Final Report

US 23/Route 224 Corridor Study

Prepared for:

Kingsport
TENNESSEE

Prepared by:

Kimley-Horn and Associates, Inc.

Table of Contents

1. EXECUTIVE SUMMARY 1
1.1 Purpose and Need 1
1.2 Study Area 1
1.3 Methodology 3
1.4 Recommendations and Cost Summary 3
2. INTRODUCTION 5
2.1 Background 5
2.2 Study Area 5
2.3 Study Goals 6
2.4 Project Team Members 6
3. DATA COLLECTION AND INVENTORY 14
3.1 General Description of the Corridor 14
3.2 Study Area Intersections 16
3.3 Physical Environment 16
3.4 Supplemental Field Data Collection 17
3.5 Traffic Conditions 17
3.6 Transit Services 27
3.7 Crash Data 27
3.8 Land Use 27
3.9 Planned Development 27
4. EXISTING CONDITIONS 27
4.1 Level of Service 28
4.2 Crash Analysis 33
4.3 Transit 34
4.4 Bicycles and Pedestrians 34
4.5 Environmental Screening 35
5. MODELING AND FORECASTING 44
5.1 Background 44
5.2 Analysis Scenarios 44
5.3 Growth Rate Methodology and Future Traffic Volume Circulation 44
5.4 Growth Rate Calibration Process and Methodology 48
5.5 Future Traffic Volume Calculation 53
6. FUTURE CONDITIONS 54
6.1 Levels of Service – Future Conditions 54
6.2 Access Management 75
7. RECOMMENDATIONS 79
7.1 General Corridor Improvements 79
7.2 US 23 Improvements 79
7.3 Route 224/SR 93 Improvements 90
7.4 Route 224 at US 58/US 421 92
7.5 Conclusions and Cost Summary 93
8. PUBLIC INVOLVEMENT 94
8.1 Summary of the Public Feedback from Meeting #1 95
8.2 Summary of the Public Feedback from Meeting #2 95

List of Tables

EXECUTIVE SUMMARY

Table 1-1: Planning Level Cost Summary 4

EXISTING CONDITIONS

Table 4-1: Level of Service Definitions 28

Table 4-2: Signalized and Unsignalized Intersection Level of Service Criteria..... 28

Table 4-3: Intersection Level of Service Summary – US 23/Route 224 Corridors 2010 Existing Volumes 29

Table 4-4: Arterial Link Level of Service Summary – US 23/Route 224 Corridors 2010 Existing Volumes 33

Table 4-5: Threatened and Endangered Species in Study Corridors Within Virginia 42

Table 4-6: Threatened and Endangered Species in Study Corridors Within Tennessee..... 42

Table 4-7: Hazardous Materials Monitoring Sites along US 23 and Route 224 Corridors..... 43

MODELING AND FORECASTING

Table 5-1: US 23 VDOT AADT Volume Estimates and Annualized Growth Rates 47

Table 5-2: Route 224 VDOT AADT Volume Estimates and Annualized Growth Rates..... 47

Table 5-3: US 58/US 421 VDOT AADT Volume Estimates and Annualized Growth Rates..... 47

Table 5-4: Traffic Analysis Zone (TAZ) Growth Rates for 2004, 2010, 2015 and 2030..... 48

Table 5-5: Future Travel Demand Growth Rates Comparison 48

Table 5-6: Proposed Annualized Traffic Growth Rates 48

FUTURE CONDITIONS

Table 6-1: Intersection Level of Service Summary – US 23/Route 224 Corridors 2015 No-Build Volumes.....54

Table 6-2: Intersection Level of Service Summary – US 23/Route 224 Corridors 2035 No-Build Volumes.....60

Table 6-3: Intersection Level of Service Summary – US 23/Route 224 Corridors 2035 Build Volumes.....60

Table 6-4: Arterial Link Level of Service Summary 71

Table 6-5: Arterial Link Level of Service Route 224/SR 93 as 4-lane Divided Facility – Build 2035 75

Table 6-6: Functional Classification System Characteristics 76

Table 6-7: VDOT Access Management Design Standards.....77

Table 6-8: Spacing Criteria for Traffic Signals.....78

RECOMMENDATIONS

Table 7-1: Access Management – Existing and Proposed Median Openings along US 23.....86

Table 7-2: Access Management – Proposed Median Openings along Route 224/SR 93 Under a 4-lane Roadway Scenario.....90

Table 7-3: Level of Service – Alternatives to Cloverleaf Interchange, Build 2035 92

Table 7-4: Planning Level Cost Summary.....93

List of Figures

EXECUTIVE SUMMARY

Figure 1-1: Study Area Map 2

INTRODUCTION

Figure 2-1: Study Area Map 7
Figure 2-2: Corridor Location Map (1 of 6) 8
Figure 2-3: Corridor Location Map (2 of 6) 9
Figure 2-4: Corridor Location Map (3 of 6) 10
Figure 2-5: Corridor Location Map (4 of 6) 11
Figure 2-6: Corridor Location Map (5 of 6) 12
Figure 2-7: Corridor Location Map (6 of 6) 13

DATA COLLECTION AND INVENTORY

Figure 3-1: Existing Zoning Map (1 of 6) 18
Figure 3-2: Existing Zoning Map (2 of 6) 19
Figure 3-3: Existing Zoning Map (3 of 6) 20
Figure 3-4: Existing Zoning Map (4 of 6) 21
Figure 3-5: Existing Zoning Map (5 of 6) 22
Figure 3-6: Existing Zoning Map (6 of 6) 23
Figure 3-7: Existing 2010 Traffic Volumes (1 of 2) 24
Figure 3-8: Existing 2010 Traffic Volumes (2 of 2) 25
Figure 3-9: Existing 2010 Average Daily Traffic (ADT) 26

EXISTING CONDITIONS

Figure 4-1: Existing 2010 Intersection LOS (1 of 2) 30
Figure 4-2: Existing 2010 Intersection LOS (2 of 2) 31
Figure 4-3: Existing 2010 Arterial LOS 32
Figure 4-4: Environmental Map (1 of 6) 36
Figure 4-5: Environmental Map (2 of 6) 37
Figure 4-6: Environmental Map (3 of 6) 38
Figure 4-7: Environmental Map (4 of 6) 39
Figure 4-8: Environmental Map (5 of 6) 40
Figure 4-9: Environmental Map (6 of 6) 41

MODELING AND FORECASTING

Figure 5-1: Study Area Traffic Analysis Zones 45
Figure 5-2: Kingsport Travel Demand Model Network 46
Figure 5-3: Kingsport Travel Demand Model 2004 Base Year Traffic Assignment 49
Figure 5-4: Kingsport Travel Demand Model 2015 No-Build Traffic Assignment 50
Figure 5-5: Kingsport Travel Demand Model 2030 No-Build Traffic Assignment 51
Figure 5-6: Kingsport Travel Demand Model 2030 Build Traffic Assignment 52

FUTURE CONDITIONS

Figure 6-1A: No-Build 2015 Traffic Volumes (1 of 2) 55
Figure 6-1B: No-Build 2015 Traffic Volumes (2 of 2) 56
Figure 6-2: No-Build 2015 Average Daily Traffic (ADT) 57
Figure 6-3A: No-Build 2015 Intersection LOS (1 of 2) 58
Figure 6-3B: No-Build 2015 Intersection LOS (2 of 2) 59
Figure 6-4A: No-Build 2035 Traffic Volumes (1 of 2) 61
Figure 6-4B: No-Build 2035 Traffic Volumes (2 of 2) 62
Figure 6-5: No-Build 2035 Average Daily Traffic (ADT) 63
Figure 6-6A: No-Build 2035 Intersection LOS (1 of 2) 64
Figure 6-6B: No-Build 2035 Intersection LOS (2 of 2) 65
Figure 6-7A: Build 2035 Traffic Volumes (1 of 2) 66
Figure 6-7B: Build 2035 Traffic Volumes (2 of 2) 67
Figure 6-8:Build 2035 Average Daily Traffic (ADT) 68
Figure 6-9A: Build 2035 Intersection LOS (1 of 2) 69
Figure 6-9B: Build 2035 Intersection LOS (2 of 2) 70
Figure 6-10: No-Build 2015 Arterial LOS 72
Figure 6-11: No-Build 2035 Arterial LOS 73
Figure 6-12: Build 2035 Arterial LOS 74

RECOMMENDATIONS

Figure 7-1: Recommended Improvements for US 23 – Kane Street to Food City Shopping Center 80
Figure 7-2: Recommended Improvements for US 23 – Jennings Street to North Fork Holston River 81
Figure 7-3: Recommended Improvements for US 23 – North Fork Holston River to East Carters Valley Road 82
Figure 7-4: Recommended Improvements for Route 224 – Emerald Valley Circle to Cliffview Lane 83
Figure 7-5: Recommended Improvements for Route 224 – East Carters Valley Road to VA/TN Line 84
Figure 7-6: Recommended Improvements for State Route 93 – East Carters Valley Road to Bloomingdale Pike 85

List of Exhibits

INTRODUCTION

Exhibit 2-1: Moccasin Gap Interchange Conceptual Plan 5

RECOMMENDATIONS

Exhibit 7-1: Proposed Cross Section Between Kane Street and Food City Shopping Center Entrance..... 86

Exhibit 7-2: Proposed Cross Section Between Food City Shopping Center Entrance and Jennings Street 87

Exhibit 7-3: Proposed Cross Section Between Jennings Street and McNutt Street/Church Street 88

Exhibit 7-4: Proposed Cross Section Between McNutt Street/Church Street and Yuma Road 89

PUBLIC INVOLVEMENT

Exhibit 8-1: Project Website Screen Shot..... 94

Exhibit 8-2: Interest in the Corridor – Public Meeting #1 96

Exhibit 8-3: Corridor of Primary Concern – Public Meeting #1 96

Exhibit 8-4: Current Conditions for Pedestrians along Route 224 and US 23 – Public Meeting #1..... 96

Exhibit 8-5: Current Conditions for Bicyclists along Route 224 and US 23 – Public Meeting #1..... 96

Exhibit 8-6: Current Appearance of Route 224 and US 23 – Public Meeting #1 97

Exhibit 8-7: Greatest Concern for the Future of the Route 224 and US 23 Corridors – Public Meeting #1 97

Exhibit 8-8: Route 224 Aerial Survey Results – Public Meeting #1 97

Exhibit 8-9: US 23 Aerial Survey Results – Public Meeting #1 97

Exhibit 8-10: US 23 Aerial Survey Results – Public Meeting #2 98

1. EXECUTIVE SUMMARY

1.1. Purpose and Need

The Kingsport Metropolitan Organization (MPO) and Virginia Department of Transportation (VDOT), in conjunction with the City of Kingsport, LENOWISCO Planning District Commission (PDC), and Tennessee Department of Transportation (TDOT) identified the need to develop a corridor study for US 23 and State Route (Route) 224. This corridor study was conducted in Southwest Virginia and Northeast Tennessee in anticipation of significant travel pattern and land use changes occurring within the general corridor limits. The overarching purpose of the study was to further the work that VDOT started with the completion of Phase I of the Moccasin Gap interchange project, located at the intersection of Route 224 and US 58/US 421, by determining how future traffic volumes on Route 224 will be impacted by the construction of Phases II and III of the Moccasin Gap interchange project. When Phases II and III are completed, Route 224 will be the major route between Gate City and the city of Kingsport. In addition, access management and safety issues on US 23 were identified in an attempt to improve the existing infrastructure. This study will identify projects that will improve the capacity of and access to/from US 23 and Route 224.

The US 23/Route 224 Corridor Study is intended to be used as a detailed planning tool by the Kingsport MPO, VDOT, and TDOT to assist with managing planned growth anticipated along the corridors as a result of recent economic retail redevelopment in Kingsport and tax incentives in Southwest Virginia, and to quantify the associated transportation network impacts. The study is intended to create a comprehensive plan that defined the strategic implementation of the necessary improvements along and adjacent to the US 23 and Route 224 corridors. The overall objective of this project is to more efficiently connect Southwest Virginia to Upper East Tennessee to allow for increasing growth in both areas. Some of this potential growth is spurred by Eastman Chemical Company (FORTUNE 500 company), which is a global company headquartered in Kingsport. Specifically, the intended outcomes of the study were to:

- Determine the safety and integrity of existing transportation infrastructure, including vehicular, bicycle, and pedestrian infrastructure
- Develop consensus-based preferred scenarios
- Provide future recommended improvements to both routes with prioritization and phasing

This study was a multi-jurisdictional transportation study that will be used as a detailed planning tool by the Kingsport MPO and local jurisdictions to assist with managing planned growth and provide an assessment of the transportation network impacts due to anticipated land development patterns. The study will assist in the strategic implementation of the transportation vision for the community.

The US 23/Route 224 Corridor Study was a collaborative partnership between the City of Kingsport, Kingsport MPO, LENOWISCO PDC, VDOT and TDOT. These entities are heretofore referred to as the “Study Team”.

