOS Model* has provided several refinements. Application of the *Bicycle LOS Model* in the metropolitan area of Philadelphia resulted in the final definition of the three effective width cases for evaluating roadways with on-street parking. Application of the *Bicycle LOS Model* in the rural areas surrounding the greater Buffalo region resulted in refinements to the "low traffic volume roadway width adjustment". A 1997 statistical enhancement to the *Model* (during statewide application in Delaware) resulted in better quantification of the effects of high speed truck traffic [see the $SP_t(1+10.38HV)^2$ term]. As a result, *Version 2.0* has the highest correlation coefficient ($R^2 = 0.77$) of any form of the *Bicycle LOS Model*.

Version 2.0 of the *Bicycle Level of Service Model (Bicycle LOS Model)* has been employed to evaluate collector and arterial roadways within Loudoun County. Its form is shown below:

[1] Landis, Bruce W. et.al. "Real-Time Human Perceptions: Toward a Bicycle Level of Service" *Transportation Research Record 1578*, Transportation Research Board, Washington, DC 1997.

Bicycle LOS = $a_1 \ln(Vol_{15}/L_n) + a_2 SP_t(1+10.38HV)^2 + a_3(1/PR_5)^2 + a_4(W_e)^2 + C$

Where:

Vol_{15} = Volume of directional traffic in 15 minute time period

$Vol_{15} = (ADT \times D \times K_d) / (4 \times PHF)$

where:

ADT = Average Daily Traffic on the segment or link

D = Directional Factor (assumed = 0.565)

K_d = Peak to Daily Factor (assumed = 0.1)

PHF = Peak Hour Factor (assumed = 1.0)

L_n = Total number of directional *through* lanes

SP_t = Effective speed limit

$SP_t = 1.1199 \ln(SP_p - 20) + 0.8103$

where:

SP_p = Posted speed limit (a surrogate for average running speed)

HV = percentage of heavy vehicles (as defined in the 1994 Highway Capacity Manual)

PR_5 = FHWA's five point pavement surface condition rating

W_e = Average effective width of outside through lane:

where:

$W_e = W_v - (10\text{ ft} \times \%\ OSPA)$ and $W_l = 0$

$W_e = W_v + W_l(1 - 2 \times \%\ OSPA)$ and $W_l > 0$ & $W_{ps} = 0$

$W_e = W_v + W_l - 2(10 \times \%\ OSPA)$ and $W_l > 0$ & $W_{ps} > 0$ and a bikelane exists

where:

W_t = total width of outside lane (and shoulder) pavement

OSPA = percentage of segment with occupied on-street parking

W_l = width of paving between the outside lane stripe and the edge of pavement

W_{ps} = width of pavement striped for on-street parking

W_v = Effective width as a function of traffic volume

and:

$W_v = W_t$ if ADT > 4,000veh/day

$W_v = W_t(2 - 0.00025 \times ADT)$ if ADT ≤ 4,000veh/day, and if the street/ road is undivided and unstriped

a_1: 0.507 a_2: 0.199 a_3: 7.066 a_4: - 0.005 C: 0.760

(a_1 - a_4) are coefficients established by the multi-variate regression analysis.

Bicycle Level of Service Model Description

The Bicycle LOS score resulting from the final equation is pre-stratified into service categories “A, B, C, D, E, and F”, according to the ranges shown in Table 1, reflecting users’ perception of the road segments level of service for bicycle travel. This stratification is in accordance with the linear scale established during the referenced research (i.e., the research project bicycle participants’ aggregate response to roadway and traffic stimuli). The *Model* is particularly responsive to the factors that are statistically significant. An example of its sensitivity to various roadway and traffic conditions is shown on the following page.

Bicycle Level-of-Service Categories

LEVEL-OF-SERVICE	Bicycle LOS Score
A	≤ 1.5
B	> 1.5 and ≤ 2.5
C	> 2.5 and ≤ 3.5
D	> 3.5 and ≤ 4.5
E	> 4.5 and ≤ 5.5
F	> 5.5

The *Bicycle LOS Model* is used by planners, engineers, and designers throughout the US and Canada in a variety of planning and design applications. Applications of the Model include:

1) Conducting a benefits comparison among proposed bikeway/roadway cross-sections
2) Identifying roadway restriping or reconfiguration opportunities to improve bicycling conditions
3) Prioritizing and programming roadway corridors for bicycle improvements
4) Creating bicycle suitability maps
5) Documenting improvements in corridor or system-wide bicycling conditions over time

Bicycle LOS Model Sensitivity Analysis

Bicycle LOS = $a_1 \ln(Vol_{15}/Ln) + a_2 SP_t(1+10.38HV)^2 + a_3(1/PR_5)^2 + a_4 (W_e)^2 + C$

where:	a_1: 0.507	a_2: 0.199	a_3: 7.066	a_4: -0.005	C: 0.760
T-statistics:	(5.689)	(3.844)	(4.902)	(-9.844)	

Baseline inputs:

ADT	=	12,000 vpd	% HV	=	1	L	=	2 lanes
SP_p	=	40 mph	W_e	=	12 ft	PR_5	=	4 (good pavement)

	BLOS	% Change
Baseline BLOS Score (Bicycle LOS)	3.98	N/A
Lane Width and Lane striping changes		
W_t = 10 ft	4.20	6% increase
W_t = 11 ft	4.09	3% increase
W_t = 12 ft - - (baseline average) - - - - - - -	3.98 - - - -	no change
W_t = 13 ft	3.85	3% reduction
W_t = 14 ft	3.72	7% reduction
W_t = 15 ft (W_l = 3 ft)	3.57 (3.08)	10%(23%) reduction
W_t = 16 ft (W_l = 4 ft)	3.42 (2.70)	14%(32%) reduction
W_t = 17 ft (W_l = 5 ft)	3.25 (2.28)	18%(43%) reduction
Traffic Volume (ADT) variations		
ADT = 1,000 Very Low	2.75	31% decrease
ADT = 5,000 Low	3.54	11% decrease
ADT = 12,000 Average - (baseline average) - -	3.98 - - - - -	no change
ADT = 15,000 High	4.09	3% increase
ADT = 25,000 Very High	4.35	9% increase
Pavement Surface conditions		
PR_5 = 2 Poor	5.30	33% increase
PR_5 = 3 Fair	4.32	9% reduction
PR_5 = 4 - - Good - (baseline average) - - -	3.98 - - - -	no change
PR_5 = 5 Very Good	3.82	4% reduction
Heavy Vehicles in percentages		
HV = 0 No Volume	3.80	5% decrease
HV = 1 - - - Very Low - (baseline average) - -	3.98 - - - - - -	no change
HV = 2 Low	4.18	5% increase
HV = 5 Moderate	4.88	23% increase[a]
HV = 10 High	6.42	61% increase[a]
HV = 15 Very High	8.39	111% increase[a]

[a]Outside the variable's range (see Reference *(1)*)

Appendix D

Bicycle Suitability Analysis Data Collection and Inventory Guidelines

Bicycle Level of Service (BLOS) and Bicycle Compatibility Index (BCI) Models

Prepared by

Toole Design Group
Washington DC- Baltimore

for the

Roanoke Valley-Alleghany Regional Commission
Bicycle Suitability Analysis Training

May 2003

Bicycle Level of Service and Bicycle Compatibility Index Model Data Needs

These data items are used to compute the final Bicycle Level of Service (BLOS) and Bicycle Compatibility Index (BCI) score for each roadway segment. Please use the following guidelines when gathering available roadway data and making measurements and observations in the field.

Existing Data (from maps and electronic databases)

Annual Average Daily Traffic (AADT) – Enter this information into the database for each roadway segment from existing traffic count databases. If necessary, use assumed values based on surrounding land uses or taking 15 minute counts in the field. AADT is converted by the database to hourly traffic volume by lane in one direction of travel.

Percent Heavy Vehicles (% HV) – Enter this information into the database from existing traffic composition databases. Generally, a heavy vehicle is any large truck with six or more tires. If necessary, use assumed values based on surrounding land uses or taking 15 minute counts in the field.

85^{th} Percentile Speed (85^{th} %) – Enter this information from existing traffic speed databases. If these data are not available, the database is programmed to add approximately 9 m.p.h. (15 k.p.h) to the posted speed to reflect a typical 85^{th} percentile speed.

Field Data (from data collection measurements)

Direction of Survey (Dir. of Sur.) – Record the direction the data collection vehicle is traveling along the segment before data collector takes measurements (NB, SB, EB, or WB).

Number of lanes of traffic (L) - Record the total number of *through* traffic lanes, in both directions, of the road segment. The presence of continuous right-turn lanes should be noted in the comments field (they should not be counted as through lanes).

Configuration (Cnfg.) – Record the configuration of the road segment as D = Divided, U = Undivided, OW = One-Way, or S = Center Turning Lane. The programmed database will output the number of travel lanes in each direction. Note in the comments if in the other direction there is a different number of through lanes.

Posted Speed Limit (SP_p) - Record as posted in m.p.h. The database is programmed to add approximately 9 m.p.h. (15 k.p.h) to the posted speed to reflect the typical 85^{th} percentile speed, unless 85^{th} percentile speeds are available from existing sources.

Width of pavement for the outside lane and shoulder (W_t) – This measurement is taken from the center of the road (yellow stripe) to the gutter pan of the curb (or to the curb if there is no gutter present). In the case of a multilane configuration, it is measured from the outside lane stripe to the edge of pavement. **W_t does not include the gutter pan.** When there is angled parking adjacent to the outside lane, W_t is measured to the traffic-side end of the parking stall stripes.

The presence of unstriped on-street parking does not change the measurement; the measurement should still be taken from the center of the road to the gutter pan.

Width of paving between the shoulder/edge stripe and the edge of pavement (W_l) – This measurement is taken when there is additional pavement to the right of an edge stripe, such as when striped shoulders, bike lanes, or parking lanes are present. It is measured from the shoulder/edge stripe to the edge of pavement, or to the gutter pan of the curb. **W_l does not include the gutter pan.** When there is angled parking adjacent to the outside lane, W_l is measured to the traffic-side end of the parking stall stripes.

Width of pavement striped for on-street parking (W_{ps}) – **Record this measurement only if there is parking to the right of a striped bike lane.** If there is parking on two sides on a one-way, single-lane street, the combined width of striped parking is reported.

Total Pavement Width (TPW) – **Record this dimension only when the roadway has a total of three or more through lanes.** This measurement is taken from one shoulder or gutter pan of the curb to the other shoulder or gutter pan of the curb. If the roadway is divided, the width of the grass/concrete median should be included in the measurement and the width of the median itself should be listed in the comments field.

Edge Type – "CG" is recorded if there is a curb and gutter on the segment. "S" is entered if there is an open shoulder. If a segment has a **curb but no gutter (i.e. the pavement extends completely to the curb face), record "CNG".**

% Occupied On-Street Parking - This is an estimate on the percentage of the segment (excluding driveways) along which there is occupied on-street parking at the time of survey. Each side is measured in increments of 25% and is recorded separately: "N/E" is the Northbound or Eastbound side of the road and "S/W" is the Southbound or Westbound side of the road. **If the parking is allowed only during off-peak periods, this should be indicated in the comments field.** Angled parking is also reported in the comments field.

Parking Time Limit – **Record this observation only when there is on-street parking.** This observation represents the number of minutes a car is typically parked along the street. The posted time limit can be recorded in most cases. However, there may be cases where the time limit does not adequately reflect the level of parking turnover. For example, a street in front of a local post office may have 60-minute parking stalls, but the people using these spaces may generally be there no more than 15 minutes at a time. In that case, the value for a 15-minute limit parking stall may be more appropriate.