To direct the Study Team, several goals were developed at the beginning of the project based on initial field reviews, information provided at the project scoping phase and comments received at the first public information meeting. The following goals, listed in no particular order, were established for this study:

- Determine the safety and integrity of existing transportation infrastructure, including vehicular, bicycle, and pedestrian, infrastructure
- Address increases in travel (by all modes)
- Enhance safety for all modes of transportation
- Develop a consensus-based scenario
- Identify recommendations to address all modes of transportation
- Coordinate with adopted plans/study efforts for Virginia and Tennessee
- Provide future recommended improvements with prioritization
- Establish a future vision for the corridors
- Determine optimal configuration of the Route 224 and US 58/US 421 intersection

1.2. Study Area

The limits of the study on US 23 were from the signalized intersection with E. Carters Valley Road in Sullivan County, Tennessee to the signalized intersection with Kane Street (US 58 Business) in Gate City, Virginia. The limits of the study on Route 224 (Wadlow Gap Road) were from the signalized intersection with Bloomingdale Pike in Sullivan County, Tennessee to the signalized intersection with US 58/Route 224/US 421 in Weber City, Virginia. Although portions of the Route 224 and US 23 corridors have an east-west alignment, for purposes of this study, both corridors were considered to have a north-south alignment through the study area. Approximately 3.2 miles of the 4.6-mile Route 224 corridor are located within Virginia. Approximately 4.0 miles of the 4.2-mile US 23 corridor are located within Virginia. The study area boundary is shown Figure 1-1.

Although this study is referred to as the US 23/Route 224 Corridor Study, routes are not designated as Route 224 and US 23 for the entire length of the corridor. Traveling south to north from Sullivan County, Tennessee into Weber City, Virginia, at the start of the Route 224 southern project limit, the corridor is designated as Route 93. At this point, Route 93 is called Wadlow Gap Road. The next route designation change occurs at the Tennessee/Virginia state line where Route 93 becomes Route 224. Approximately 3.2 miles north of the state line, Route 224 terminates at the signalized intersection of US23/US 58/US 421. At its southern project limits in Sullivan County, Tennessee, US 23 is designated as US 23 and continues north to its intersection with US 58/US 421 (approximately 3 miles). US 23 becomes US 23/US 58/US 421 heading north to Kane Street in Gate City, Virginia, which is the northern project limit.

An inventory of existing roadway conditions was prepared at the study area intersections (as defined later in this section). Existing traffic data and accident data for the study area, and more specifically the study area intersections, was provided by VDOT, TDOT, City of Kingsport, Kingsport MPO and LENOWISCO PDC. A request was also made by the Study Team for all recent and relevant studies and county board / city council action regarding zoning or comprehensive plans.

Observations from field reconnaissance of existing physical and operational conditions for the Route 224 corridor revealed that the corridor is in a rural setting with rolling terrain with cut and fill sections throughout. Route 224 is a two-lane primary route with an average pavement width of 21 feet with between 1 foot and 6 foot gravel shoulders. Most major intersections include left- and right-turn lanes with adequate sight distance.

Legend

- Study Corridor
- Corporation Limits
- County Line
- Highway
- Local Road
- Rail Line
- Water Feature

0 1,500 3,000 6,000
Feet

Location Map

Not To Scale

US 23 / Route 224 Corridor Study

Project Area Study Map

Figure 1 - 1

Observations from field reconnaissance of existing physical and operational conditions for the US 23 corridor reveal that the corridor exists within an urban setting with level terrain and minimum cut and fill sections throughout. On some portions of US 23, the roadway is a four-lane, divided (raised median) section and on other portions, it is a five-lane section with a center two-way left-turn lane. Curb and gutter exists on a majority of the corridor. The average pavement width is 44 feet with variable width paved shoulders. Most major intersections include left- and right-turn lanes with adequate sight distance. Within the study area, US 23 has 25 crossovers or 1 every 844 feet and 182 commercial or residential driveways, or 1 every 116 feet along the 4.1 mile study corridor.

The following intersections within the study area were identified and analyzed. Two of the thirteen intersections were in Tennessee with the remainder located in Virginia.

1. Route 93 at Bloomingdale Pike [Signalized] – Tennessee
2. Route 224 at E. Carters Valley Rd (Route 704) [Unsignalized]
3. Route 224 at Nottingham Rd (Route 614) [Unsignalized]
4. Route 224 at Whispering Cir (Route 951) [Unsignalized]
5. Route 224 at Spring Dr (Route 708) [Unsignalized]
6. Route 224 at Whispering Circle (Route 952) [Unsignalized]
7. Route 224 at Bristol Hwy (US 58/US 421) [Unsignalized]
8. US 23 at Kane St (US 421 Business) [Signalized]
9. US 23 at Wadlow Gap Rd (US 58/US 421/Route 224) [Signalized]
10. US 23 at Shopping Center Entrance [Signalized]
11. US 23 at Jennings St (Route 744) [Signalized]
12. US 23 at Yuma Rd (Route 614) [Signalized]
13. Lynn Garden Drive at E/W Carters Valley Rd (Route 704) [Signalized] – Tennessee

1.3. Methodology

The consultant team collected existing condition information related to the study area by reviewing relevant literature, conducting a field inventory of automobile, bicycle and pedestrian facilities, identifying potential environmental constraints, obtaining crash and traffic data, and collecting public response surveys. Analysis was performed on the crash data and existing traffic data to determine corridor and intersection safety characteristics as well as levels of service and operational capacity. The existing conditions analysis was used as a baseline to develop recommended improvements for future corridor needs.

The consultant team used the Kingsport Area Travel Demand Model to determine baseline and future traffic demands. The consultant team used a combination of historical traffic count data, socio-economic data from the regional travel demand model, and traffic volume projections to develop growth rates that, based on the needs and assumptions in the study, could be applied to the study corridor for the development of future traffic volumes. The growth rates were applied to the existing traffic volumes to develop 2015 No-Build, 2035 No-Build and 2035 Build traffic volumes. The No-Build scenario applies only projected growth within the study area on the existing network, while the Build scenario applies projected growth within the study area on the network with recommended improvements. Additional analysis was performed using the future corridor and intersection traffic volumes under the 2015 No-Build, 2035 No-Build and 2035 Build scenarios to determine projected levels of service and operational capacity of the corridors. Recommended improvements and analyses were modified and refined iteratively to promote the fulfillment of the study area goals and needs identified in Section 1.1. Recommended improvement alternatives analyzed for future conditions, as they related to capacity and level of services included:

- Roadway widening and cross-sectional modifications to the US 23 and Route 224 corridors
- Turn lane installations/modifications at intersections and median crossovers
- Intersection configuration changes
- Pedestrian enhancements
- Alternative configurations of the Route 224 and US 58/US 421 intersection: traffic signal, diamond interchange, cloverleaf interchange and roundabout

1.4. Recommendations and Cost Summary

A number of corridor-wide improvement recommendations were developed for the US 23 and Route 224 corridors within the study area. These improvements were developed based on field observations, results of the project analyses, and input received from the public. The overall recommended improvements to the US 23 and Route 224 corridors are identified below.

US 23 Improvements

- Develop an access management plan on US 23 corridor beginning at the Tennessee/Virginia state line, continuing north through Weber City, and ending at Kane Street in Gate City.
- Construct a raised median and implement several driveway modifications along US 23 within Weber City to manage access along this segment of the corridor.
- Construct a curb and gutter section, including sidewalks, along portions of US 23 to better define driveway limits and provide pedestrian access.
- Upgrade turn lane storage and taper lengths to meet current VDOT and TDOT standards, where warranted, based on projected traffic volumes.
- Install stop bars and stop signs on all publically-maintained side street approaches at intersections on US 23.
- Coordinate traffic signals throughout the US 23 corridor to improve travel time and reduce delay.
- Install overhead street name signs on mast arms at all signalized intersections.
- Improve and/or consolidate railroad crossings that intersect US 23.

- Develop intersection and spot improvements based on safety and operational results.
- Update all traffic signals and signing to meet current federal and state standards.

Route 224 Improvements

- Straighten two horizontal curves south of the bridge over the North Fork of the Holston River to improve sight distance.
- Pave shoulders on the east and west sides of Route 224 from the intersection of US 58/US 421 south to the Virginia/Tennessee state line.
- Replace damaged or install missing guardrail and upgrade guardrail end treatments along Route 224 from the intersection of US 58/US 421 south to the Virginia/Tennessee state line to meet latest VDOT and TDOT standards.
- Widen SR 93 to a 5-lane facility with a center two-way left-turn lane from the Virginia/Tennessee state line to Bloomingdale Pike.
- Construct left- and right-turn lanes at intersections where they are warranted based on state standards.
- Install stop bars and stop signs to all public maintained side street approaches at intersections with Route 224.
- Upgrade turn lane storage and taper lengths to meet current VDOT and TDOT standards, where needed.
- Update all traffic signals and signing to meet current federal and state standards.
- Develop intersection and spot improvements based on crash and operational analysis results.
- Install overhead street name signs on mast arms at all signalized intersections.

Route 224 at US 58/US 421 Intersection Improvements

The consultant team analyzed alternatives to the cloverleaf interchange recommended at the intersection of Route 224 and US 58/US 421 in the Moccasin Gap study. The projected 2035 Build volumes did not warrant further analysis of the cloverleaf interchange; however, the alternatives considered included a diamond interchange, a single-point urban interchange (SPUI), a single-lane roundabout, a multi-lane roundabout, and an at-grade signalized intersection. The single-lane roundabout alternative was chosen as the preferred alternative due to its ability to accommodate for future growth.

The design of the roundabout should include geometry that can be easily modified to a multi-lane roundabout if or when future traffic volumes warrant this change. This alternative is also appealing due to its ability to integrate streetscape elements and aesthetics within the roundabout. The proposed roundabout is to include a right-turn slip lane for vehicles making a northbound right-turn movement from Route 224 to US 58/US 421. This slip lane will provide free-flow access for traffic making this movement. Additional benefits of a roundabout include reducing the frequency and severity of crashes, reducing traffic delays and stops, slowing excessive speeds, and reducing long-term operational costs. In the near term, it is recommended to construct a northbound right-turn lane on Route 224 with 200 feet of storage and 200 feet of taper. The proposed turn lane will improve congestion through this intersection as vehicles will no longer be forced to stop or slow down for right-turning vehicles ahead of them on the road. Rear-end crashes may also be reduced at this location since slowing vehicles will have their own turn lane.

Conclusions and Cost Summary

Recommendations described previously take into consideration field observations, results of the project analyses, and input received during public outreach efforts. These recommendations are intended to enhance the safety and integrity of the existing transportation infrastructure while providing for the continued growth and economic development of the study area region. Many of the improvements can be implemented within a 1-year period using federal safety improvement funds or annual maintenance funds. Other improvements require programming into the VDOT Six-Year Improvement Program for additional planning, engineering, design and construction for future implementation.

Planning level cost estimates were developed to provide VDOT, Kingsport MPO and LENOWISCO MPO's a tool for programming prioritizing future improvements in the corridor to meet the needs of the growing region. Planning costs were included for an optional widening project on Route 224/SR 93, from a 2-lane to 4-lane facility, should future growth require additional capacity to achieve desirable levels of service. Table 1-1 contains the planning level cost summary for both corridors in the study area.

Table 1-1: Planning Level Cost Summary

Improvement Section	Planning Level Cost
US 23 Improvements	$43,800,000
Route 224/SR 93 Improvements (as a 2-lane section)	$10,500,000
Route 224/SR 93 Widening (as a 4-lane divided section)	$45,400,000
Route 224 and US 58/US 421 Single-Lane Roundabout	$1,600,000
Route 224 and US 58/US 421 Two-Lane Roundabout	$3,100,000

Costs in the table above are based on the guidelines in the Transportation and Mobility Planning Division's Statewide Planning Level Cost Estimates worksheet dated January 2009. Typical section unit costs include 25% for PE and construction contingencies. The typical section unit costs do not include bridge, right-of-way (ROW) or other improvement costs. These numbers are preliminary and are not based on design. The unit costs used to compute the planning level construction cost are based on an understanding of local geographic conditions.

2. INTRODUCTION

The Kingsport Metropolitan Organization (MPO) and Virginia Department of Transportation (VDOT), in conjunction with the City of Kingsport, LENOWISCO Planning District Commission (PDC), and Tennessee Department of Transportation (TDOT) identified the need to develop a corridor study for State Route (Route) 224 and US 23. This report, the US 23/Route 224 Corridor Study documents the findings of the project team and presents the following information: data collection and inventory summaries; existing conditions analyses; future conditions analyses; development/analysis of the considered alternatives; and the final recommendations with the plan of action for the corridor. The study area for this project lies in both Virginia and Tennessee and is shown in Figure 2-1. The limits of the study area are described in further detail in the subsequent sections.

The US 23/Route 224 Corridor Study is intended to be used as a detailed planning tool by the Kingsport MPO, VDOT, and TDOT to assist with managing planned growth anticipated along the corridor as a result of recent economic retail redevelopment in Kingsport and tax incentives in Southwest Virginia, to quantify the associated transportation network impacts, that ultimately creates a comprehensive plan that defines the strategically implementation of the necessary improvements along and adjacent to the US 23 and Route 224 corridors.

2.1. Background

This corridor study is being conducted in Southwest Virginia and Northeast Tennessee in anticipation of significant travel pattern and land use changes occurring within the general corridor limits. The overarching purpose of the study is further the work that VDOT has started with the completion of Phase I of the Moccasin Gap interchange project to determine how future traffic volumes on Route 224 will be impacted by the construction of Phases II and III of the Moccasin Gap interchange project. (Exhibit 2-1) When Phases II and III are completed, Route 224 will be the major route between Gate City and the city of Kingsport. In addition, access management and safety issues on US 23 will be identified in an attempt to improve the existing infrastructure. This study will identify projects that will improve the capacity of and access to/from US 23 and Route 224.

The overall objective of this project is to more efficiently connect Southwest Virginia to Upper East Tennessee to allow for increasing growth in both areas. Some of this potential growth is spurred by Eastman Chemical Company (FORTUNE 500 company), which is a global company headquartered in Kingsport. Specifically, the outcomes of the study are as follows:

- Determine the safety and integrity of existing transportation infrastructure, including vehicular, bicycle, and pedestrian infrastructure
- Develop consensus-based preferred scenarios
- Provide future recommended improvements to both routes with prioritization and phasing

The Study is a multi-jurisdictional transportation study that will be used as a detailed planning tool by the Kingsport MPO and local jurisdictions to assist with managing planned growth and provide an assessment of the transportation network impacts due to anticipated land development patterns. The study will assist in the strategic implementation of the transportation vision for the community.

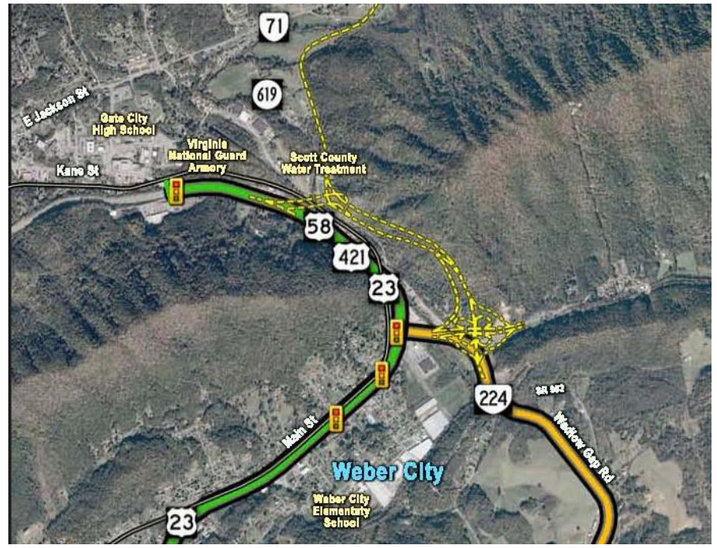


Exhibit 2-1: Moccasin Gap Interchange Conceptual Plan

2.2. Study Area

The limits of the study on Route 224 (Wadlow Gap Road) are from the signalized intersection with Bloomingdale Pike in Sullivan County, Tennessee to the signalized intersection with US 58/Route 224/US 421 in Weber City, Virginia. The limits of the study on US 23 are from the signalized intersection with E. Carters Valley Road in Sullivan County, Tennessee to the signalized intersection with Kane Street (US 58 Business) in Gate City, Virginia. Although portions of the Route 224 and US 23 corridors have an east-west alignment, for purposes of this study, both corridors are considered to have a north-south alignment through the study area. Approximately 3.2 miles of the 4.6-mile Route 224 corridor are located within Virginia. Approximately 4.0 miles of the 4.2-mile US 23 corridor are located within Virginia. The study area boundary is shown in Figure 2-1. More detailed study area maps are provided in Figure 2-2 through Figure 2-7.

Although this study is referred to as the US 23/Route 224 Corridor Study, routes are not designated as Route 224 and US 23 for the entire length of the corridor. Traveling south to north from Sullivan County, Tennessee into Weber City, Virginia, at the start of the Route 224 southern project limit, the corridor is designated as Route 93. At this point, Route 93 is called Wadlow Gap Road. The next route designation change occurs at the Tennessee/Virginia state line where Route 93 becomes Route 224. Approximately 3.2 miles north of the state line, Route 224 terminates at the signalized intersection of US23/US 58/US 421. At its southern project limits in Sullivan County, Tennessee, US 23 is designated as US 23 and continues north to its intersection with US 58/US 421 (approximately

3 miles). US 23 is designated as US 23/US 58/US 421 heading north to Kane Street in Gate City, Virginia, which is the northern project limit.

Although the name and route designations change several times along the study corridors, for this report "Route 224" and "US 23" will be used as the universal names for their respective sections of road within the study area.

2.3. Study Goals

To direct the study team, several goals were developed at the beginning of the project based on initial field reviews, information provided at the project scoping phase and comments received at the first public information meeting. The following eight goals, listed in no particular order, were established for the study.

- Determine the safety and integrity of existing transportation infrastructure, including vehicular, bicycle, and pedestrian, infrastructure
- Address increases in travel (by all modes)
- Enhance safety for all modes of transportation
- Develop a consensus-based scenario
- Identify recommendations to address all modes of transportation
- Coordinate with adopted plans/study efforts for Virginia and Tennessee
- Provide future recommended improvements with prioritization
- Establish a future vision for the corridors
- Determine optimal configuration of the Route 224 and US 58/US 421 intersection

2.4. Project Team Members

2.4.1. Study Team

The US 23/Route 224 Corridor Study is a collaborative partnership between the City of Kingsport, Kingsport MPO, LENOWISCO PDC, VDOT and TDOT. These individuals are heretofore referred to as the "Study Team".

Agency/Organization	Contact
Kingsport MPO	Mr. Chris Campbell *Project Manager*
City of Kingsport	Mr. Michael Thompson
LENOWISCO PDC	Mr. Chris Starnes
VDOT	Mr. Donny Necessary

2.4.2. Consultant Team

The consultant team consisted of Kimley-Horn and Davenport Transportation Consulting.

Legend

- Study Corridor
- Corporation Limits
- County Line
- Highway
- Local Road
- Rail Line
- Water Feature

0 1,500 3,000 6,000
Feet

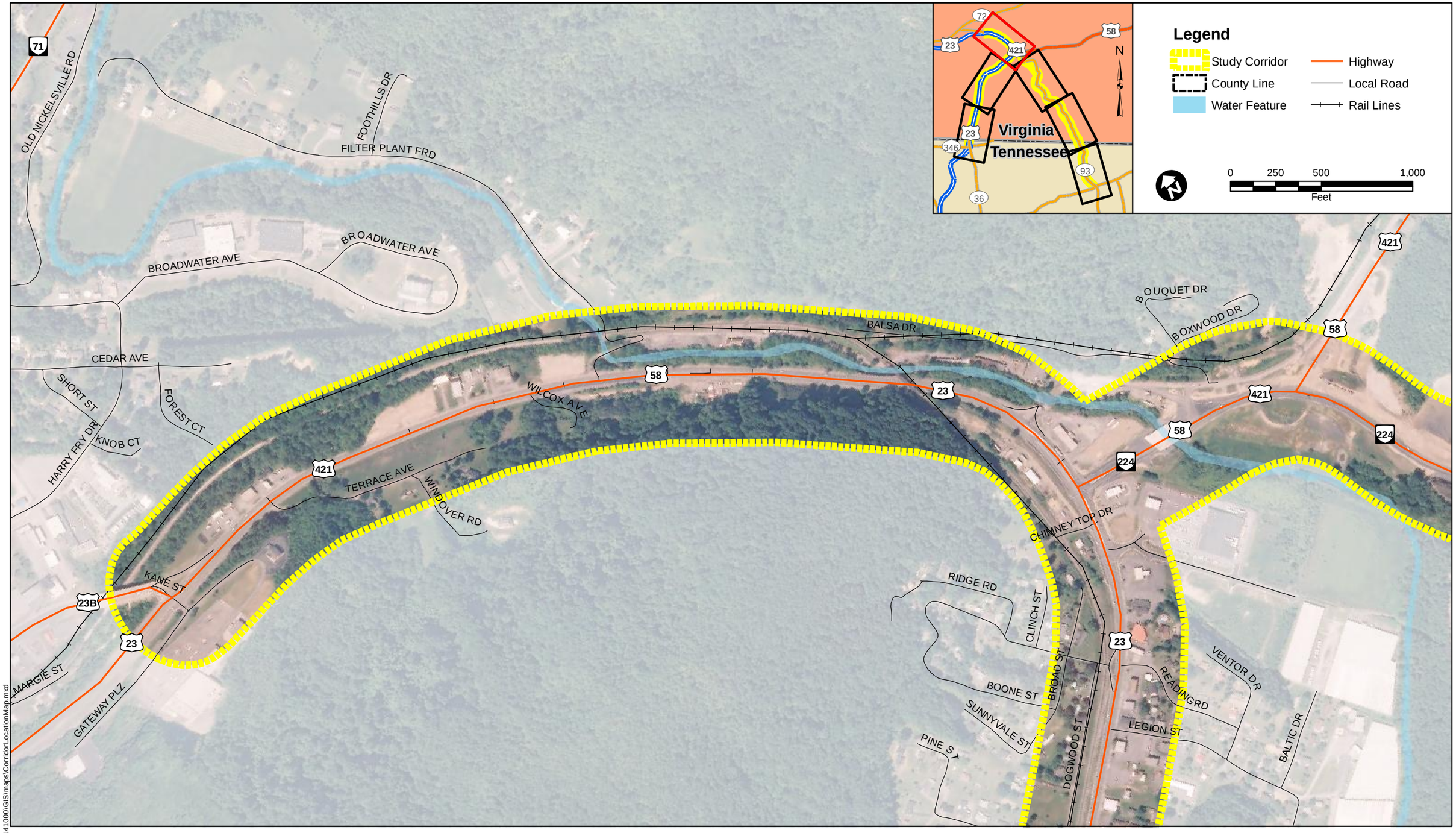
Location Map

Not To Scale

US 23 / Route 224 Corridor Study

Project Area Study Map

Figure 2 - 1



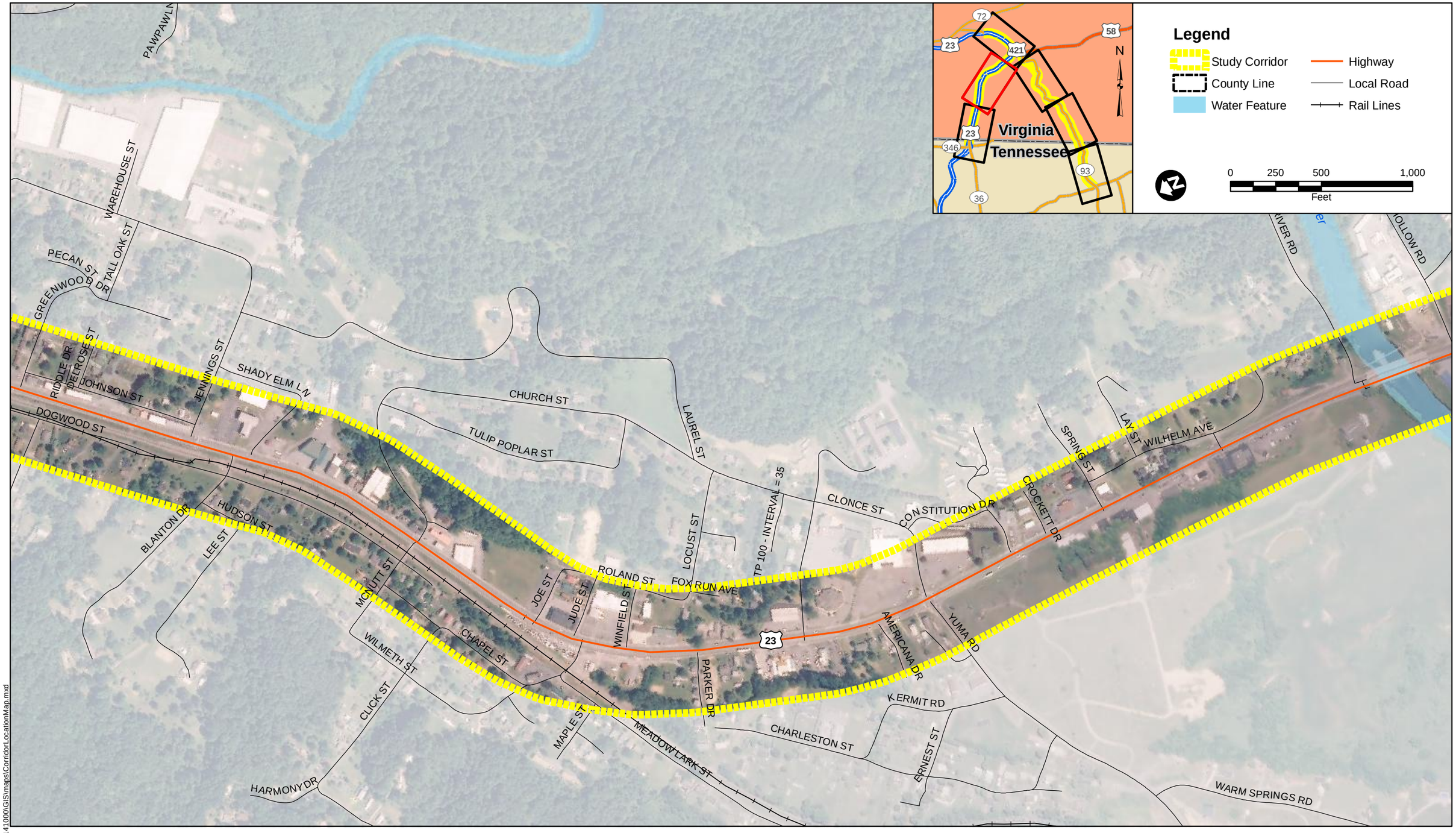
K:\RIC_TPTO\prj\prj\113141000\GIS\mapsS\CorridorLocationMap.mxd