Pavement Condition:

Travel Lane (PC_t) - Pavement condition of the outside motor vehicle travel lane is evaluated according to FHWA's five-point pavement surface condition rating shown below. Unpaved travel lanes should be scored with a zero (0).

Shoulder or Bike lane (PC_l) - Pavement condition of the shoulder or bike lane is evaluated according to the FHWA's five-point pavement surface condition rating shown below. (Unpaved shoulders **do not** receive a zero score, see roadside profile condition.)

Pavement Condition Descriptions

RATING	PAVEMENT CONDITION
5.0 (Very Good)	Only new or nearly new pavements are likely to be smooth enough and free of cracks and patches to qualify for this category.
4.0 (Good)	Pavement, although not as smooth as described above, gives a first class ride and exhibits signs of surface deterioration.
3.0 (Fair)	Riding qualities are noticeably inferior to those above; may be barely tolerable for high-speed traffic. Defects may include rutting, map cracking, and extensive patching.
2.0 (Poor)	Pavements have deteriorated to such an extent that they affect the speed of free-flow traffic. Flexible pavement has distress over 50 percent or more of the surface. Rigid pavement distress includes joint spalling, patching, etc.
1.0 (Very Poor)	Pavements that are in an extremely deteriorated condition. Distress occurs over 75 percent or more of the surface.

Source: U.S. Department of Transportation. Highway Performance Monitoring System-Field Manual. Federal Highway Administration. Washington, DC 1987.

Residential Development – "Y" indicates that the roadway is in a predominantly residential area. If the land use adjacent to the roadway includes commercial, industrial, or other non-residential development, enter "N".

High Right-Turn Volume – "Y" indicates that there is a high volume of vehicles turning right into all driveways and intersecting streets along the segment being evaluated (at least 270 vehicles per hour). Otherwise, "N" is entered.

Designated Bike Lane - "Y" indicates that a bike lane is designated (by sign or pavement markings) on the segment, otherwise "N" is entered.

Designated Bicycle Route – "Y" indicates that the segment is marked with bicycle route (segment has green "BIKE ROUTE" signs or signs with a specific bike route letter or number), otherwise "N" is entered.

Share the Road Signs – "Y" indicates that the segment is marked with "Share the Road" signs (yellow bike warning sign with "Share the Road" beneath), otherwise "N" is entered.

Rumble Strips – "Y" indicates that the segment has shoulder rumble strips, otherwise "N" is entered. Note the approximate width of the rumble strips in the comments field and whether they are on the shoulder or travel lane.

Steep Grade – "Y" indicates that the segment has a steep grade. A steep grade is considered to be a grade of over 5%, as estimated by the data collection team.

Number of Left Turn Bays – Record the number of left turn bays within the segment **(consider both directions)**. A left turn bay is a lane designated for left turns only. If there is a lane that is designated for both straight and left-turning traffic, do not record it as a left turn bay.

% of Segment with Sidewalk or Sidepath - The percentage of sidewalk coverage (estimated in increments of 10%) of the segment is to be collected for both sides of the roadway. Sidepaths and trails within the roadway right-of-way should be considered to be sidewalks for the purpose of data collection. Make sure to collect information about sidewalks on bridges. Each side is measured in increments of 10% and is recorded separately: "N/E" is the Northbound or Eastbound side of the road and "S/W" is the Southbound or Westbound side of the road.

Buffer Width (W_b) - The width of a grass or other buffer between the edge of the pavement (or curb face, which includes the top of the curb, if present) and the beginning edge of the sidewalk. If the sidewalk contains a line of trees, mailboxes, plantings, etc., the width of these obstructions should be included in the buffer width measurement. The gutter pan is not included in the buffer. If the buffer is different on each side of the road, the average width is recorded.

Tree Spacing in Buffer - The spacing of trees within a buffer measured from foot on center (length of spacing between trees). Trees can either be in a grass buffer or in a sidewalk. Trees that are not between the sidewalk and roadway should not be considered. If the tree spacing is different on each side of the road, the average spacing is recorded.

Sidewalk/Sidepath Width (W_s) - The width of the sidewalk (or sidepath), measured from the edge of the buffer to the backside of the sidewalk. If a grass buffer is not present, the width is measured from the curb face (the top of the curb is included in the measurement). Each side is measured separately: "N/E" is the Northbound or Eastbound side of the road and "S/W" is the Southbound or Westbound side of the road.

Roadside Profile Condition – **This data item will be collected only for facilities with no sidewalks (or sidepaths).** It will be used to assist in determining the condition of the lateral area available for bikeway, sidepath or sidewalk construction. This evaluation is meant to be general, and is applied to area between the outside edge of the pavement and the right-of-way line, or the 10-20 feet of space adjacent to the edge of the pavement. Roadside profiles will be rated 1, 2, or 3. Condition 1 is a generally buildable shoulder, such as a built gravel shoulder of 4'+ or 10-12 feet of clear space, free of obstructions and with a grade similar to the roadway. Condition 2 is a somewhat buildable shoulder which may be narrower, have more frequent obstructions or some areas with steeper grades. Condition 3 is for roadside conditions with severe slopes, ditches, trees or other features making it unbuildable without a major construction effort.

<u>Notes:</u>

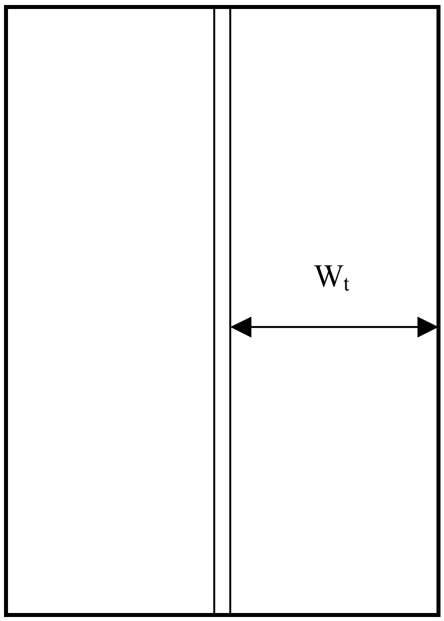
The accuracy of all width measurements is 0.5 feet. Measurements should be taken from the middle of roadway stripes (or the middle between the two centerline stripes). When there is a major change in roadway cross-section within a segment (i.e. the road changes from 2 lanes to 4 lanes in the middle of the segment), the two parts of the segment should be entered on two separate lines on the data collection sheet. Minor changes, such as changes in speed limit, several feet of variation in paved shoulder width, or narrowing of lanes at a small bridge do not require resegmentation. **In these cases, the predominant cross-section characteristics should be recorded and notes regarding variations should be recorded in the comments field.** In addition, if there is any noticeable difference in the above parameters between two directions (north/south or east/west) on a roadway segment, the data describing the other direction should be recorded in the comment field of the database, along with the direction. All other special conditions and assumptions made during the data collection on the segments should be recorded in the comments field of the database.

Please call Bob Schneider at Toole Design Group (301-362-1600 x107) if you have any questions while collecting data in the field.

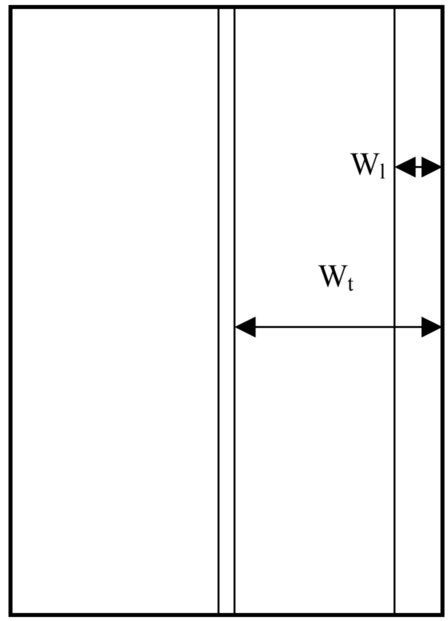
Width Measurement Examples

Diagrams adapted from Sprinkle Consulting, Inc. *Width Measurements - Examples*

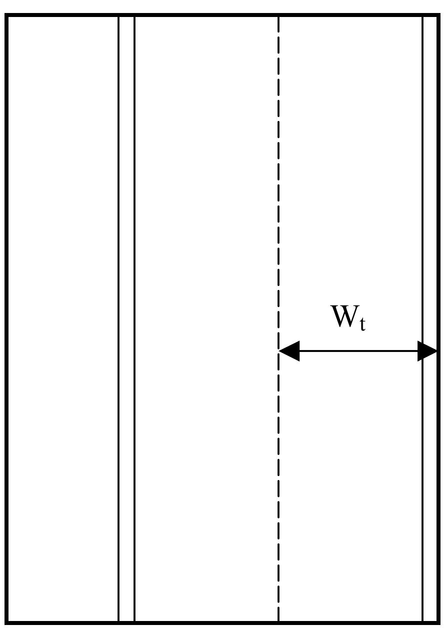
Example 1:
*No shoulder/bike lane
*No parking



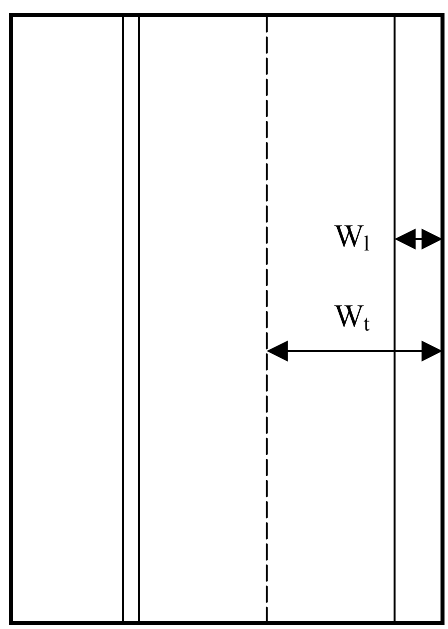
Example 2:
*Shoulder/bike lane
*No parking



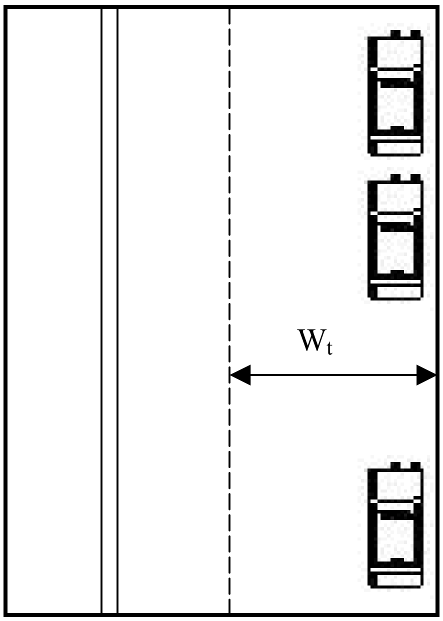
Example 3:
*Multi-lane configuration
*No shoulder/bike lane
*No parking



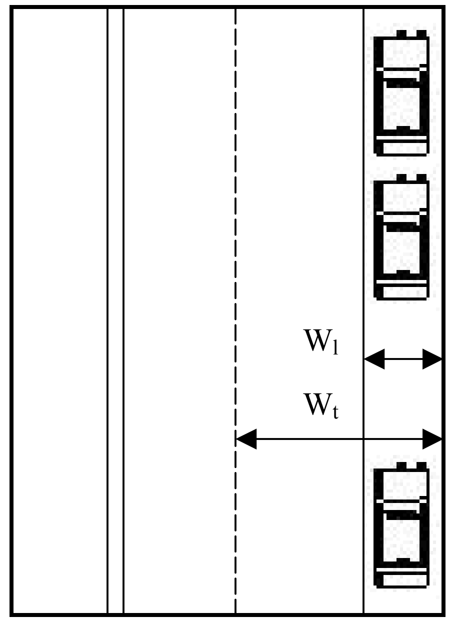
Example 4:
*Multi-lane configuration
*Shoulder/bike lane
*No parking