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

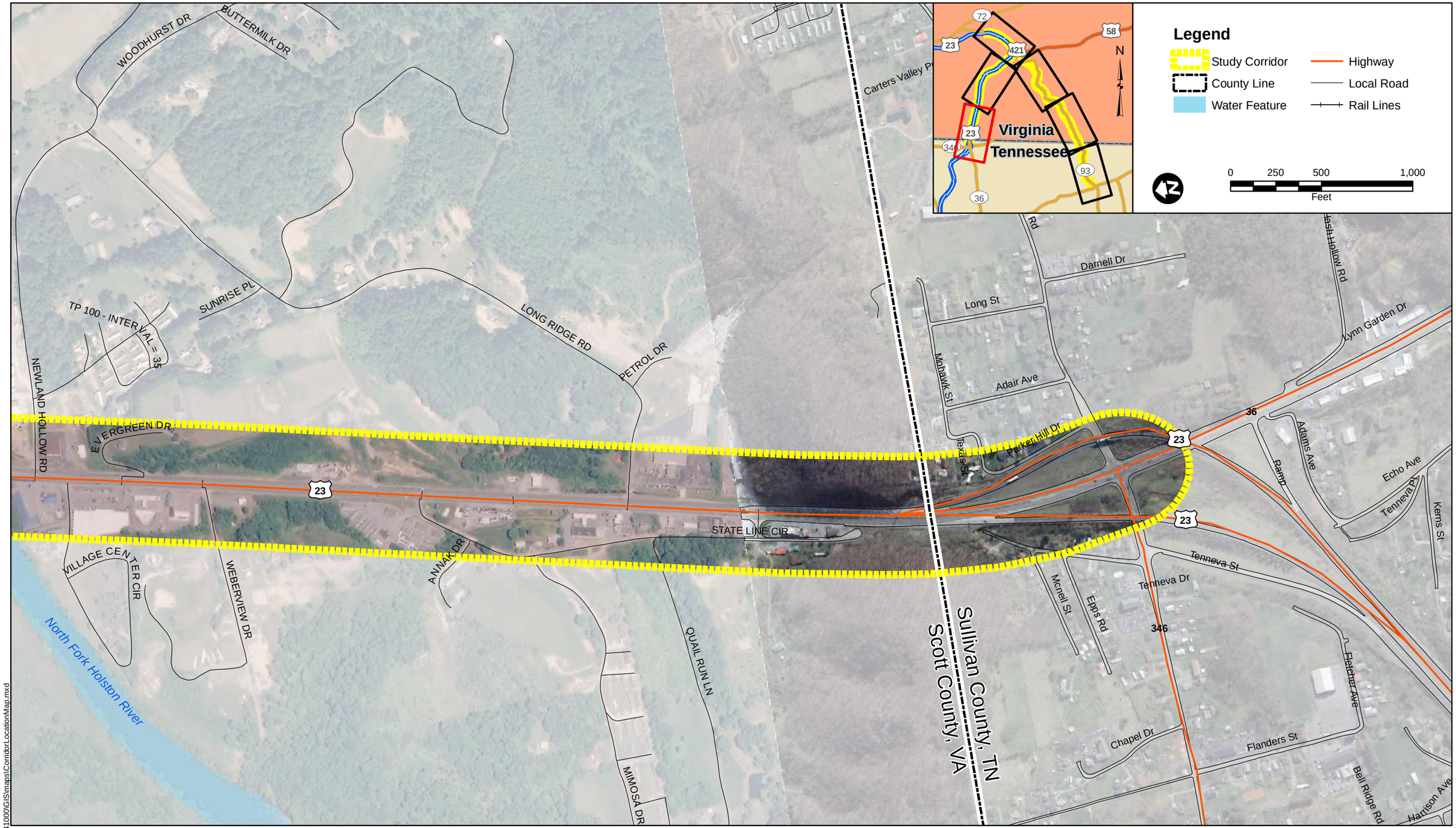
Corridor Location Map

Figure 2 - 2



K:\RIC_TPTO\prj\pn\113141000\GIS\mapsl\CorridorLocationMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Corridor Location Map	Figure 2 - 3



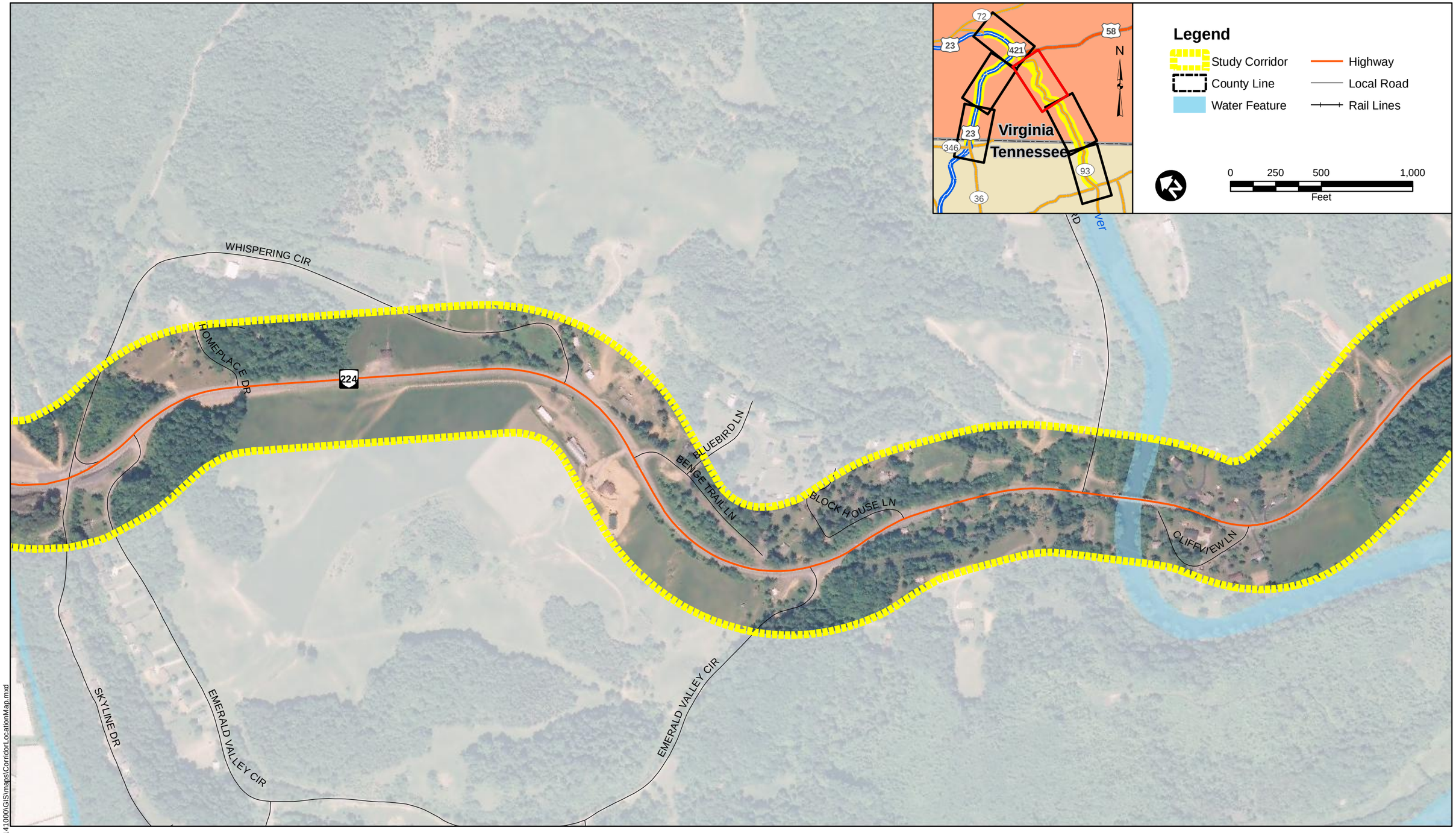
K:\RIC_TPTO\prj\pn\113141000\GIS\maps\CorridorLocationMap.mxd

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

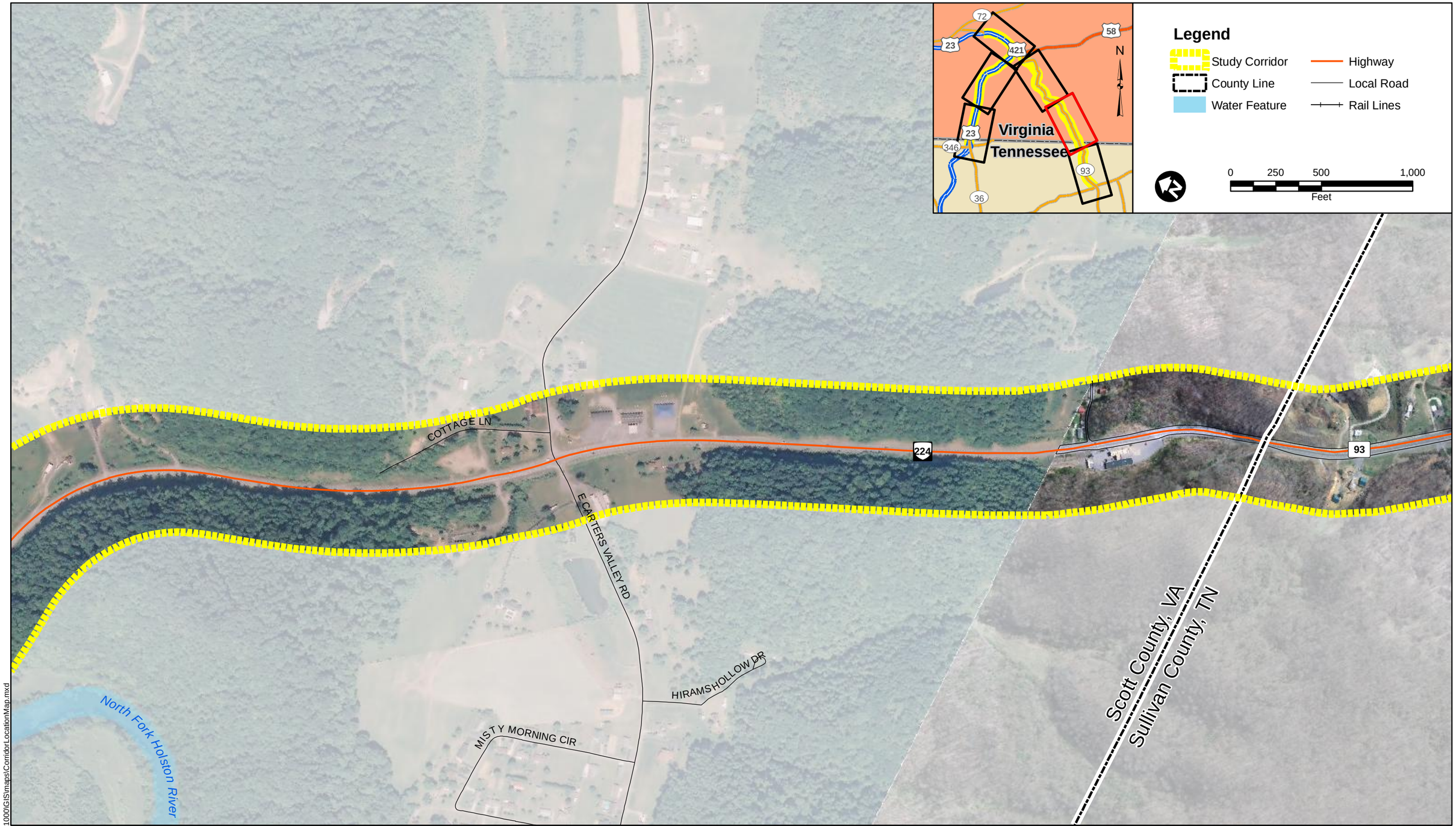
Corridor Location Map

Figure 2 - 4



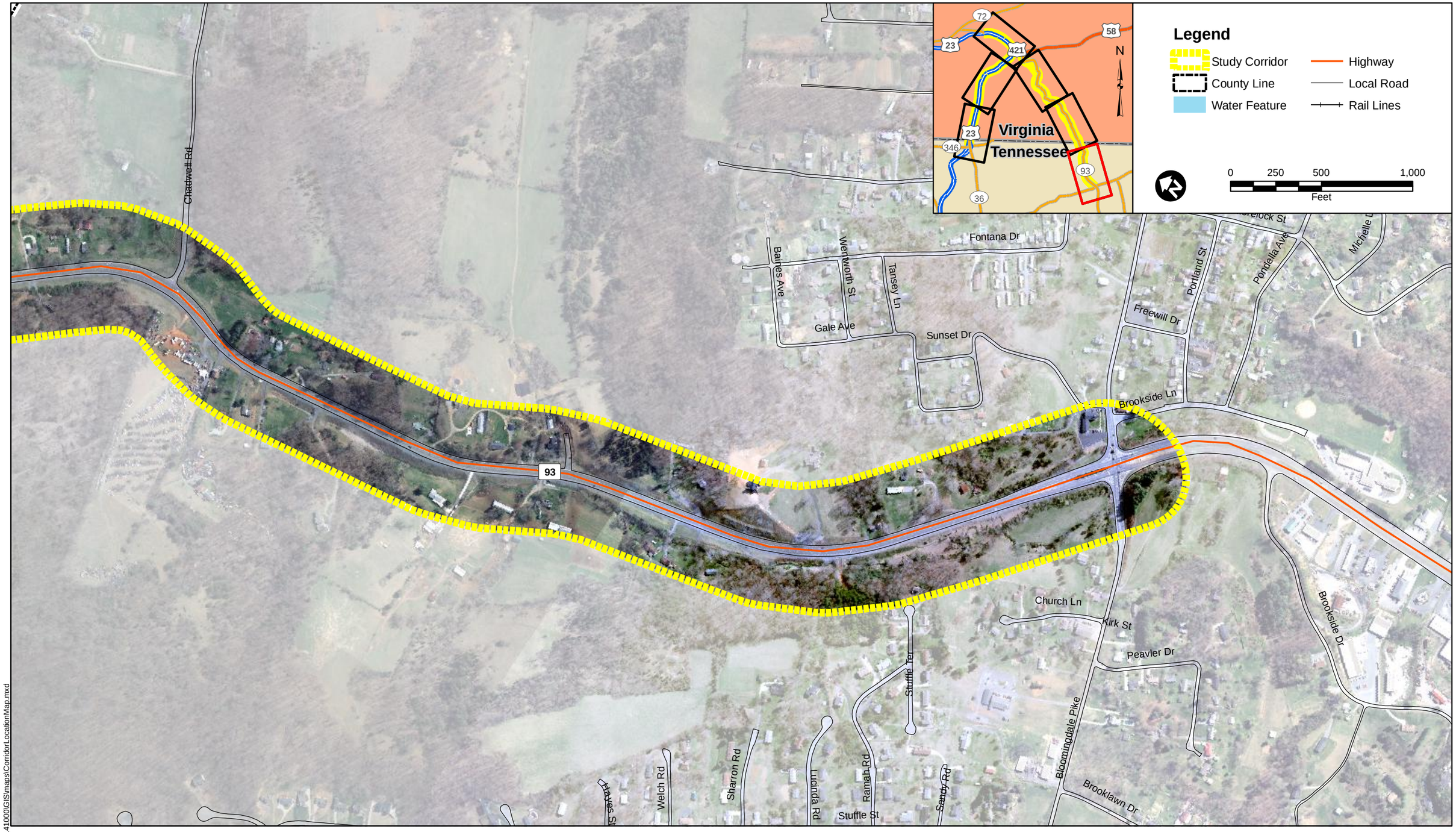
K:\RIC_TPTO\prj\pn\113141000\GIS\maps\CorridorLocationMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Corridor Location Map	Figure 2 - 5



K:\RIC_TPTO\prj\pn\111314100\GIS\maps\CorridorLocationMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Corridor Location Map	Figure 2 - 6



K:\RIC_TPTO\prj\pn\113141000\GIS\maps\CorridorLocationMap.mxd

Kingsport
TENNESSEE

US 23 / Route 224 Corridor Study

Corridor Location Map

Figure 2 - 7

3. DATA COLLECTION AND INVENTORY

An inventory of existing roadway conditions was prepared at the study area intersections (as defined later in this section). Existing traffic data and accident data for the study area and more specifically the study area intersections was provided by VDOT, TDOT, City of Kingsport, Kingsport MPO and LENOWISCO PDC. A request was made to the Study Team for all recent and relevant studies and county board / city council action regarding zoning or comprehensive plans.

3.1. General Description of the Corridor

The character of the Route 224 and US 23 corridors gradually changes between the southern and northern termini. In the section below, these changes are described in greater detail.

3.1.1. Existing Geometry

Observations from field reconnaissance of existing physical and operational conditions for the Route 224 corridor reveal that the corridor is in a rural setting with rolling terrain and with cut and fill sections throughout. Route 224 is a two-lane primary route with an average width of 21 feet and between 1 foot and 6 feet gravel shoulders. Left- and right-turn lanes exist at most of the major intersections. Sight distance varies significantly between the two corridors.

Observations from field reconnaissance of existing physical and operational conditions for the US 23 corridor revealed that the corridor exists within an urban setting with relatively level terrain and minimum cut and fill sections throughout. On some portions of US 23, the roadway is a four-lane, divided (raised median) section and on other portions, it is a five-lane section with center two-way left-turn lane. Curb and gutter exists on a majority of the corridor. The average width is 44 feet and variable width paved shoulders. Most major intersections provide left and right turn lanes with adequate sight distance. Within the study area on US 23, 25 crossovers (1 every 844 feet) and 182 commercial or residential driveway entrances (1 every 116 feet) along the 4.1 mile study corridor.

The existing geometry for the intersections within the study area is shown in Appendix D.

3.1.2. Route 93/State Route 224

Bloomingdale Pike to Virginia State Line

This section of Route 93 is a four-lane undivided roadway with widely spaced intersections. The roadway is lined with wooded areas on both sides and single-family residential units dispersed throughout. The speed limit in this section of the corridor is 40 mph.

Virginia State Line to the Holston River

This section of Route 224 tapers down to a two-lane, undivided roadway just north of the Virginia state line and continues to be rural in nature. The mountainous terrain causes Route 224 to become a curvy road as it traverses through this section of the corridor. The land uses surrounding Route 224 includes scattered single-family residential units, a couple of gas stations, and farmland. The single family residences become more tightly spaced approaching the Holston River. The speed limit in this section of corridor is 40 mph.

Northbound Route 93 Approaching State Line / Northbound Route 93 Between Bloomingdale Pike and State Line

Northbound Route 224 North of State Line / Northbound Route 224 Approaching Holston River

Holston River to US 58/US 421/US 23

This section of Route 224 continues as a rural, mountainous, two-lane, undivided roadway surrounded by dense vegetation. The land use surrounding Route 224 includes scattered single family residential units along with farmland. As Route 224 approaches its intersection with US 58/US 421, it widens out to a three-lane section with a two-way center left-turn lane. The speed limit in this section of the corridor is 50 mph.

Northbound Route 224 North of Holston River / Northbound Route 224 Approaching US 58/US 421

3.1.3. US 23

Carters Valley Road to Holston River

This section of US 23 is a four-lane, divided roadway with various commercial land uses surrounding the corridor on both sides. On the opposite side of the commercial strip that surrounds the corridor are single family residential units and farmland making this section suburban in nature. The speed limit in this section of corridor is 45 mph, transitioning to 40 mph just south of the river.

Northbound US 23 Approaching State Line / Northbound US 23 Approaching Holston River

Holston River to US 58/US 421

The four-lane, divided section of US 23 continues on its approach to Weber City. The commercial land uses surrounding US 23 become denser moving north. The roadway tapers down to a four-lane section with a small striped median (less than the width of a travel lane) passing through Weber City. Sidewalk is present on one side of US 23 through much of this section of corridor. The railroad begins to parallel US 23 to the west. The Food City shopping center is located at the northern end of this section. The speed limit in this section of corridor is 40 mph.

Northbound US 23 Between Holston River and US 58/US 421 / Northbound US 23 Approaching US 58/US 421

US 58/US 421 to Kane Street

The four-lane, divided section of road continues through this section of corridor. The commercial land use ends and the corridor becomes a rural section with dense vegetation surrounding both sides of the road. The terrain through this corridor is generally rolling terrain. The railroad crosses over US 23 and does not continue to parallel the corridor. The speed limit in this section of corridor is 45 mph.

Southbound US 23 Approaching Railroad Overpass / US 23 at Kane Street

3.2. Study Area Intersections

The following intersections within the study area were identified and analyzed. Two of the thirteen intersections were in Tennessee with the remainder located in Virginia.

1. Route 93 at Bloomingdale Pike [Signalized] – Tennessee
2. Route 224 at E. Carters Valley Rd (Route 704) [Unsignalized]
3. Route 224 at Nottingham Rd (Route 614) [Unsignalized]
4. Route 224 at Whispering Cir (Route 951) [Unsignalized]
5. Route 224 at Spring Dr (Route 708) [Unsignalized]
6. Route 224 at Whispering Cir (Route 952) [Unsignalized]
7. Route 224 at Bristol Hwy (US 58/US 421) [Unsignalized]
8. US 23 at Kane St (US 421 Business) [Signalized]
9. US 23 at Wadlow Gap Rd (US 58/US 421/Route 224) [Signalized]
10. US 23 at Shopping Center Entrance [Signalized]
11. US 23 at Jennings St (Route 744) [Signalized]
12. US 23 at Yuma Rd (Route 614) [Signalized]
13. Lynn Garden Drive at E/W Carters Valley Rd (Route 704) [Signalized] – Tennessee

3.3. Physical Environment

A comprehensive review of available data pertaining to the existing and planned physical environment along the Route 224 and US 23 corridors was conducted; where possible, the data was obtained in ESRI-compatible format. The obtained published and electronic data and reports were used to document existing and planned conditions in the study area. This review included the following information which was provided by VDOT, TDOT, City of Kingsport, Kingsport MPO and LENOWISCO PDC.

1. Digital aerial photography
2. Development applications (permit applications)
3. Recent site plans
4. Property lines
5. Planimetrics
6. Wetlands and floodplains
7. Planning policy boundaries (land use, zoning, comprehensive plan areas, city/county lines, neighborhoods, etc.)
8. Streams and bodies of water
9. Roads and sidewalks
10. Roadway structures (i.e. bridges)
11. Thoroughfare/collector street/local street plans/layers
12. Bikeways
13. Traffic signals
14. Street lights
15. Utilities
16. Curbs and driveways
17. Environmental data (threatened/endangered species, superfund sites, underground storage tanks, etc.)
18. Contours/topography
19. Steep slopes
20. Right-of-way

21. Buildings
22. Transit stops
23. Historic resources

Zoning and parcel information is included in Figure 3-1 through Figure 3-6. Parcels that are located adjacent to the corridor study area and have the potential to be impacted by future improvements have been compiled and included in Appendix A.

In addition, a field inventory of the corridor was conducted in May 2010 to confirm roadway geometry, current land uses, parking restrictions, transit stop locations, bicycle facilities and pedestrian accommodations. Corridor photos collected during the field reviews are included in Appendix B. During the field inventory, visual observations were noted regarding the operations of automobile, pedestrian and bicycle traffic.

3.4. Supplemental Field Data Collection

A review of field conditions was conducted in the study area to augment and verify some of the aforementioned data. Field data related to cross-sections, roadway geometry and topographic information was summarized on the base mapping in Appendix D. This review was limited to visual verification of the following information.

- Signal timings
- Intersection traffic control and laneage (including signs)
- Street cross section (number of lanes, lane width, edge treatment, median treatment, presence of turn lanes, surface)
- On-street parking regulations and loading zones
- Sidewalks, bikeways, medians, and crosswalks
- Streams
- Curb and gutter/shoulder treatment
- Turn lanes (length and location)
- Lighting
- Steep slopes
- General overhead utility routes/locations
- Major drainage structures
- Land use and development
- Business names

3.5. Traffic Conditions

3.5.1. Turning Movement Data

Available intersection traffic count data collected in 2007 and 2008 from VDOT, TDOT, City of Kingsport, Kingsport MPO and LENOWISCO PDC were obtained and reviewed. Traffic count data collected during various traffic studies conducted by others were also reviewed. Collection of existing Turning Movement Count (TMC) data was conducted on May, 2010 at the study area intersections and is summarized on Figure 3-7 and Figure 3-8. Complete TMC data is included in Appendix C.

3.5.2. Average Daily Traffic & Heavy Vehicle Percentages

Average Daily Traffic (ADT) data and heavy vehicle percentages were collected on May, 2010 at the following selected locations along the corridor to supplement and verify the available data.

Route 224

1. Between Bloomingdale Pike and VA State Line
2. Between VA State Line and E Carters Valley Rd
3. Between E Carters Valley Rd and Route 614
4. Between Route 614 and US 58/US 421
5. US 58/US 421 between Route 224 and US 23

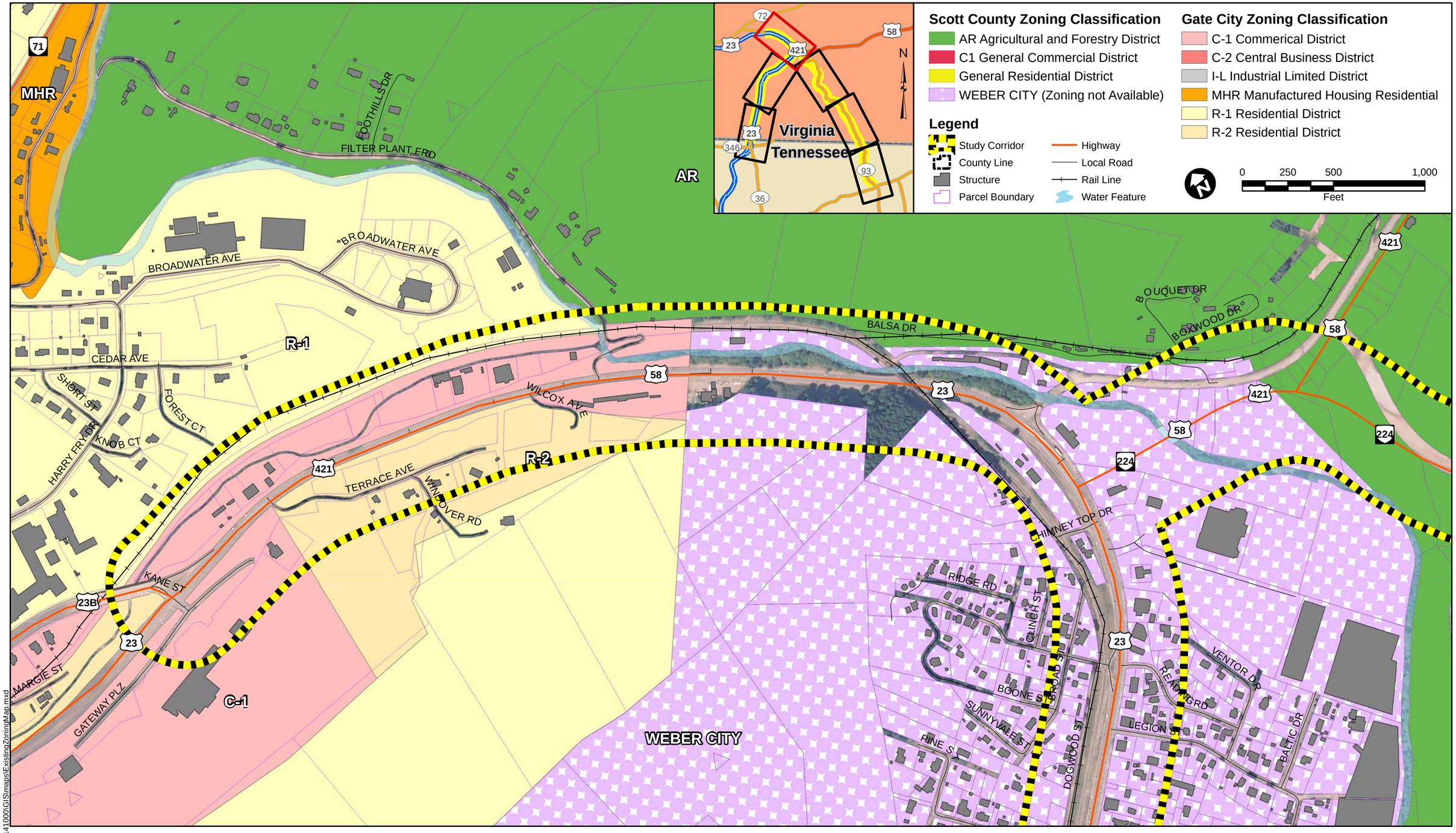
US 23

1. Between Kane St and US 58/US 421
2. Between US 58/US 421 and Jennings St
3. Between Jennings St and Route 614
4. Between Route 614 and E/W Carters Valley Rd

The 2010 ADT data was used for the establishment of the 2010 base year and is summarized in Figure 3-9 along with the heavy vehicle percentages. The complete count data, including vehicle classifications, is included in Appendix C.