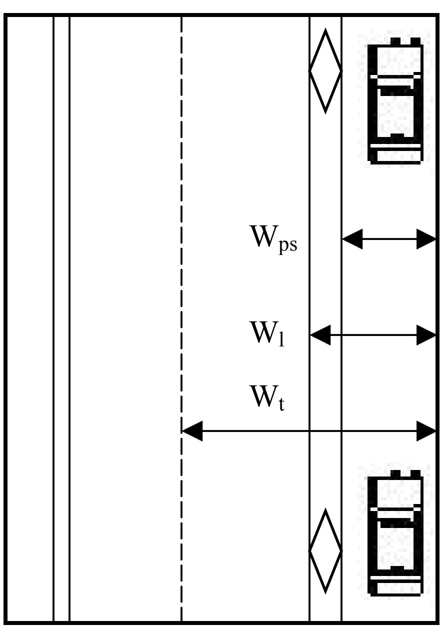
Example 5:
*Multi-lane configuration
*No shoulder/bike lane
*Parking with no stripe



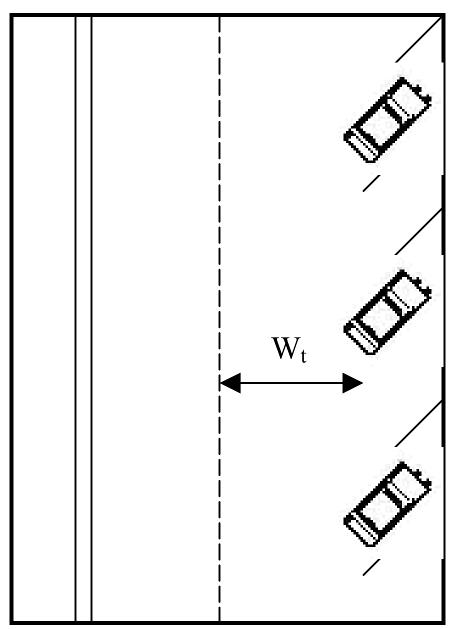
Example 6:
*Multi-lane configuration
*Parking with longitudinal separation stripe



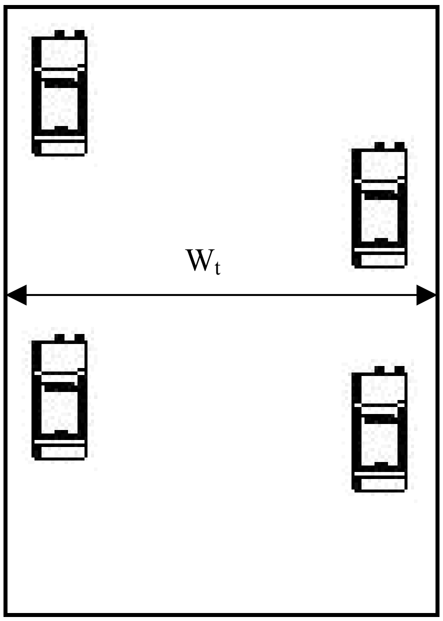
Example 7:
*Multi-lane configuration
*Shoulder/bike lane
*Parking with longitudinal separation stripe



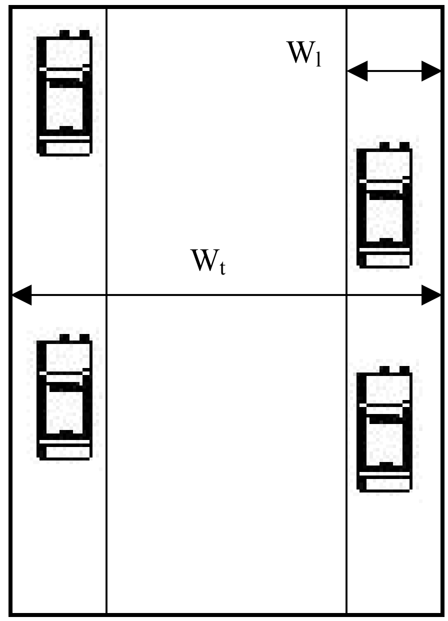
Example 8:
*Multi-lane configuration
*No shoulder/bike lane
*Angled parking



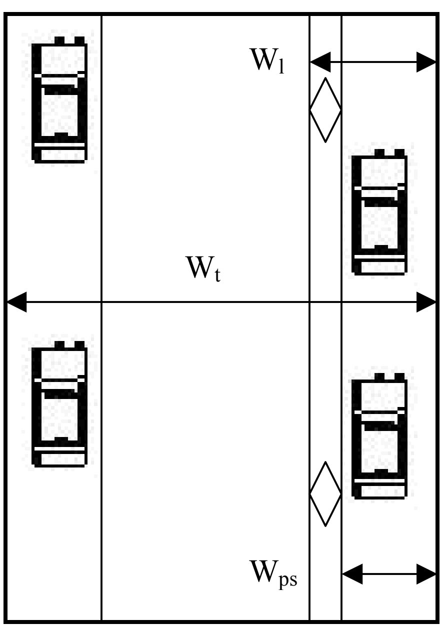
Example 9:
*One-way street (one lane)
*No shoulder/bike lane
*One/two side parking with no stripe



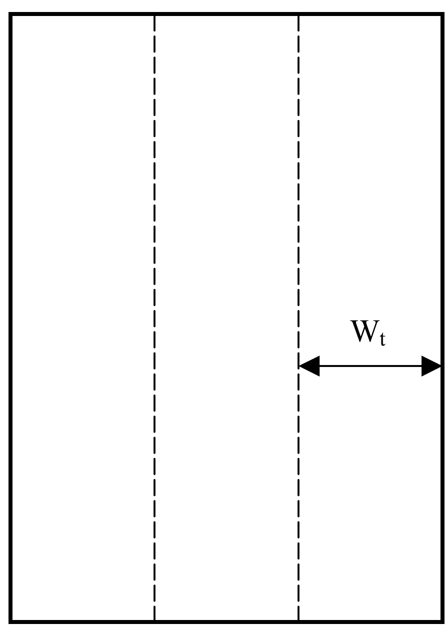
Example 10:
*One-way street (one lane)
*One/two side parking with longitudinal separation stripe



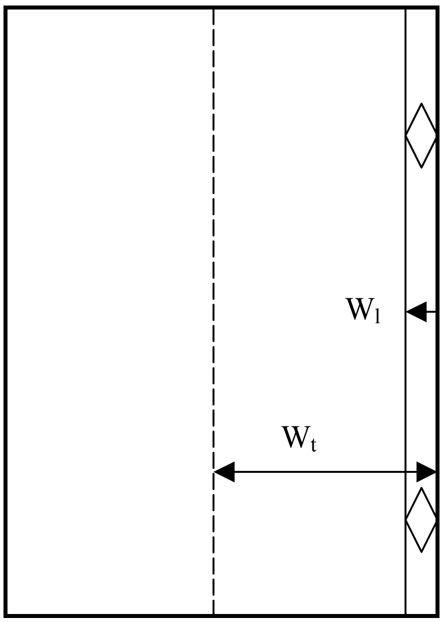
Example 11:
*One-way street (one lane)
*Shoulder/bike lane
*One/two side parking with longitudinal separation stripe



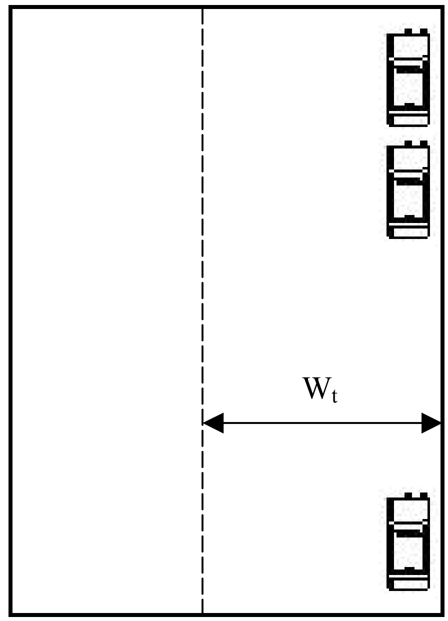
Example 12:
*One-way multi-lane street
*No shoulder/bike lane
*No parking



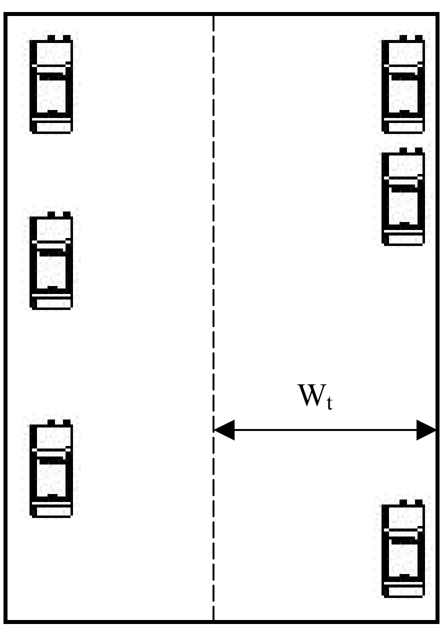
Example 13:
*One-way multi-lane street
*Shoulder/bike lane
*No parking



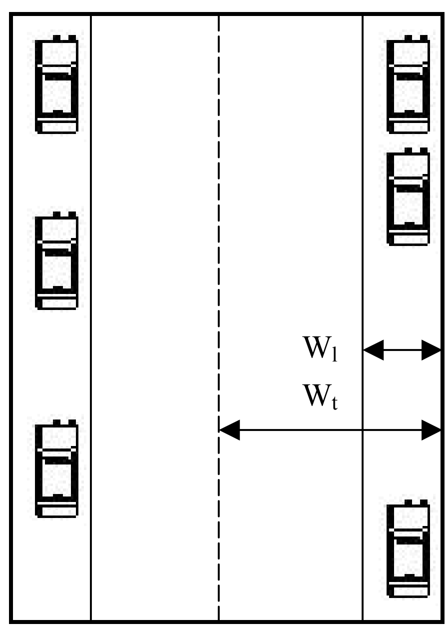
Example 14:
*One-way multi-lane street
*No shoulder/bike lane
*One side parking with no stripe



Example 15:
*One-way multi-lane street
*No shoulder/bike lane
*Two sides parking with no stripe

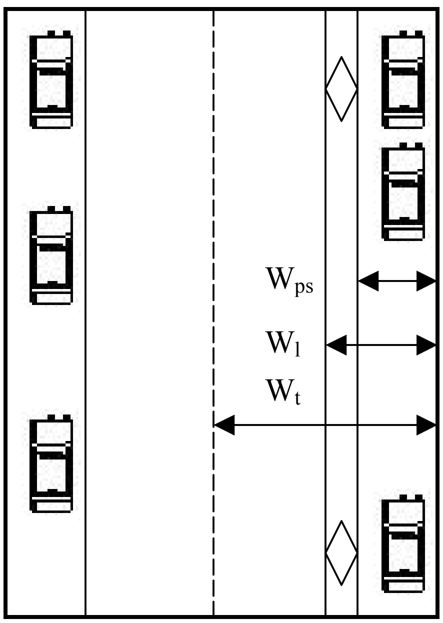


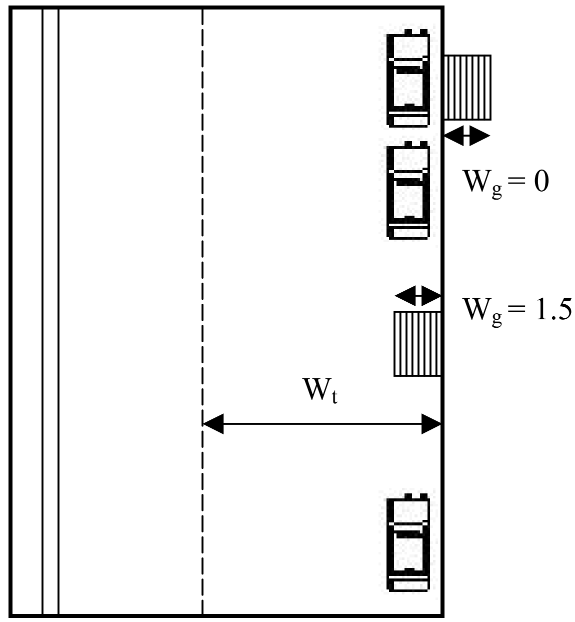
Example 16:
*One-way multi-lane street
*One/two sides parking with longitudinal separation stripe