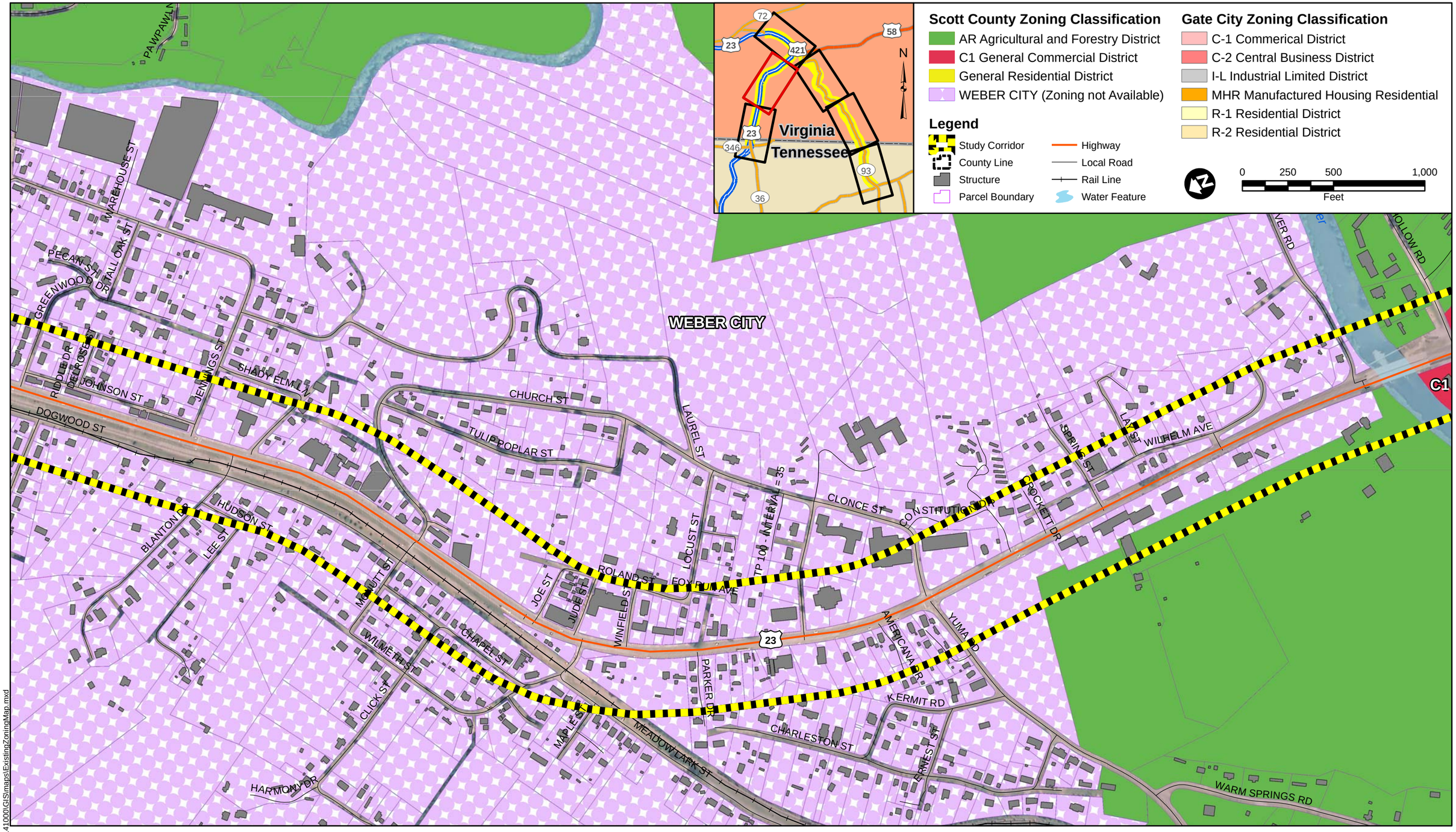
3.5.3. Pedestrian and Bicycle Inventory

Key elements of the existing pedestrian and bicycle infrastructure in the study corridor were inventoried to include existence of sidewalks, bicycle accommodations (lanes, paths, or other facilities), and pedestrian refuges, crosswalks, and signage. Deficiencies within the bicycle and pedestrian facilities were noted in Section 4.4.



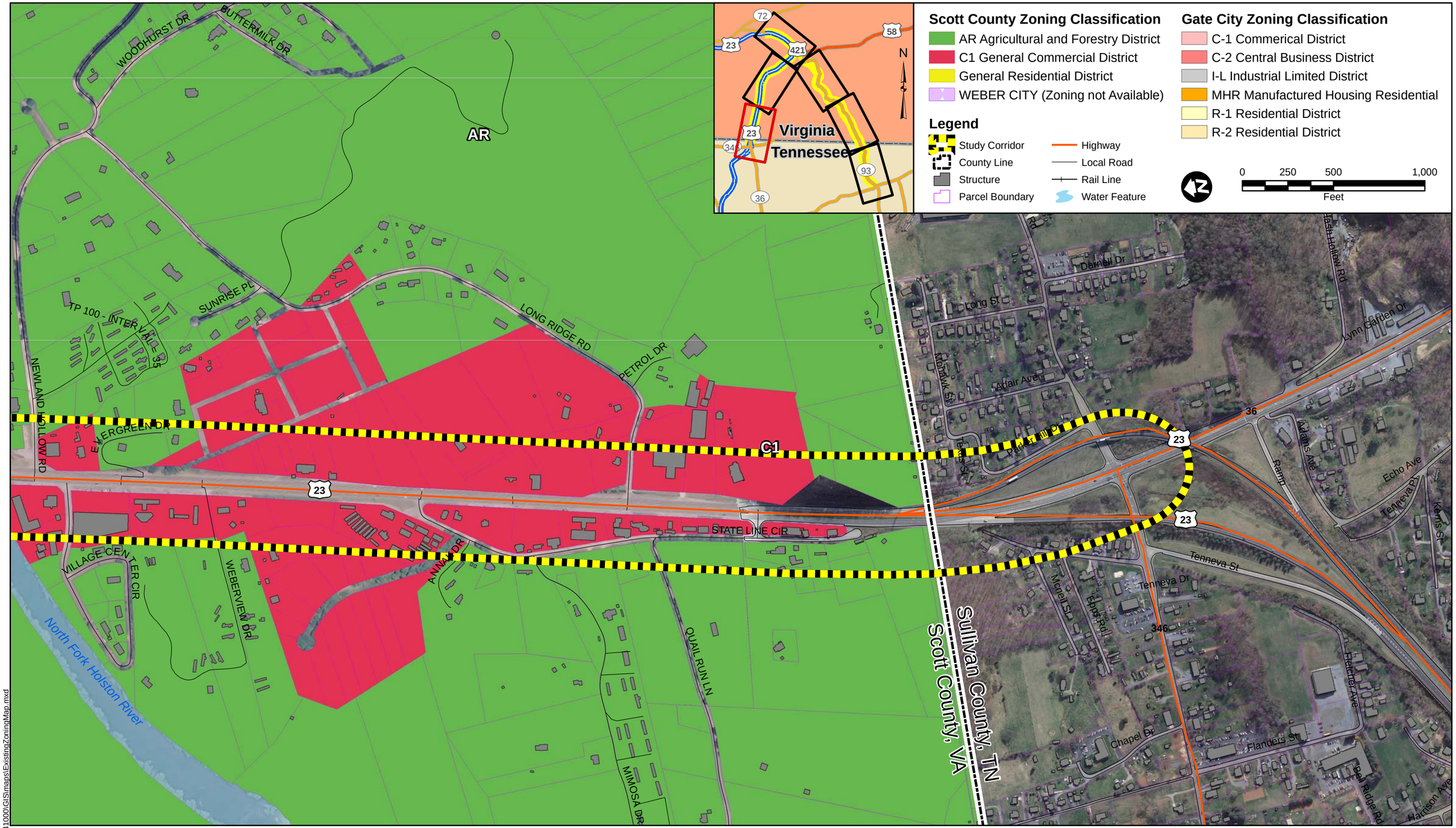
K:\RIC_TPTO\prjnm\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Existing Zoning Map	Figure 3 - 1



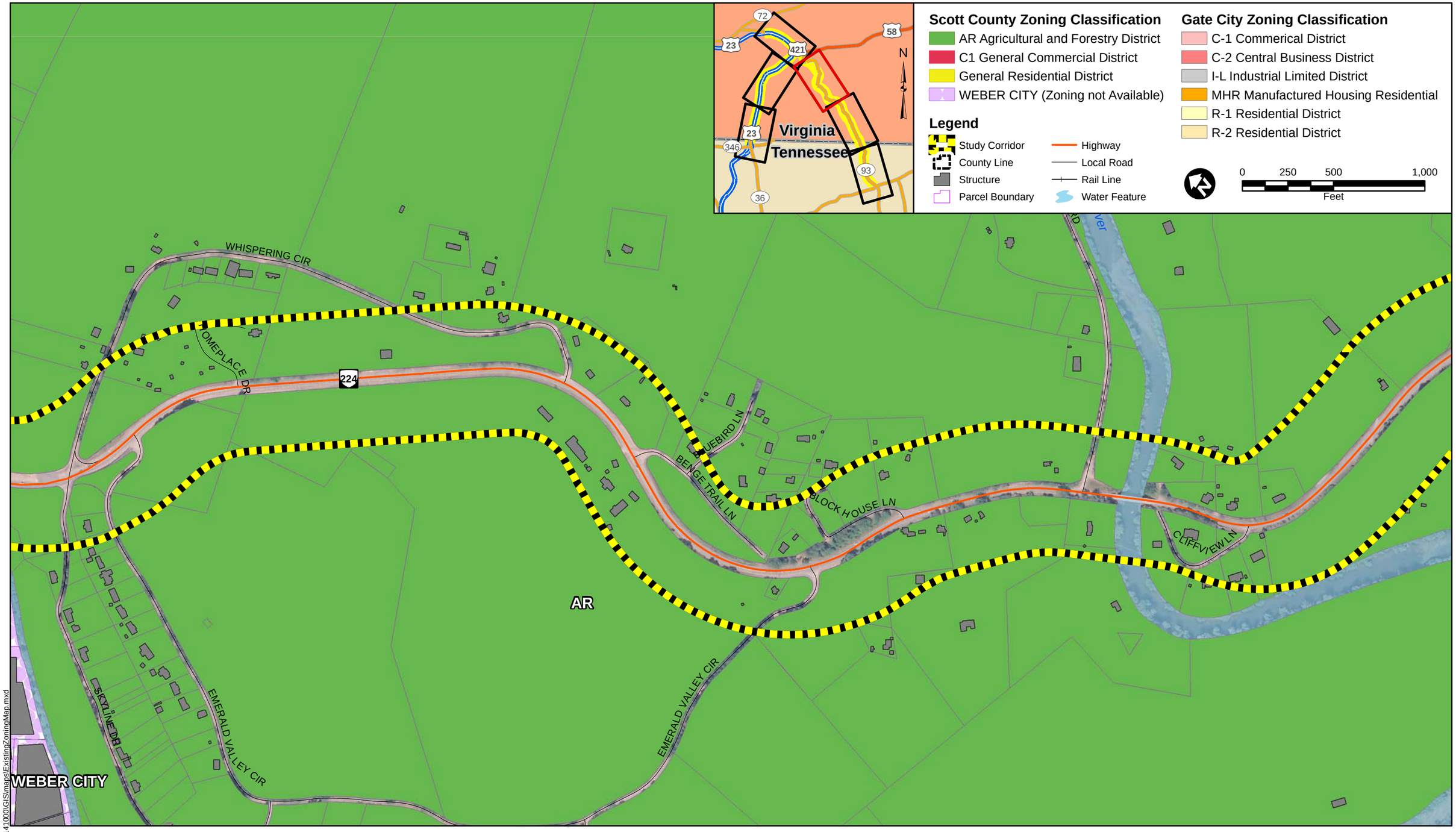
K:\RIC_TPTO\prj\prj\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Existing Zoning Map	Figure 3 - 2



K:\RIC_TPTO\prj\pn\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport Tennessee	US 23 / Route 224 Corridor Study	Existing Zoning Map	Figure 3 - 3



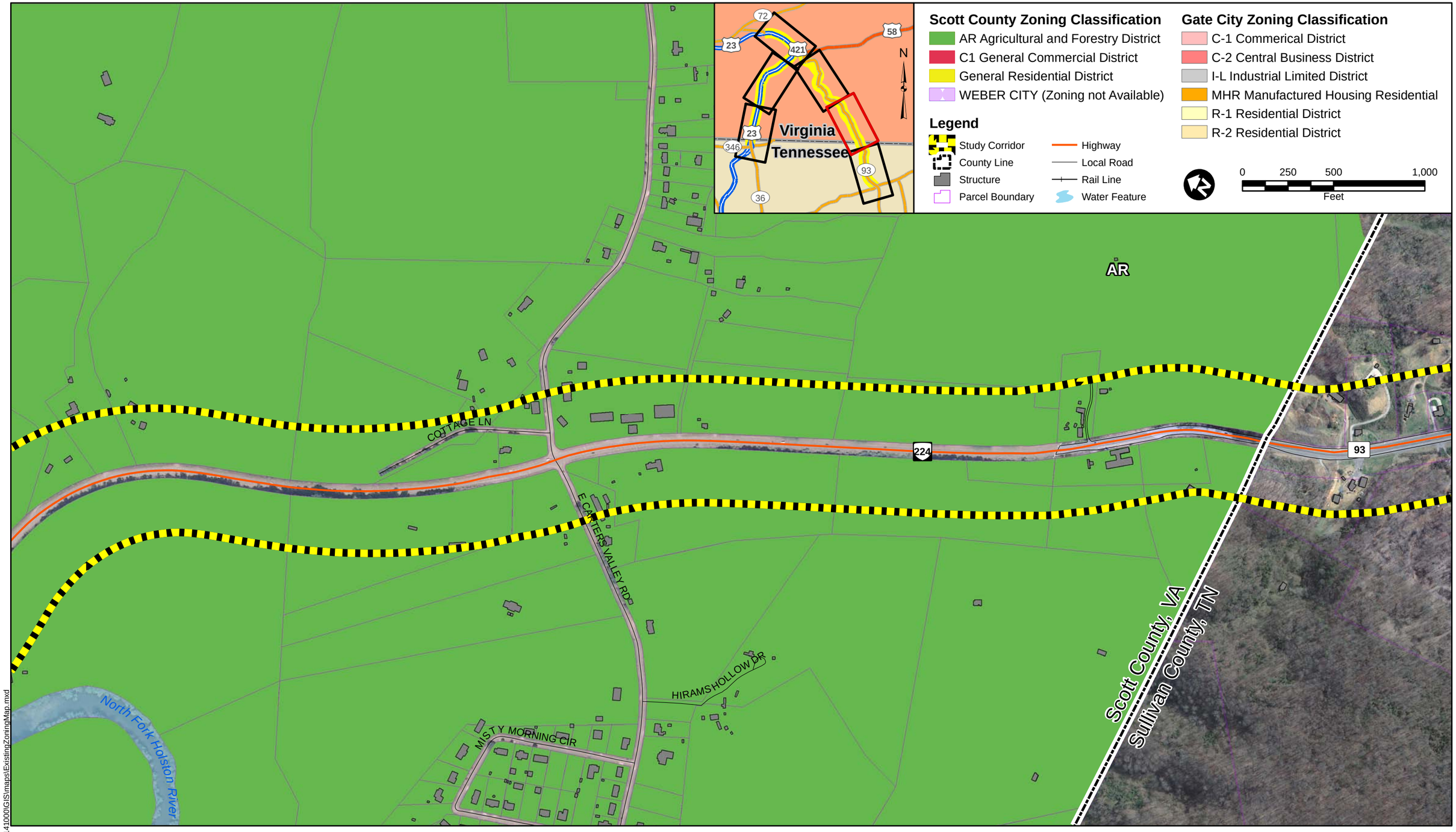
K:\RIC_TPTO\prj\pn\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

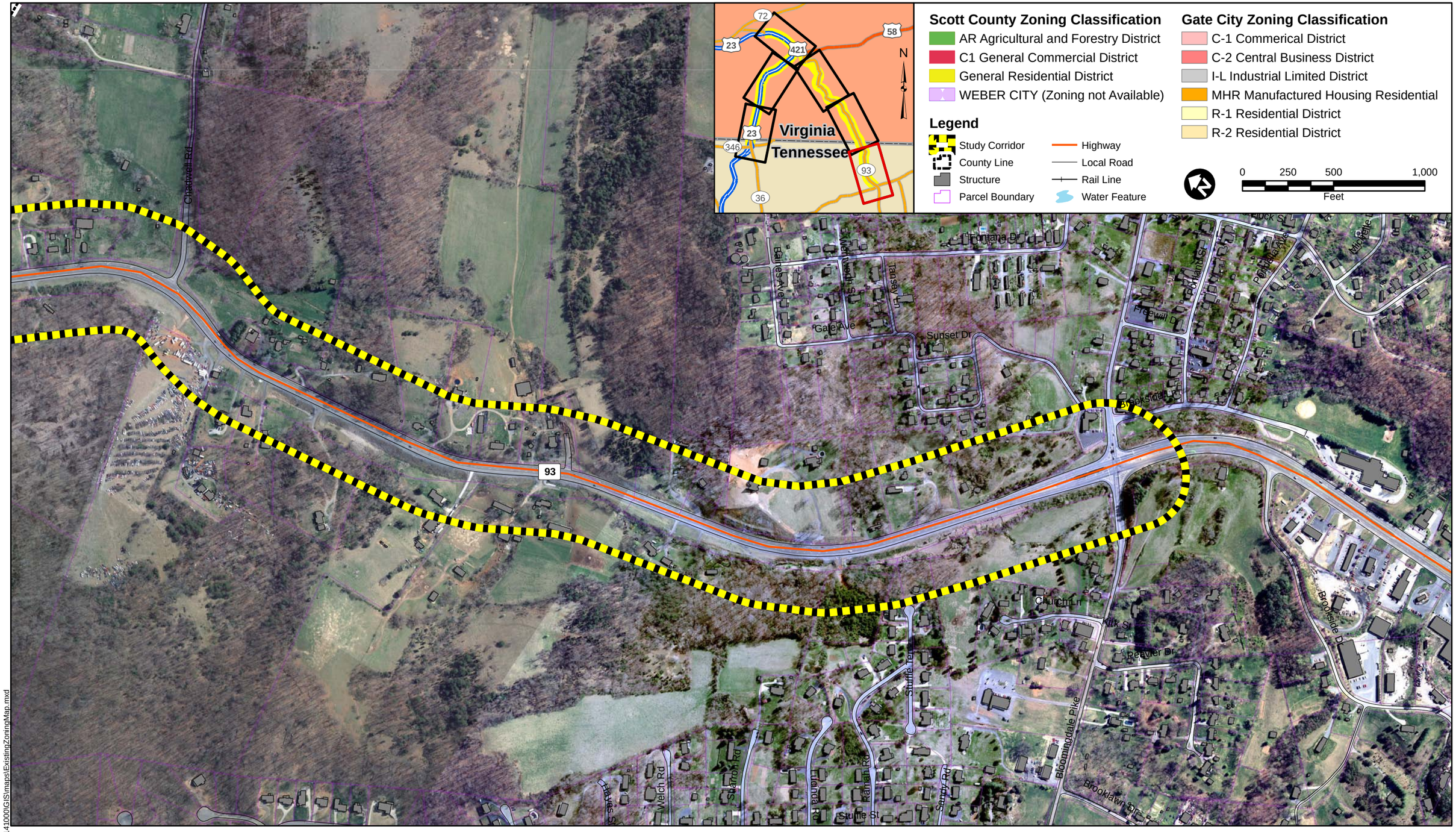
Existing Zoning Map

Figure 3 - 4



K:\RIC_TPTO\prj\pn\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Existing Zoning Map	Figure 3 - 5



Scott County Zoning Classification

- AR Agricultural and Forestry District
- C1 General Commercial District
- General Residential District
- WEBER CITY (Zoning not Available)

Gate City Zoning Classification

- C-1 Commerical District
- C-2 Central Business District
- I-L Industrial Limited District
- MHR Manufactured Housing Residential
- R-1 Residential District
- R-2 Residential District

Legend

- Study Corridor
- County Line
- Structure
- Parcel Boundary
- Highway
- Local Road
- Rail Line
- Water Feature

0 250 500 1,000
Feet

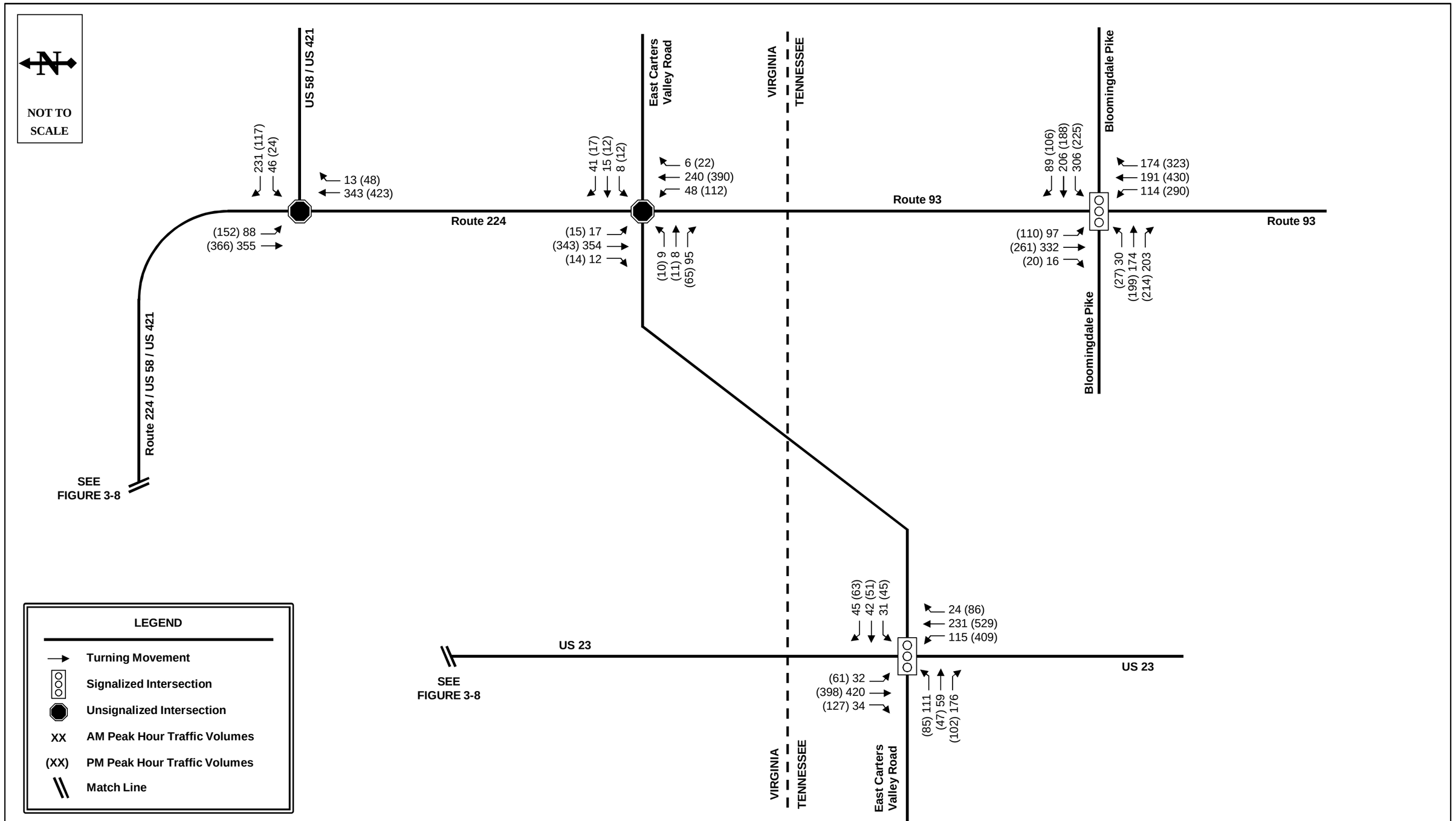
K:\RIC_TPTO\prj\pnl\113141000\GIS\maps\ExistingZoningMap.mxd

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing Zoning Map

Figure 3 - 6



Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Traffic Volumes (1 of 2)

Figure 3-7

NOT TO SCALE

SEE FIGURE 3-7

Route 224 / US 58 / US 421

345 (363)
146 (134)

105 (179)
792 (911)

(347) 333
(731) 873

Shopping Center Entrance

47 (171)
32 (100)

31 (166)
846 (928)

(118) 43
(784) 971

Jennings Street

37 (20)
128 (32)

101 (14)
738 (947)

(15) 70
(759) 803

2 (26)
5 (24)
23 (56)

18 (41)
626 (813)
36 (158)

(41) 22
(648) 787
(124) 76

(86) 194
(12) 4
(57) 113

US 23

SEE FIGURE 3-7

Yuma Road (Route 614)

781 (703)
316 (504)
19 (55)

16 (38)
20 (70)
3 (26)

Kane Street

(569) 743
(55) 24
(27) 16

(19) 53
(452) 392
(16) 11

US 23

LEGEND

- Turning Movement
- Signalized Intersection
- Unsignalized Intersection
- XX — AM Peak Hour Traffic Volumes
- (XX) — PM Peak Hour Traffic Volumes
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Traffic Volumes (2 of 2)

Figure 3-8

NOT TO SCALE

US 58 / US 421

Route 614

East Carters Valley Road

VIRGINIA

TENNESSEE

Bloomingdale Pike

Route 93

9,000
11%

Route 224

8,000
11%

10,200
37%

10,900
7%

12,500
11%

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

27,000
7%

22,300
7%

US 23

20,600
31%

21,700
21%

US 23

Yuma Road (Route 614)

East Carters Valley Road

Kane Street

US 23

VIRGINIA

TENNESSEE

LEGEND

- Travel Direction
- Signalized Intersection
- Unsignalized Intersection
- X,XXX / XX% — Average Daily Traffic (ADT) / Heavy Vehicle %

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Average Daily Traffic (ADT)

Figure 3-9

3.5.4. Location of Activity Centers and Planned New Developments

The location and type of an activity center can have a substantial impact on the traffic operations of the surrounding roadway network. Activity centers generally include community facilities (schools and libraries), shopping centers/areas, downtown business districts, major transit stations/stops, parks, and attractors for pedestrians and bicyclists. No activity centers and no new developments were identified directly along the study corridor.