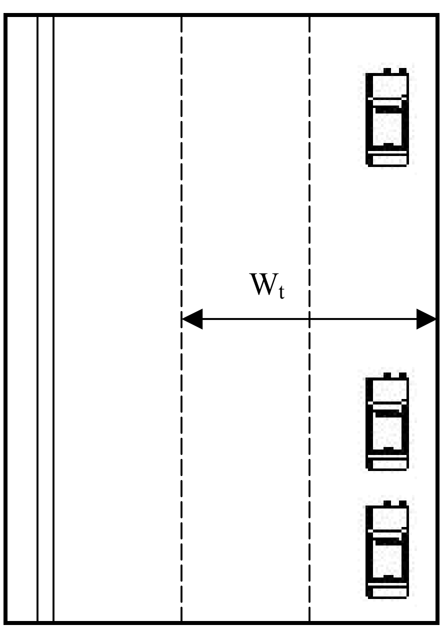
Example 17:
*One-way multi-lane street
*Shoulder/bike lane
*One/two sides parking with longitudinal separation stripe

Example 18:
*No Shoulder/bike lane
*Presence of grates
*Parking with no stripe

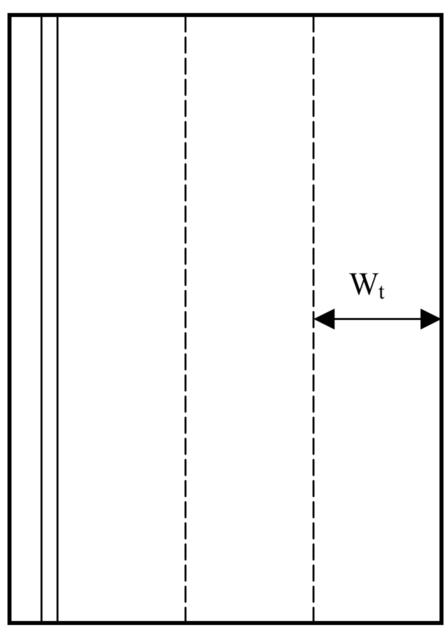




Example 19:
*Variations to measurements due to time of day parking restrictions

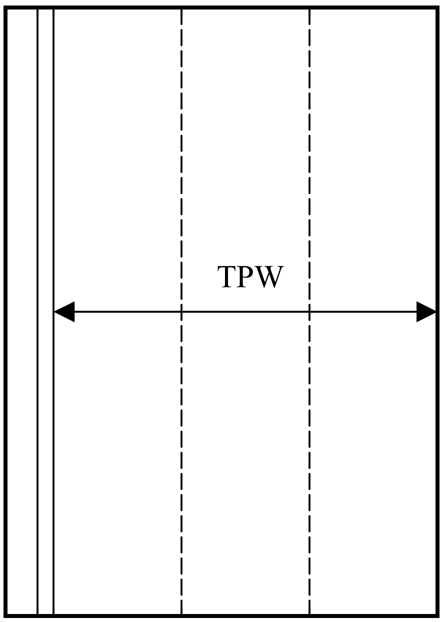


Off-Peak Conditions



Peak Conditions

Optional Example 20:
*Multi-lane street
*No shoulder/bike lane



Appendix E

CENSUS TRANSPORTATION PLANNING PACKAGE (CTPP 2000)

Table 1. Profile of Selected 1990 and 2000 Characteristics

Geographic Area: Botetourt County, Virginia

Subject	1990 Census		Census 2000		Change 1990 to 2000	
	Number	Percent	Number	Percent	Number	Percent
POPULATION						
Total population	24,992	100.0	30,496	100.0	5,504	22.0
In households	24,387	97.6	29,962	98.2	5,575	22.9
In group quarters	605	2.4	534	1.8	-71	-11.7
HOUSEHOLD SIZE						
Total households	9,110	100.0	11,662	100.0	2,552	28.0
1-person household	1,606	17.6	2,237	19.2	631	39.3
2-person household	3,153	34.6	4,532	38.9	1,379	43.7
3-person household	1,976	21.7	2,183	18.7	207	10.5
4-person household	1,617	17.7	1,814	15.6	197	12.2
5-or-more-person household	758	8.3	896	7.7	138	18.2
Mean number of persons per household	2.68	(X)	2.57	(X)	-0.11	(X)
VEHICLES AVAILABLE[1]						
Total households	9,110	100.0	11,662	100.0	2,552	28.0
No vehicle available	435	4.8	435	3.7	0	0.0
1 vehicle available	1,945	21.4	2,226	19.1	281	14.4
2 vehicles available	3,709	40.7	4,912	42.1	1,203	32.4
3 vehicles available	1,993	21.9	2,729	23.4	736	36.9
4 vehicles available	733	8.0	995	8.5	262	35.7
5 or more vehicles available	295	3.2	365	3.1	70	23.7
Mean vehicles per household	2.18	(X)	2.24	(X)	0.06	(X)
WORKERS BY SEX[1]						
Workers 16 years and over	12,712	100.0	15,520	100.0	2,808	22.1
Male	7,014	55.2	8,295	53.4	1,281	18.3
Female	5,698	44.8	7,225	46.6	1,527	26.8
MEANS OF TRANSPORTATION TO WORK						
Workers 16 years and over	12,712	100.0	15,519	100.0	2,807	22.1
Drove alone	10,548	83.0	13,471	86.8	2,923	27.7
Carpooled	1,584	12.5	1,364	8.8	-220	-13.9
Public transportation (including taxicab)	50	0.4	71	0.5	21	42.0
Bicycle or walked	202	1.6	85	0.5	-117	-57.9
Motorcycle or other means	46	0.4	49	0.3	3	6.5
Worked at home	282	2.2	479	3.1	197	69.9
TRAVEL TIME TO WORK						
Workers who did not work at home	12,430	100.0	15,040	100.0	2,610	21.0
Less than 5 minutes	368	3.0	291	1.9	-77	-20.9
5 to 9 minutes	814	6.5	1,071	7.1	257	31.6
10 to 14 minutes	1,389	11.2	1,568	10.4	179	12.9
15 to 19 minutes	1,764	14.2	1,915	12.7	151	8.6
20 to 29 minutes	3,534	28.4	4,372	29.1	838	23.7
30 to 44 minutes	3,281	26.4	4,055	27.0	774	23.6
45 or more minutes	1,280	10.3	1,768	11.8	488	38.1
Mean travel time to work (minutes)	23.9	(X)	26.7	(X)	2.8	(X)

TIME LEAVING HOME TO GO TO WORK						
Workers who did not work at home	12,430	100.0	15,040	100.0	2,610	21.0
5:00 a.m. to 6:59 a.m.	3,731	30.0	4,230	28.1	499	13.4
7:00 a.m. to 7:59 a.m.	4,082	32.8	5,451	36.2	1,369	33.5
8:00 a.m. to 8:59 a.m.	2,019	16.2	2,353	15.6	334	16.5
9:00 a.m. to 9:59 a.m.	430	3.5	472	3.1	42	9.8
10:00 a.m. to 11:59 a.m.	245	2.0	263	1.7	18	7.3
12:00 p.m. to 11:59 p.m.	1,697	13.7	1,881	12.5	184	10.8
12:00 a.m. to 4:59 a.m.	226	1.8	390	2.6	164	72.6

1See the entry for this item in the Technical Notes in the root directory or state subdirectories (filename: tech_notes.txt).

(X)Not applicable.

Source:U.S. Census Bureau. Census of Population and Housing, 1990 and 2000 long-form (sample) data.

CENSUS TRANSPORTATION PLANNING PACKAGE (CTPP 2000)

Table 1. Profile of Selected 1990 and 2000 Characteristics

Geographic Area: Roanoke city, Virginia

Subject	1990 Census		Census 2000		Change 1990 to 2000	
	Number	Percent	Number	Percent	Number	Percent
POPULATION						
Total population	96,397	100.0	94,911	100.0	-1,486	-1.5
In households	94,459	98.0	92,375	97.3	-2,084	-2.2
In group quarters	1,938	2.0	2,536	2.7	598	30.9
HOUSEHOLD SIZE						
Total households	41,064	100.0	42,026	100.0	962	2.3
1-person household	13,233	32.2	15,117	36.0	1,884	14.2
2-person household	13,673	33.3	13,938	33.2	265	1.9
3-person household	6,880	16.8	6,387	15.2	-493	-7.2
4-person household	4,454	10.8	4,012	9.5	-442	-9.9
5-or-more-person household	2,824	6.9	2,572	6.1	-252	-8.9
Mean number of persons per household	2.30	(X)	2.20	(X)	-0.10	(X)
VEHICLES AVAILABLE[1]						
Total households	41,064	100.0	42,026	100.0	962	2.3
No vehicle available	6,270	15.3	5,279	12.6	-991	-15.8
1 vehicle available	15,958	38.9	17,435	41.5	1,477	9.3
2 vehicles available	13,360	32.5	13,403	31.9	43	0.3
3 vehicles available	4,093	10.0	4,363	10.4	270	6.6
4 vehicles available	1,081	2.6	1,194	2.8	113	10.5
5 or more vehicles available	302	0.7	352	0.8	50	16.6
Mean vehicles per household	1.48	(X)	1.52	(X)	0.04	(X)
WORKERS BY SEX[1]						
Workers 16 years and over	44,806	100.0	43,695	100.0	-1,111	-2.5
Male	23,049	51.4	21,670	49.6	-1,379	-6.0
Female	21,757	48.6	22,025	50.4	268	1.2
MEANS OF TRANSPORTATION TO WORK						
Workers 16 years and over	44,806	100.0	43,694	100.0	-1,112	-2.5
Drove alone	34,590	77.2	34,821	79.7	231	0.7
Carpooled	6,509	14.5	5,405	12.4	-1,104	-17.0
Public transportation (including taxicab)	1,353	3.0	1,350	3.1	-3	-0.2
Bicycle or walked	1,396	3.1	867	2.0	-529	-37.9
Motorcycle or other means	373	0.8	425	1.0	52	13.9
Worked at home	585	1.3	826	1.9	241	41.2
TRAVEL TIME TO WORK						
Workers who did not work at home	44,221	100.0	42,868	100.0	-1,353	-3.1
Less than 5 minutes	1,167	2.6	918	2.1	-249	-21.3
5 to 9 minutes	5,897	13.3	5,348	12.5	-549	-9.3
10 to 14 minutes	10,261	23.2	9,598	22.4	-663	-6.5
15 to 19 minutes	12,317	27.9	11,220	26.2	-1,097	-8.9
20 to 29 minutes	8,662	19.6	8,988	21.0	326	3.8
30 to 44 minutes	3,890	8.8	4,311	10.1	421	10.8
45 or more minutes	2,027	4.6	2,485	5.8	458	22.6
Mean travel time to work (minutes)	16.8	(X)	19.3	(X)	2.5	(X)

TIME LEAVING HOME TO GO TO WORK						
Workers who did not work at home	44,221	100.0	42,868	100.0	-1,353	-3.1
5:00 a.m. to 6:59 a.m.	10,848	24.5	10,866	25.3	18	0.2
7:00 a.m. to 7:59 a.m.	14,165	32.0	13,314	31.1	-851	-6.0
8:00 a.m. to 8:59 a.m.	8,295	18.8	7,381	17.2	-914	-11.0
9:00 a.m. to 9:59 a.m.	2,364	5.3	2,270	5.3	-94	-4.0
10:00 a.m. to 11:59 a.m.	1,180	2.7	1,706	4.0	526	44.6
12:00 p.m. to 11:59 p.m.	6,605	14.9	6,278	14.6	-327	-5.0
12:00 a.m. to 4:59 a.m.	764	1.7	1,053	2.5	289	37.8

1See the entry for this item in the Technical Notes in the root directory or state subdirectories (filename: tech_notes.txt).

(X)Not applicable.

Source:U.S. Census Bureau. Census of Population and Housing, 1990 and 2000 long-form (sample) data.

CENSUS TRANSPORTATION PLANNING PACKAGE (CTPP 2000) Table 1. Profile of Selected 1990 and 2000 Characteristics						
Geographic Area: Roanoke County, Virginia						
Subject	1990 Census		Census 2000		Change 1990 to 2000	
	Number	Percent	Number	Percent	Number	Percent
POPULATION						
Total population	79,332	100.0	85,778	100.0	6,446	8.1
In households	77,072	97.2	83,512	97.4	6,440	8.4
In group quarters	2,260	2.8	2,266	2.6	6	0.3
HOUSEHOLD SIZE						
Total households	30,264	100.0	34,734	100.0	4,470	14.8
1-person household	6,366	21.0	8,661	24.9	2,295	36.1
2-person household	10,831	35.8	12,987	37.4	2,156	19.9
3-person household	6,000	19.8	5,976	17.2	-24	-0.4
4-person household	5,017	16.6	4,920	14.2	-97	-1.9
5-or-more-person household	2,050	6.8	2,190	6.3	140	6.8
Mean number of persons per household	2.55	(X)	2.40	(X)	-0.14	(X)
VEHICLES AVAILABLE[1]						
Total households	30,264	100.0	34,734	100.0	4,470	14.8
No vehicle available	1,316	4.3	1,489	4.3	173	13.1
1 vehicle available	7,890	26.1	9,555	27.5	1,665	21.1
2 vehicles available	12,634	41.7	15,025	43.3	2,391	18.9
3 vehicles available	6,055	20.0	6,192	17.8	137	2.3
4 vehicles available	1,778	5.9	1,806	5.2	28	1.6
5 or more vehicles available	591	2.0	667	1.9	76	12.9
Mean vehicles per household	2.04	(X)	1.98	(X)	-0.05	(X)
WORKERS BY SEX[1]						
Workers 16 years and over	42,247	100.0	43,420	100.0	1,173	2.8
Male	22,360	52.9	22,505	51.8	145	0.6
Female	19,887	47.1	20,915	48.2	1,028	5.2
MEANS OF TRANSPORTATION TO WORK						
Workers 16 years and over	42,247	100.0	43,419	100.0	1,172	2.8
Drove alone	36,448	86.3	38,072	87.7	1,624	4.5
Carpooled	3,818	9.0	3,356	7.7	-462	-12.1
Public transportation (including taxicab)	74	0.2	94	0.2	20	27.0
Bicycle or walked	587	1.4	530	1.2	-57	-9.7
Motorcycle or other means	189	0.4	187	0.4	-2	-1.1
Worked at home	1,131	2.7	1,180	2.7	49	4.3
TRAVEL TIME TO WORK						
Workers who did not work at home	41,116	100.0	42,239	100.0	1,123	2.7
Less than 5 minutes	906	2.2	967	2.3	61	6.7
5 to 9 minutes	4,507	11.0	4,340	10.3	-167	-3.7
10 to 14 minutes	7,085	17.2	7,227	17.1	142	2.0
15 to 19 minutes	9,588	23.3	9,216	21.8	-372	-3.9
20 to 29 minutes	12,020	29.2	12,625	29.9	605	5.0
30 to 44 minutes	5,301	12.9	5,364	12.7	63	1.2
45 or more minutes	1,709	4.2	2,500	5.9	791	46.3
Mean travel time to work (minutes)	18.6	(X)	20.7	(X)	2.1	(X)

TIME LEAVING HOME TO GO TO WORK						
Workers who did not work at home	41,116	100.0	42,239	100.0	1,123	2.7
5:00 a.m. to 6:59 a.m.	8,321	20.2	8,854	21.0	533	6.4
7:00 a.m. to 7:59 a.m.	16,288	39.6	16,954	40.1	666	4.1
8:00 a.m. to 8:59 a.m.	7,974	19.4	7,825	18.5	-149	-1.9
9:00 a.m. to 9:59 a.m.	1,895	4.6	2,038	4.8	143	7.5
10:00 a.m. to 11:59 a.m.	948	2.3	1,182	2.8	234	24.7
12:00 p.m. to 11:59 p.m.	5,016	12.2	4,572	10.8	-444	-8.9
12:00 a.m. to 4:59 a.m.	674	1.6	814	1.9	140	20.8

1See the entry for this item in the Technical Notes in the root directory or state subdirectories (filename: tech_notes.txt).

(X)Not applicable.

Source:U.S. Census Bureau. Census of Population and Housing, 1990 and 2000 long-form (sample) data.

CENSUS TRANSPORTATION PLANNING PACKAGE (CTPP 2000)

Table 1. Profile of Selected 1990 and 2000 Characteristics

Geographic Area: Salem city, Virginia

Subject	1990 Census		Census 2000		Change 1990 to 2000	
	Number	Percent	Number	Percent	Number	Percent
POPULATION						
Total population	23,756	100.0	24,747	100.0	991	4.2
In households	21,693	91.3	23,060	93.2	1,367	6.3
In group quarters	2,063	8.7	1,687	6.8	-376	-18.2
HOUSEHOLD SIZE						
Total households	9,179	100.0	9,933	100.0	754	8.2
1-person household	2,435	26.5	2,889	29.1	454	18.6
2-person household	3,330	36.3	3,614	36.4	284	8.5
3-person household	1,683	18.3	1,635	16.5	-48	-2.9
4-person household	1,221	13.3	1,222	12.3	1	0.1
5-or-more-person household	510	5.6	573	5.8	63	12.4
Mean number of persons per household	2.36	(X)	2.32	(X)	-0.04	(X)
VEHICLES AVAILABLE[1]						
Total households	9,179	100.0	9,933	100.0	754	8.2
No vehicle available	586	6.4	591	5.9	5	0.9
1 vehicle available	3,179	34.6	3,418	34.4	239	7.5
2 vehicles available	3,465	37.7	3,892	39.2	427	12.3
3 vehicles available	1,394	15.2	1,547	15.6	153	11.0
4 vehicles available	413	4.5	385	3.9	-28	-6.8
5 or more vehicles available	142	1.5	100	1.0	-42	-29.6
Mean vehicles per household	1.82	(X)	1.80	(X)	-0.02	(X)
WORKERS BY SEX[1]						
Workers 16 years and over	11,949	100.0	12,190	100.0	241	2.0
Male	6,036	50.5	6,060	49.7	24	0.4
Female	5,913	49.5	6,130	50.3	217	3.7
MEANS OF TRANSPORTATION TO WORK						
Workers 16 years and over	11,949	100.0	12,188	100.0	239	2.0
Drove alone	10,088	84.4	10,261	84.2	173	1.7
Carpooled	1,019	8.5	1,094	9.0	75	7.4
Public transportation (including taxicab)	7	0.1	41	0.3	34	485.7
Bicycle or walked	553	4.6	518	4.3	-35	-6.3
Motorcycle or other means	67	0.6	84	0.7	17	25.4
Worked at home	215	1.8	190	1.6	-25	-11.6
TRAVEL TIME TO WORK						
Workers who did not work at home	11,734	100.0	11,998	100.0	264	2.2
Less than 5 minutes	507	4.3	709	5.9	202	39.8
5 to 9 minutes	2,064	17.6	2,053	17.1	-11	-0.5
10 to 14 minutes	2,503	21.3	2,545	21.2	42	1.7
15 to 19 minutes	2,644	22.5	2,460	20.5	-184	-7.0
20 to 29 minutes	2,614	22.3	2,773	23.1	159	6.1
30 to 44 minutes	1,018	8.7	949	7.9	-69	-6.8
45 or more minutes	384	3.3	509	4.2	125	32.6
Mean travel time to work (minutes)	16.2	(X)	17.0	(X)	0.8	(X)

TIME LEAVING HOME TO GO TO WORK						
Workers who did not work at home	11,734	100.0	11,998	100.0	264	2.2
5:00 a.m. to 6:59 a.m.	2,791	23.8	2,593	21.6	-198	-7.1
7:00 a.m. to 7:59 a.m.	4,029	34.3	4,322	36.0	293	7.3
8:00 a.m. to 8:59 a.m.	2,031	17.3	1,963	16.4	-68	-3.3
9:00 a.m. to 9:59 a.m.	690	5.9	486	4.1	-204	-29.6
10:00 a.m. to 11:59 a.m.	370	3.2	465	3.9	95	25.7
12:00 p.m. to 11:59 p.m.	1,709	14.6	1,964	16.4	255	14.9
12:00 a.m. to 4:59 a.m.	114	1.0	205	1.7	91	79.8

1See the entry for this item in the Technical Notes in the root directory or state subdirectories (filename: tech_notes.txt).

(X)Not applicable.

Source:U.S. Census Bureau. Census of Population and Housing, 1990 and 2000 long-form (sample) data.

Appendix F

Summary of Bicycling-Related References in Local Comprehensive Plans

Excerpts from Botetourt County's Comprehensive Plan (Adopted 1998)

Chapter 9: Transportation

Bikeways

Several Bikeway Plans have been developed for both the urbanized and rural areas of Botetourt County. Bikeways are meant to diversify modes of transportation, increase the safety and number of bicyclists, and increase the quality of life within Botetourt. Other goals of the Bikeway Plans are to include consideration of bicyclists in the design and implementation of roadways and to utilize a set of design standards for the bikeways. Some of the roads considered for bikeway improvements inside the County include Routes 11, 43, 220, 460, 601, 640, 651, 654, 738, 779, and the portion of the Blue Ridge Parkway that runs through Botetourt inside the Metropolitan Planning Organization boundary. All road improvements to accommodate the bikeways call for either a wider lane or a wider shoulder. These bikeways are being discussed in detail in both the "Bikeway Plan for the Roanoke Valley" and the "Rural Bikeway Plan."

- Wide lanes are usually 2 to 3 feet wider than the average automobile lane to allow vehicles to pass bicyclist without leaving their lanes. These are usually used on roads with lower traffic volumes and have slower speeds.
- Wide shoulders can be the most economical means of creating bikeways in rural areas. The width of these shoulders can vary according to traffic speeds and volumes, but they are usually between 4 and 6 feet wide although they are sometimes as narrow as 2 feet. This also allows ample emergency pull-off space for automobiles (96).

Excerpts from Roanoke County's Comprehensive Plan from (1998)

- **Chapter 3: Land Use Issues**

Neighborhood Conservation

Single-family neighborhoods are traditionally the most protected land uses. The strategic placement of non-residential land uses, such as parks, schools, libraries and churches (determined by neighborhood preference and need) can play a vital role in preserving and enhancing neighborhood character. Also, creative site planning practices can enhance the opportunity for attached housing to achieve compatibility with adjacent detached housing.

Guidelines

- Incorporate greenways within neighborhoods as well as from neighborhoods to adjacent institutional services, other neighborhoods and commercial centers.

Objectives

- Within the development areas, plan for an interconnected framework of greenways, parks and activity/retail centers.

Guidelines

- Take an inventory of all environmental features and resources present on site in order to create a site development plan that is able to preserve and benefit from the existing natural features.

- Retail support should be located in central locations, easily accessible by car, bike or foot.

- Create common recreational open space for all neighborhood residents (22-23).

- **Regionalism**

Issues and Opportunities

- The Roanoke Valley has the unique opportunity to develop a world-class bikeway and greenway system that is inter-jurisdictional and interconnected (36).

- **Chapter 4: Community Facilities: Transportation**

Introduction

The predominant transportation mode in Roanoke County is the automobile. The County maintains a close working relationship with the Virginia Department of Transportation (VDOT) on all road and vehicular traffic related issues. The State of Virginia owns, constructs and maintains all roads in the County and is responsible for the maintenance of all rights-of-ways.

More emphasis should be placed on other modes of transportation in the County including bicycles, pedestrian walks and public transit. As the County's population continues to age, public transit will become even more relevant to maintaining a high quality of life. The evolving mix of transportation alternatives will better serve all segments of the County population.

Roanoke County should give consideration to issues of sustainable development when making transportation decisions by using resources efficiently and preserving resources, where possible, for future generations (75).

Issues and Opportunities

- The transportation system of the County is predominately vehicle based. There is little infrastructure to support alternative modes of transportation such as bicycling (bike lanes) and walking (sidewalks/improved shoulders) (77).

Objectives

- Work toward a more balanced transportation system - one that is multi-modal (78).

- **Functional Road Classification – Design Requirements**

  - **Secondary Roads**

Urban Collector (example is VA 720, Colonial Avenue)

- The standard cross-section for urban collectors includes sidewalk, curb and gutter.

- Travel lanes have a minimum 10-foot width with 12-foot width being desirable.

- Sidewalks or other similar facilities shall be installed to facilitate pedestrian access to commercial, retail, or civic uses, which shall be required to accommodate walk/jog/bike trails (83).

- **Bikeways**

Introduction

This portion of the Transportation Plan focuses on developing a network of on- and off-road interconnected bicycling facilities that provide an alternative to the automobile. It borrows heavily from the Metropolitan Planning Organization's Bikeway Plan.

A bikeway is any road or path which in some manner is specifically designated as open to bicycle travel, whether such facilities are designated exclusively for bicycles or to be shared with other transportation modes. Bicycles are most commonly used for recreation, but also for commuting and personal errands. Where suitable terrain exists and there are no conflicts in uses, many proposed greenways will be able to accommodate bicycles. For example, the recently completed greenway at Garst Mill Park permits bicyclists in addition to its many pedestrians and provides safe off-road facilities with no conflict from automobiles.

Goal

- To encourage the development of a logical bicycling network by examining Roanoke County's overall road connectivity, promoting driver and bicycle safety programs and insuring that the Bikeway Plan is financially feasible.

Issues and Opportunities

- Bikeways are a significant factor in the quality of life in Roanoke County.
- Bicycle and pedestrian modes of transportation provide excellent alternatives to motorized vehicles.
- If identified early in the road improvement planning process, funding can be set aside for bikeway construction in Roanoke County.
- At the State level, bicycle facility design standards have been established providing bikeway development guidelines from initial planning stages to final construction details.
- Bicycling is healthy, economical and energy efficient.
- Bicycling encourages better use of the existing transportation network by minimally impacting physical surroundings as well as government budgets.

Objectives

- Include bicycling in all stages of transportation and land use planning.
- Identify existing and future bike routes (on- and off-street) in urban, suburban and rural areas and ensure that they are not eliminated as development occurs.
- Identify bicycle route corridors before they are developed and preserve rights-of-way for bike facility's improvements.

Implementation Strategies

- Encourage developers to construct bicycle routes and parking facilities within their projects (Obj. A, B, C).

- Establish a local bicycle fund consisting of annual allocations for bike facility construction and maintenance (Obj. A, B, C).

- Create an advisory committee to monitor progress on facility improvements such as pavement striping, signage and roadway improvements (Obj. A).

- Appoint one individual to coordinate County bicycle planning facility efforts (Obj. A).

- Examine traffic calming techniques (reduced speed limits, narrowed streets and other safety features) in order to provide safer and more pleasant conditions for motorists, bicyclists and pedestrians (Obj. A).

- Encourage bicycle-parking facilities as part of new building or major renovations on residential, commercial or industrial developments (Obj. A).

- Install bicycle-parking facilities at public buildings (Obj. A).

- Encourage widened curb lanes, provide bike lanes or paved shoulders on all major roadways (Obj. A, B, C)

- Identify physical barriers to bicycling and walking (such as rivers, bridges, railroad tracks and highway crossings) and implement solutions to overcome them (Obj. A, B)

- Develop bicycle and pedestrian friendly intersections that facilitate safe through movement (Obj. A, B)

- Construct all new or upgraded bridges to full road width and provide bicycle lanes or separated facilities for cyclists and pedestrians (Obj. A, B)

- Where feasible, build separated bicycle facilities adjacent to all new roads that prohibit bicycling unless alternate bike-compatible roads exist nearby (Obj. A, B)

- Roanoke County should officially adopt the Bikeway Plan to qualify for potential State or Federal funding for bicycle accommodations (Obj. A)

- The following bicycle facility classifications shall apply to those proposed improvements selected for funding:

    - Group A - Bike Trail or Path: a completely separated right-of- way designated exclusively for bicycles and pedestrians with minimized vehicle cross flows;

    - Group B - Bike Lane: on-road bikeway designated by striping signing, adequate pavement width and markings for the preferential or exclusive use of bicyclists;

    - Group C - Widened Outside Lane or Paved Shoulder: a roadway with a widened outside or paved shoulder that is constructed with an additional 2 to 3 feet of pavement width to accommodate bicycles;

    - Group D - Re-stripe for Shared Roadway: roadway designated for potential use by bicycles that is re-striped to increase the outside lane width and decrease the inside lane width minimizing potential conflicts with passing motorists;

    - Group E - No Improvement Necessary: roadway currently adequate for bicycle use.

    (Obj. A, B)

- **Chapter 5: Resource Preservation**

Greenways

A greenway is a corridor of protected open space managed for conservation, recreation and nonmotorized transportation. Greenways often follow natural geographic features such as ridgelines, stream valleys and rivers, but may also be built along canals, utility corridors or abandoned rail lines. Most greenways include a trail or bike path, but others may be designed strictly for environmental or scenic protection.

Greenways, as vegetated linear parks, provide tree cover, wildlife habitat, and riparian buffers to protect streams. The environmental benefits include reduced storm water runoff, flood reduction, water quality protection, and preservation of biological diversity. The trails within the greenways provide access between neighborhoods and destination points, opportunity to travel without an automobile, outdoor education classrooms, and close-to-home paths for walking, jogging, bicycling and roller blading. Tree cover and use of bicycles instead of cars provide for better air quality, fewer hard-surfaced parking lots and reduced energy costs. Although greenways are a collateral component of a countywide park system, they do not replace the need for additional parkland.

In the spring of 1995, the four local governments appointed representatives to a Greenways Steering Committee, which was provided staff support by the Fifth Planning District Commission. A consulting firm was hired to develop a Conceptual Greenway Plan for the Roanoke Valley involving elected officials, civic leaders and the general public.

The Greenway Commission, appointed by the four Valley governments, is an advisory body. Its responsibilities include: facilitate cooperation and coordination among jurisdictions in greenway planning and development; recommend funding sources for greenway construction; develop uniform standards for design and construction; and, pursue public/private partnerships for greenway development.

The backbone of the Roanoke Valley greenway system is the Roanoke River, which runs for over 20 miles through Roanoke County, Salem, Roanoke City and Vinton. In 1998 the Roanoke River Greenway Implementation Plan will be completed, focusing on that portion of the river in Salem and west Roanoke County.

In August 1997, the first one-half mile of greenway, through Garst Mill Park, was completed and opened. This was the first completed section of greenway in Roanoke County and is being very heavily used.

Construction will begin in 1998 on the Hanging Rock Battlefield Trail, which travels through portions of Salem and Roanoke County. Also in 1998, construction is scheduled to begin on the Wolf Creek Greenway in the Town of Vinton. This trail will connect to the new bicycle lanes to be built on Hardy Road and the existing trail system in Goode and Stonebridge Parks in Roanoke County.

While a significant amount of progress has been made on greenways over the last 2 or 3 years there are substantial steps still to be taken. (96-97).

- **Chapter 6: Future Land Use Types**

Land Use Types:

- **Parks and Outdoor Recreation** - Small-scale facilities that serve the rural neighborhoods or are used for community purposes. These recreation facilities should be linked to the residential areas by greenways, bike trails and pedestrian paths.

- **Eco-tourism** - Facilities that serve a niche market and are often outdoor, sports oriented. Designed in an environmentally sensitive way to protect the valuable natural resources of the rural areas.

- **Rural Community Centers** - Includes institutional uses such as schools, religious assembly facilities, clubs and meeting rooms that serve the needs of the surrounding rural village residents.

- **Convenience Retail** - Establishments that provide retail goods and services to the surrounding rural village residents.

Land Use Types

- **Single-Family Residential** - Attached and detached housing at a reasonable density that is not significantly higher than the existing neighborhood. Infill lots or community re-development should be designed to be sensitive to the surrounding neighborhood but can be at reasonably higher density. New single-family residential developments should incorporate greenways and bike and pedestrian trails. Cluster developments are encouraged.

- **Neighborhood Institutional Centers** - Uses that serve the neighborhood residents including parks, schools, religious assembly facilities, recreational and park facilities, community meeting areas and clubs. These facilities should be linked to the residential areas by greenways, bike trails and pedestrian paths.

- **Neighborhood Commercial** - Low impact services to serve the local neighborhood that are consistent with the Community Plan design guidelines (118).

Development

A future land use area where most new neighborhood development will occur, including large-scale planned developments which mix residential with retail and office uses. Innovation in housing design and environmental sensitivity in site development is a key objective. Clustered developments are encouraged, as is the use of greenways and bike and pedestrian trails.

Land Use Types

- **Conventional Residential** - Single-family developments in conventional lots. Includes attached, detached and zero-lot line housing options. Greenways and bike and pedestrian trails are encouraged.

- **Cluster Residential** - Single family developments with similar gross density of conventional subdivisions but individual lot sizes may be reduced to accommodate the clustering of housing while allocating common open space. Includes attached, detached and zero-lot line housing options. Greenways and bike and pedestrian trails are encouraged.

- **Multi-family** - Developments of 6-12 units per acre. Clustering is encouraged, as are greenways and bike and pedestrian trails.

- **Planned Residential Development** - Mixed housing types at a gross density range of 4-8 units per acre. Includes conventional housing, cluster housing, zero lot-line housing, townhouses and garden apartments. Greenways and bike and pedestrian trails are encouraged.

- **Planned Community Development** - Planned residential development mixed with office parks, neighborhood shopping centers and supporting retail development. The majority of the development is residential with a maximum limit set on the retail land. Greenways and bike and pedestrian trails are encouraged.

- **Community Activity Centers** - Facilities which serve the neighboring residents including parks, schools, religious assembly facilities, parks and recreational facilities and community clubs and meeting areas. These activity centers should be linked to residential areas by greenways, bike and pedestrian trails (118-120).

Transportation

- Ensure that County citizens and staff have the opportunity to participate in transportation planning at the initial stages of plan development.

- Require that transportation plans consider the viability and economic feasibility of alternative modes of transportation including greenways, bike paths, sidewalks and walking trails (125).

Greenways

- Greenways and greenway easements should be incorporated into new residential subdivisions and office and industrial parks.

- New road construction and widening of existing roads should include serious consideration of greenways and bikeways and their associated benefits and costs.

- Provide for the construction and maintenance of greenways by incorporating them into the Department of Parks and Recreation's park system with adequate funding (125).

Excerpts from the City of Roanoke's Vision 2020 Comprehensive Plans

Roanoke Neighborhood Plans

- **Belmont-Fallon**

Bicycle/Pedestrian Access

> "The Tinker Creek Greenway opened in 2001 and provides recreation and transportation connections along the eastern border with Vinton. The Mill Mountain Greenway will run along the western border of Belmont. As a fully developed neighborhood, there are few opportunities for separate greenway facilities. Most connections will be along existing streets and connect major destinations such as schools, parks, and other greenways" (22).

Infrastructure Policies

> "Streetscapes, especially at gateways and along major transportation routes, will be attractive. Functionally, streets will accommodate autos, pedestrians, and bicycles. Trees should be used to create a canopy over streets, so large species of trees should be used whenever possible" (38)

Infrastructure Actions

> "Improve the streetscape of major corridors in the neighborhood such as Bullitt/Jamison, Tazewell, 9th Street, and 13th Street. Traffic-calming strategies should be incorporated into improvements. The priority should be on installing trees and providing an improved pedestrian environment. Comprehensive streetscape and traffic calming improvements should be implemented along the Bullitt-Jamison corridor and the existing one-way arrangement should be evaluated for possible conversion to two-way streets. Ninth Street should be reconfigured into an urban boulevard, with a landscaped center median and on-street parking. Turn lanes at major intersections may need to be retained to provide adequate capacity" (38).

- **Downtown**

Infrastructure Policies

> "Support and extend the system of bikeways and trails that link the parts of downtown to each other, to neighborhoods, and to the region's remarkable recreational amenities" (7).

"For Downtown Roanoke to attract new economy companies the regional trail and greenway network must better link downtown to the mountains. The regional network is one of the area's greatest assets, but severely underutilized as it relates to the business districts. A special effort should be made in the next five years to connect the City Market Building and Railwalk to the regional trail system along the edge of the Gainsboro Neighborhood and CBI. New connections should be designed to accommodate both bike and pedestrian users and trails should take on an urban character as the move through-out downtown" (49).

- **Gainsboro**

Infrastructure Polices

"Major streets will be attractive and will be designed for pedestrian and bike accommodations. Major streets will be designed to move traffic smoothly, but at speeds that promote the livability of the neighborhood" (24).

Infrastructure Actions

"Review the design of major streets and initiate projects to create pedestrian and bike friendly corridors where automobile traffic travels at speeds appropriate for a neighborhood setting. The priority for traffic calming measures should be on Gainsboro Road. Develop a neighborhood-specific streetscape plan for sidewalks, street signs, curbs, curb cuts, travel lanes, planting strips, and street lighting" (24).

- **Greater Deyerle**

Neighborhood Comments (Transportation Section)

"Residents are concerned for the safety of pedestrians on neighborhood streets, especially Deyerle, Mud Lick, and Keagy Roads. A pedestrian walkway is critically needed on these major roads. In lieu of sidewalks or a park, it is the residents' recommendation that a system of walking/jogging trails that are more natural in character be established where feasible" (16). (No explicit mention of bikes/bikeways/greenways)

- **Greater Raleigh Court**

Greater Raleigh Court Neighborhood Values

"Greater Raleigh Court's self-sufficient community, "a town within a city," should be preserved and promoted. This "village" concept incorporates the elements of everyday life: housing, workplace, education, shopping, human services, and recreation — into a convenient, compact, pedestrian/bicycle friendly, mixed-use neighborhood. Residents who support each other and who work together to support the neighborhood are important elements of the community. Businesses in the Grandin Village commercial area are an important part of the community and should be supported and enhanced" (11).

"Commercial areas throughout Greater Raleigh Court should be geographically compact and pedestrian/bicycle-oriented. Design of businesses and their accessory uses, such as signs and parking areas, should be in character with the surrounding residential area. Haphazard or piecemeal expansion of commercial areas and strip development should be avoided" (11).

"The pedestrian-friendly character of the neighborhood should be maintained and enhanced through a complete, well-maintained sidewalk system and through the development of greenways. Neighborhood schools and parks within walking distance should be preserved" (11).

Traffic Transportation and Parking

"As in all neighborhoods, multi-modal transportation should be encouraged. Pedestrian and bicycle transportation, especially, should be encouraged by providing complete sidewalk systems and bicycle accommodations on streets that connect schools, parks, libraries, and commercial areas…City policies, capital improvements, and future land-use decisions should foster multi-modal transportation. Opportunities to encourage multi-modal transportation should be identified and pursued as a part of development or improvement projects in the neighborhood" (15).

Goals and Action Strategies (Traffic Transportation and Parking)

- Reduce traffic problems, including pedestrian/bicycle/motor vehicle conflicts, and make the streets friendlier for pedestrians and bicycles.

- Encourage alternative modes of transportation, develop a greenway system linking neighborhood destinations such as the shopping village, schools, library, and parks.

- Encourage use of bicycle, mass transit, and pedestrian transportation (27).

- **London-Melrose/Shenandoah West**

Streetscapes

> "As a two-lane street, Shenandoah is too wide. It should be assessed for redesign of lane striping, and on-street parking. In addition, it is identified in the *Bikeway Plan for the Roanoke Valley* as having the potential for bike lanes. The Plan notes that it would not require widening to accommodate bike lanes" (14).
>
> "Loudon Avenue and Salem Turnpike are designated as a potential greenway route in the *Roanoke Valley Conceptual Greenway Plan* and in Vision 2001-2020. The current width of both should allow for bike lanes without additional right-of-way being acquired" (14).

Actions

> "Assess Shenandoah Avenue for redesign of lane striping, on-street parking, and bike lanes. "
>
> "Create the bicycle and greenway routes identified in the Bikeway Plan for the Roanoke Valley and the Roanoke Valley Conceptual Greenway Plan." (17).

Quality of Life

> "Work with the Department of Parks and Recreation to determine the priority and feasibility of developing a master plan for Horton Park, considering the following needs:
>
> - Greenway Corridors and Connections
>
> "Create the bicycle and greenway routes identified in the Bikeway Plan for the Roanoke Valley and the Roanoke Valley Conceptual Greenway Plan." (21)

- **Melrose – Rugby**

Quality of Life: Strategies

> "3.3 Seek opportunities for enhanced access to the proposed Lick Run Greenway" (11).

Infrastructure: Pedestrian Systems

> "The proposed Lick Run Greenway will provide recreational and bicycle transportation facilities to the neighborhood. The greenway will follow the path of Lick Run to the north of Melrose-Rugby, between Valley View

Mall and Hotel Roanoke, providing the neighborhood with pedestrian access to Valley View Mall, downtown, and the Civic Center" (14).

10th Street Widening

"In April 2000, City Council approved a plan to widen the road to add bike lanes, sidewalks, and turn lanes to improve safety at selected intersections" (15).

Strategies

"Include design features in road construction plans that maintain a unified neighborhood and provide for pedestrian and bicycle traffic" (16).

- **Old Southwest**

"Greenways are corridors of protected open space used for recreation, conservation and transportation. Greenways link neighborhoods and connect the City to the greater region. Old Southwest residents have expressed support for greenway connections to Smith Park, Wasena Park and the Riverside Centre for Research and Technology. The development of greenways is supported in *Vision 2001-2020*" (16).

- **Peters Creek North**

Quality of Life: Greenways

"Greenways and bike trials are important quality of life elements that are missing from the Peters Creek North area. No greenways currently exist in the planning area. The Roanoke Valley Conceptual Greenway Plan recommends greenways along the Peters Creek and Hershberger Road corridors. In addition, opportunities might exist to extend the Lick Run Greenway between Hershberger Road and, Peters Creek Road. Potential opportunities exist to enhance the greenway system in the Roanoke Valley through the use of utility easements, acquisition of flood plains and riparian buffer zones, possible residential and commercial greenway-specific land dedications, and the use of bike-lanes and greenway-dedicated sidewalks on low-volume residential streets" (16).

Infrastructure: Policies

"Hershberger Road and Cove Road improvements:

- Sidewalks and/or greenways should be provided to accommodate pedestrians and bicyclists.
- Street trees should be provided between the sidewalks and curb to

reduce the visual, noise impacts on surrounding residences, and provide separation of pedestrian and vehicular traffic.

- A landscaped median and turn lanes should be provided.
- Traffic claming devices should be incorporated" (21)

Southern Hills

Infrastructure: Transportation

"The close proximity to the Blue Ridge Parkway and the Mill Mountain Parkway Spur is a community asset. Access between the parkway and the local commercial center and other areas of the city should be enhanced with pedestrian/bike paths along 220" (13).

Infrastructure Recommendations: Policies

"Safe, convenient auto, pedestrian, and bicycle access should be provided throughout the neighborhood. New streets should be designed according to the recommended street designs in the Infrastructure section" (23).

- **South Roanoke**

Action Strategies: Parks and Recreation

"Recommend the development of a greenway system along the Roanoke River with a connected system of bikeways and pedestrian paths" (22).

Excerpts from Salem's New Comprehensive Plan

- **Chapter IV – Goals, Objectives and Strategies**

Government Services

Fire and Emergency Medical Services (EMS)

The Salem Fire and EMS Department currently consists of 62 full-time employees who are diverse in performance of their assigned duties. They are highly trained in many areas of fire and emergency medical services.

Objective: Continue to design and provide a variety of citizen safety education programs.

Strategy: Continue citizen safety education programs in the areas of fire prevention and safety, first aid, CPR, and bicycle safety (45-46).

Transportation and Infrastructure

Apperson Drive/Route 419 Intersection Improvements

Improvements are planned for the intersection of Apperson Drive and Route 419. Preliminary engineering funding needs have been identified, but no funding has been allocated for right-of way acquisition or construction. The MPO's regional bikeway plan suggests that the design for these improvements should incorporate wider travel lanes or paved shoulders to accommodate bicycle usage (58).

Streets and General Maintenance

The Streets and General Maintenance Department is comprised of six divisions, each with a specific area of responsibility. These divisions are beautification, building maintenance, fleet management, sanitation, streets and street signs, and pavement marking.

Goal: To provide professional and cost-effective services to the citizens of Salem in the areas of streets and general maintenance of public facilities.

Strategy: Monitor, maintain, and repair all streets, curbs, gutters, storm drains, sidewalks and driveway entrances along public roadways.

Strategy: Explore the creation and funding of a sidewalk and bikeway/greenway expansion program within the City.

Strategy: Continue to coordinate with the Department of Engineering and the City Manager's office on issues pertaining to future paving, road widening, utility coordination, and curbing and sidewalk expansion initiatives (64-66).

Excerpts from Town of Vinton Comprehensive Plan from 1994

- **Goals, Objectives, and Policy Recommendations**

Goals

- To maintain or improve the quality of the natural environment in and around the Town of Vinton.

Objectives

- To encourage modes of transportation which reduce environmental impacts.
- Policy Recommendation 6.4.1: Continue to support Valley Metro and the bus routes through Vinton.
- Policy Recommendation 6.4.2: Participate in a regional bicycle system designed for efficient transportation and commuting. (92-93).

Appendix G

VDOT POLICY RELATIVE TO BICYCLE FACILITIES

I. GENERAL GUIDELINES FOR BICYCLE FACILITIES

a. Local governments are encouraged to develop bicycle facilities on a local and regional basis in order to satisfy the demands within each geographic area.

b. The Department's participation in bicycle facilities is oriented toward facilities that may be constructed either as part of a highway construction project or an independent transportation project.

c. Bicycle facilities can include shared wide highway lanes, paved highway shoulders, bicycle lanes, bicycle paths, multipurpose paths, and other physical improvements to better accommodate bicyclists.

d. Bicycle facilities may be constructed for access purposes when the conditions under Section V are met.

II. COMPREHENSIVE BICYCLE PLAN DEVELOPMENT

a. The Department will participate in comprehensive bicycle facility planning in the urbanized areas of the State (population greater than 50,000) as part of the Continuous, Comprehensive, and Cooperative ("3C") transportation planning process.

b. The Department may assist all other local governments and Planning District Commissions in developing a comprehensive bicycle facility plan when requested. This may be either technical or financial assistance.

III. DEPARTMENT PARTICIPATION IN BICYCLE FACILITIES

a. The Department will consider financially participating in the construction of a bicycle facility where all the following conditions are satisfied:

1. The bicycle facility will not impair the safety of the bicyclist, motorist, or pedestrian, and is designed to meet current AASHTO guidelines and/or VDOT guidelines.

2. The bicycle facility will be accessible to users and will form a segment located and designed pursuant to a comprehensive bicycle plan that has been adopted by the local jurisdiction or is part of the AASHTO approved Interstate Bicycle Route System.

3. It is reasonably expected that the bicycle facility will have sufficient use in relation to cost to justify expenditure of public funds in its

construction and maintenance, or the bicycle facility is a significant link in a comprehensive bicycle system that is needed for route continuity.

4. The Department will initiate bicycle facility construction only at the request of the affected local government, with the exception of the AASHTO approved Interstate Bicycle Route System. Local government is defined as follows:

   1. Primary System Projects
      a. County Boards of Supervisors
      b. City/Town Councils

   2. Secondary System Projects
      a. County Boards of Supervisors

   3. Urban System Projects
      a. City/Town Councils

5. Bicycle facility design plans must be coordinated with the affected local government and approved by the Department prior to any official implementation by the Department.

b. All proposed highway projects involving major construction or redevelopment along the AASHTO approved Interstate Bicycle Route System should provide the necessary design features to facilitate bike travel along those routes.

c. The Department may elect not to participate in the construction of a bicycle facility even if all the conditions in IIIa and IIIb are met.

IV. **FINANCIAL PARTICIPATION**

a. For a Department approved bicycle facility project that is constructed either concurrently with a highway project or built as an independent transportation project, the Department may financially participate as follows:

   1. Primary System - in all jurisdictions, except towns under 3,500 population where the Department maintains the Primary System highways, all additional preliminary engineering, right-of-way, and 1/2 of the construction costs for the bicycle facility may be borne by the Primary System highway construction funds allocated for the Construction District. For the following exceptions, the additional costs may be borne totally by the Primary System funds allocated:

      - Towns under 3,500 population
      - Relocated Existing Bicycle Facilities
      - Paved Shoulders and Shared Roadways where provisions for such are necessary to provide for proper motor vehicle traffic service
      - AASHTO Approved Interstate Bicycle Route System (Item IV a.4)

2. Secondary System - In counties and towns where the Department maintains the Secondary System highway, all additional preliminary engineering, right-of-way, and 1/2 of the construction costs for the bicycle facility may be borne by the Secondary System highway construction funds allocated for the county. For the following exceptions, the additional costs may be borne totally by the Secondary System funds allocated:

- Relocated Existing Bicycle Facilities
- Paved Shoulders and Shared Roadways for highways functionally classified as Arterials or Collectors where provisions for such are necessary to provide for proper motor vehicle traffic service
- AASHTO Approved Interstate Bicycle Route System (Item IV a.4)

3. Urban System - In all cities and towns that maintain their own highways, the cost for additional preliminary engineering, right-of-way, and construction of bicycle facilities may be borne by the Urban System construction funds allocated to the locality with the same local match required by law for construction of the highway project.

4. AASHTO Approved Interstate Bicycle Route System - For all bicycle projects located along the AASHTO approved Interstate Bicycle Route System on the Primary and Secondary Systems, the additional costs for preliminary engineering, right-of-way, and construction of the bicycle facility may be borne totally by the funds allocated by law for those systems. The additional costs for those Interstate Bicycle System projects on the Urban System may be borne by the urban funds allocated to the locality with the same local match required by law for construction of the highway project.

b. For a Department approved bicycle facility project that is built as an independent transportation project and is not associated with the primary, secondary, or urban systems, the Department's funding participation will be determined through a negotiated agreement with the locality involved.

V. **BICYCLE ACCESS FACILITIES**

a. The Department may participate in the development of bicycle access facilities to serve public recreational areas and historic sites based upon the current Recreational Access Fund Policy.

VI. **EXISTING ROADS**

In some instances, for route continuity, bicycle facilities may be routed over existing facilities which are not planned for expansion. In these cases, these facilities are an operational feature and usually result on the identification of a bike lane, restriction of parking, or some other physical modification to accommodate bicycle travel. It is necessary for the Transportation Planning Engineer to coordinate with the District Administrator, the District Traffic Engineer, and appropriate Divisions in the Central Office to assure agreement on the method of treatment for a bikeway over an existing route. All of the conditions of Sections III and IV need to be met. Financial participation will be the same as in Section IV.

VII MAJOR DEVELOPMENTS AND SITE PLANS

a. When bicycle facilities are considered as a part of the total development of a tract of property where the road system will be maintained in the future by the Department and the local government requires bikeways in new developments, the following conditions must be satisfied:

1. The bicycle element of the entire plan for the development must be reviewed and approved by the local government prior to final approval by the Transportation Planning Engineer. Appropriate review must be made, and communication regarding the resolution of bicycle facility systems must be carried on between the Resident Engineer, District Traffic Engineer, and the Transportation Planning Engineer.

2. Along any roadways identified in the site plan, which will be maintained in the future by the Department, a bike trail may be incorporated into the development parallel to but off of the right-of-way dedicated for street purposes. The maintenance and the responsibility for operating the bike trail would fall on the owner which would be either the locality, the developer, or other entity with the responsibility of maintenance of the common land of the development and not the responsibility of this Department. The bike trail right-of-way will be exclusive of the road right-of-way; thus, future changes and/or modifications in the bike trail would not be the responsibility of this Department.

3. Bikeways within the roadway right-of-way shall be designed to meet AASHTO guidelines and/or VDOT guidelines.

b. For major developments and site plans where the road system will not be maintained in the future by the Department, all bicycle facility connections to Department maintained facilities shall be subject to review and approval by the District Administrator.

VIII. MAINTENANCE

The department will maintain approved bicycle facilities located within the right-of-way for roadways which are under its operational control, except for snow and ice removal. If the Department does not maintain the adjacent road then the bicycle facility must be maintained by others.

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Bibliography

American Association of State Highway and Transportation Officials. 1999. *Guide for the Development of Bicycle Facilities*. American Association of State Highway and Transportation Officials: Washington, D.C.

American Association of State Highway and Transportation Officials. 2001. *A Policy on Geometric Design of Highways and Streets.* American Association of State Highway and Transportation Officials: Washington, D.C.

Center for Transportation Analysis, Oak Ridge National Laboratory. 1995. *National Personal Transportation Survey.* Retrieved May22, 2003 from the National Personal Transportation Survey website: http://www-cta.ornl.gov/npts/1995/Doc/index.shtml

City of Roanoke. 2001.*Vision 2001-2020.* Retrieved May 2, 2002 from the City of Roanoke Comprehensive Plan website: http://www.roanokegov.com/vision/overview.html

City of Salem. 2003. *Comprehensive Plan of the City of Salem, Virginia.* Retrieved May 5, 2003 from the City of Salem Comprehensive Plan website: http://www.ci.salem.va.us/government/cp_2003.pdf

Fifth Planning District Commission. 1998. Botetourt County Comprehensive Plan.

Luvall, Jeffrey C. and Dale Quattrochi. 1996. *What's hot in Huntsville and what's not: A NASA thermal remote sensing project.* Retreived July15, 2003 *from* NASA's Global Hydrology and Climate Center: http://www.ghcc.msfc.nasa.gov/land/heatisl/heatisl.htm.

Office of the Surgeon General. (2003). *The Surgeon General's Call To Action To Prevent and Decrease Overweight and Obesity.* Retrieved May 26, 2003 from Office of the Surgeon General: http://www.surgeongeneral.gov/topics/obesity/calltoaction/toc.htm.

Pucher, John and John L. Renne. 2003. *Socioeconomics of Urban Travel: Evidence from the 2001 NHTS*. Available Online: http://policy.rutgers.edu/papers/14.pdf

Roanoke Valley Alleghany Regional Commission. 2003. *Rural Transportation Planning Assistance Program FY 2004.* Available Online: http://www.rvarc.org/work/rural.pdf

Roanoke Valley Area Metropolitan Planning Organization. 2003. *Unified Planning Work Program FY 2004.* Available Online: http://www.rvarc.org/work/urban.pdf.

Roanoke Valley Area Metropolitan Planning Organization. 1997. *Regional Bikeway Plan for the Roanoke Valley Area.* Available Online: http://www.rvarc.org/work/bike97.pdf

Roanoke Valley Area Metropolitan Planning Organization. 2002. *Early Action Compact for the Roanoke Metropolitan Statistical Area (MSA) in the Commonwealth of Virginia.* Available Online: http://www.rvarc.org/work/eacfinal.pdf.

Roanoke Valley Greenways homepage. 2003. Available Online: http://www.greenways.org/ (Accessed May 29, 2003).

Flink, Charles A. and Robert M. Searns. 1993. *Greenways: A Guide to Planning, Design, and Development*. The Conservation Fund. Island Press: Washington D.C.

Southeast Regional Climate Center. 2002. Historical Climate Summaries for Virginia. Retrieved May 15, 2003: http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?va7285

United States Census Bureau. Census Transportation Planning Package (CTPP) [CD-ROM]. Washington, DC.

United States Census Bureau. September 2000. Summary File 3. [CD-ROM]. Washington, DC.

United States Department of Transportation, Federal Highway Administration. 1999. *A Comparative Analysis of Bicycle Lanes Versus Wide Curb Lanes: Final Report.* PUBLICATION NO. FHWA-RD-99-034. Available Online: http://http://www.fhwa.dot.gov/tfhrc/safety/pubs/99034/99034.pdf.

US Department of Transportation, Federal Highway Administration. 1998. *Bicycle Compatibility Index: A Level of Service Concept, Implementation Manual.* Publication Number FHWA-98-098. Retrieved February18, 2003 from the Bicycle Compatibility Index website: http://www.hsrc.unc.edu/research/pedbike/98095/index.html.

United States Department of Transportation, Federal Highway Administration*. 2000. Manual on Uniform Traffic Control Devices.* Available Online: http://mutcd.fhwa.dot.gov/kno-millennium_12.28.01.htm.

United States Department of Transportation, Federal Highway Administration. 1994. *Roadway Design Treatments to Accommodate Bicycles*. Publication No. FHWA-RD-92-073.

Virginia Department of Transportation. 2001. *Road Design Manual*, *Section A-5-Bicycle Facility Guidelines.* Available Online: http://www.virginiadot.org/infoservice/resources/bk-designguide.pdf.

Virginia Department of Transportation. 2002. *The Virginia Bicycle Facility Resource Guide.* [CD-ROM]. Richmond, VA.

Virginia Department of Transportation. 2002. State Highway Planning System (SHiPS).