3.6. Transit Services

At the time of this study, no public transit service is offered to the Weber City or Gate City communities. There are, however, semi-private, grant-funded shuttle services for the elderly.

3.7. Crash Data

The most recent three (3) years of available crash data was obtained from VDOT, TDOT and City of Kingsport for crashes on Route 224 and US 23 (see Appendix E).

Due to jurisdictional boundaries, the study corridors were divided accordingly:

- From the intersection of Lynn Garden Drive and East / West Carters Valley Road to the Virginia State Line– 43 crashes (from 12/29/06 to 12/29/09)
- Route 93 from the intersection of Route 93 and Bloomingdale Pike to the Virginia State Line – 70 crashes (from 01/01/06 to 08/28/09)
- Route 224 from the Tennessee State Line to the intersection of US 23 and US 58/US 421/US 23 in Weber City – 27 crashes (from 04/01/06 to 04/30/09)
- US 23 from the Tennessee State Line to the intersection of US 23 and Kane Street in Gate City – 177 crashes (from 02/01/07 to 02/28/10)

3.8. Land Use

Along Route 224 several commercial properties exist on the corridor and large acreage agriculture properties exist with single-family dwellings throughout. The Scott County Comprehensive Plan indicates an expansion of commercial future land use in the north section of Route 224 adjacent to the US 58 intersection. Research indicates that there are no recreation or conservation easements, although a land owner has created a pioneer village as an interpretive site open to the public.

A majority of the properties are commercial along the southern portion of the US 23 corridor on both the east and west sides of the road. Single-family residential dwellings are prominent on the west side and sporadic on the east side of US 23 from approximately Route 614 to the Food City Shopping Center. From the Food City Shopping Center to Kane Street intersection with US 23, the majority of the property is undeveloped or owned by Scott County. There is a historic marker and wayside adjacent to the intersection of US 23 and Route 619 (Filter Plant Road).

3.9. Planned Development

At the time of this study, there are no proposed or discussed developments within the Route 224 corridor. Along the US 23 corridor, there is one active development located on the north side of US 23 at Route 619 (Filter Plant Road). The Scott County School Board is developing an athletic facility which will provide baseball and soccer fields. Additionally, there has been interest shown in developing property on the west side of US 23 in the vicinity of the North Fork Holston River. However, no formal submissions of plans have been made at time of this study.

4. EXISTING CONDITIONS

A thorough understanding of the 2010 existing conditions in the Route 224 and US 23 corridors required that detailed field observations be completed in the early stages of the project, prior to completing the analyses. The existing conditions analyses were developed using the data collection discussed in the previous chapter of the report, as well as visual observations of the operational characteristics.. The existing conditions analysis provides a general review of baseline conditions. This chapter of the report describes the analysis of the traffic conditions, transit conditions and pedestrian/bicycle conditions within the corridor. The intent of the quantitative and qualitative analyses was to provide a starting point for improvements with more of an emphasis placed on future conditions analysis and mitigation strategies. In addition, the results of the first public meeting are discussed at the end of the chapter.

4.1. Level of Service

Capacity analysis allows planners and traffic engineers to determine the impacts of traffic on the surrounding roadway network. The Transportation Research Board's (TRB) *Highway Capacity Manual* (HCM) methodologies govern the methodology for evaluating capacity and the quality of service provided to road users traveling through a roadway network. There are six letter grades of Levels of Service (LOS) from A to F, with LOS A representing the best operating conditions and LOS F the worst operating conditions. Table 4-1 shows in detail how each of these levels of service are interpreted.

4.1.1. Intersection Level of Service

For both signalized and unsignalized intersections, level of service is defined in terms of delay, a measure of driver discomfort, frustration, fuel consumption and lost travel time. Table 4-2 summarizes the delay associated with each LOS category:

Table 4-2: Signalized and Unsignalized Intersection Level of Service Criteria

Signalized Intersections		Unsignalized Intersections	
Level of Service	Control Delay per Vehicle (sec/veh)	Level of Service	Average Control Delay (sec/veh)
A	≤ 10	A	≤ 10
B	> 10 to ≤ 20	B	> 10 to ≤ 15
C	> 20 to ≤ 35	C	> 15 to ≤ 25
D	> 35 to ≤ 55	D	> 25 to ≤ 35
E	> 55 to ≤ 80	E	> 35 to ≤ 50
F	> 80	F	> 50

SOURCE: Exhibit 16-2 and Exhibit 17-2 from "HCM 2000"

The existing Synchro 7.0 model was developed for intersection analyses as a base and was updated as needed (using existing traffic impact studies, if possible) to reflect existing conditions of the study corridor intersections. The existing network was modeled to reflect existing laneage and timings. These study documents intersection levels of service for the AM and PM peak hours based on collected data. LOS results were tabulated as shown in Table 4-3 and conclusions were drawn upon existing operational deficiencies of study area intersections.

Table 4-1: Level of Service Definitions

LOS	Roadway Segments or Controlled Access Highways	Intersections
A	Free flow, low traffic density	No vehicle waits longer than one signal indication.
B	Delay is not unreasonable, stable traffic flow	On a rare occasion, motorists wait through more than one signal indication
C	Stable condition, movements somewhat restricted due to higher volumes, but not objectionable for motorists.	Intermittently, drivers wait through more than one signal indication and occasionally backups may develop behind left turning vehicles, traffic flow still stable and acceptable.
D	Movements more restricted queues and delays may occur during short peaks, but lower demands occur often enough to permit clearing, thus preventing excessive backups.	Delays at intersections may become extensive with some, especially left-turning vehicles waiting two or more signal indications, but enough cycles with lower demand occur to permit periodic clearance, thus preventing excessive backups.
E	Actual capacity of the roadway involves delay to all motorists due to congestion.	Very long queues may create lengthy delays, especially for left turning vehicles.
F	Forced flow with demand volumes greater than capacity resulting in complete congestion. Volumes drop to zero in extreme cases.	Backups from locations down-stream restrict or prevent movement of vehicles out of approach, creating a storage area during part or all of an hour.

SOURCE: A Policy on Design of Design of Urban Highways and Arterial Streets - AASHTO, 1973 based upon material published in Highway Capacity Manual, National Academy of Sciences, 1965.

Table 4-3 summarizes the 2010 intersection LOS based on the 2010 traffic volumes. The 2010 AM and PM intersection movement and overall intersection LOS are shown on Figure 4-1 and Figure 4-2.

As shown on Figure 4-1 and Figure 4-2, all 7 of the signalized intersections operate at an overall LOS C or better during the AM and PM peak hours. All individual movements operate at LOS D or better during the AM and PM peak hours.

Table 4-3: Intersection Level of Service Summary – US 23/Route 224 Corridors 2010 Existing Volumes

	Lane Group	Eastbound				Westbound				Northbound				Southbound				Intersection Overall	
		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak			
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	AM	PM
Route 224/93 at Bloomingdale Pike (Signalized)	Left	B	16.8	C	21.3	C	22.7	C	26.3	B	19.0	B	19.7	B	18.6	B	16.7		
	Through	C	31.6	D	38.1	C	33.5	D	37.2	C	26.4	C	29.0	C	27.9	C	27.1	LOS C	LOS C
	Right	C	28.3	C	32.2	C	27.6	C	31.5	C	25.6	C	26.7	C	24.7	C	24.8	26.5	28.2
	Approach	C	28.9	C	34.2	C	27.1	C	31.3	C	24.3	C	25.7	C	25.8	C	24.0		
Route 224 at E. Carters Valley Road (unsignalized)	Left		-		-		-		-	A	8.3	A	8.5	A	7.8	A	8.3		
	Through	B	13.8	C	17.4	B	14.7	D	25.5		-		-		-		-		
	Right		-		-		-		-		-		-		-		-		
	Approach	B	13.8	C	17.4	B	14.7	D	25.5	A	1.4	A	1.8	A	0.3	A	0.3		
Route 224 at US 58/US 421 (unsignalized)	Left		-		-	C	22.7	D	31.6		-		-	A	8.4	A	9.1		
	Through		-		-		-		-		-		-		-		-		
	Right		-		-	B	13.9	B	13.1		-		-		-		-		
	Approach		-		-	C	15.3	C	16.3		-		-	A	1.7	A	2.7		
US 23 at Kane Street (signalized)	Left	D	39.8	D	45.8	D	40.3	D	39.6		-		-	C	20.6	C	26.9		
	Through	C	24.4	C	28.4	C	25.7	C	24.9	D	35.9	D	41.2	C	20.2	C	26.5	LOS B	LOS C
	Right	C	21.1	C	23.9	A	1.4	A	1.1	C	33.8	C	34.6	B	13.7	B	19.4	16.3	20.6
	Approach	C	26.1	C	28.9	A	8.9	B	12.3	D	35.0	D	39.3	C	20.3	C	26.4		
US 23 at US 58/US 421 (signalized)	Left		-		-	C	29.4	C	31.8		-		-	C	30.1	C	32.3		
	Through		-		-		-		-	C	20.6	C	21.1	A	6.8	A	5.9	LOS B	LOS B
	Right		-		-	C	25.9	C	28.3	B	15.1	B	14.9		-		-	18.1	19.5
	Approach		-		-	C	26.9	C	29.2	B	19.9	C	20.1	B	13.2	B	14.4		
US 23 at Shopping Center Entrance (signalized)	Left		-		-	C	24.4	C	31.1		-		-	C	26.8	C	31.8		
	Through		-		-		-		-	A	9.5	C	22.0	A	4.1	A	7.5	LOS A	LOS B
	Right		-		-		-		-	A	6.9	B	15.7		-		-	7.8	18.1
	Approach		-		-	C	24.4	C	31.1	A	9.4	C	21.1	A	5.1	B	10.7		
US 23 at Jennings Street (signalized)	Left		-		-	C	26.9	C	30.5		-		-	C	31.4	D	46.4		
	Through		-		-		-		-	B	18.8	A	8.2	A	7.6	A	3.6	LOS B	LOS A
	Right		-		-		-		-		-		-		-		-	15.2	7.2
	Approach		-		-	C	26.9	C	30.5	B	18.8	A	8.2	A	9.5	A	4.4		
US 23 at Route 614 (signalized)	Left		-		-		-		-	D	37.0	D	39.2	C	29.5	C	30.8		
	Through	D	37.7	D	36.9	D	38.2	C	34.5	B	19.9	C	22.5	B	16.5	C	21.0	LOS C	LOS C
	Right	C	27.3	C	31.3		-		-		-		-		-		-	21.3	24.9
	Approach	C	33.9	C	34.9	D	38.2	C	34.5	C	20.8	C	25.1	B	16.8	C	21.5		
US 23 at E. Carters Valley Road (signalized)	Left	B	16.8	C	21.1	B	15.0	B	19.7	A	6.6	A	9.6	B	13.2	B	17.7		
	Through	B	16.4	B	19.7	B	15.0	B	19.7	A	5.8	A	5.3	B	14.9	B	17.9	LOS B	LOS B
	Right		-		-		-		-	A	5.4	A	4.5	B	12.7	B	15.7	12.7	12.6
	Approach	B	16.5	C	20.2	B	15.0	B	19.7	A	6.0	A	6.9	B	14.6	B	17.4		

T

All movements at the two study area unsignalized intersections operate at LOS D or better during both the AM and PM peak hours, as shown on Figure 4-1 and Figure 4-2. Intersection level of service calculations are provided in Appendix F.

4.1.2. Arterial Link Levels of Service

Highway Capacity Software (HCS), a traffic analysis tool based on the theory of HCM, was used to analyze arterial levels of service on the two-lane and multi-lane roadways for the suburban and rural portions of the corridor. For two-lane highways, LOS is defined in terms of percent time-spent-following (the average percent of total travel time that vehicles must travel in platoons behind slower vehicles due to the inability to pass on a two-lane highway) and average travel speed. The HCM defines two classes of two-lane highways based on driver expectations, functional classification, length of trip (long or short), purpose of trip (commuting or sight-seeing/recreational), and connectivity with other facilities. The following roadway links were analyzed:

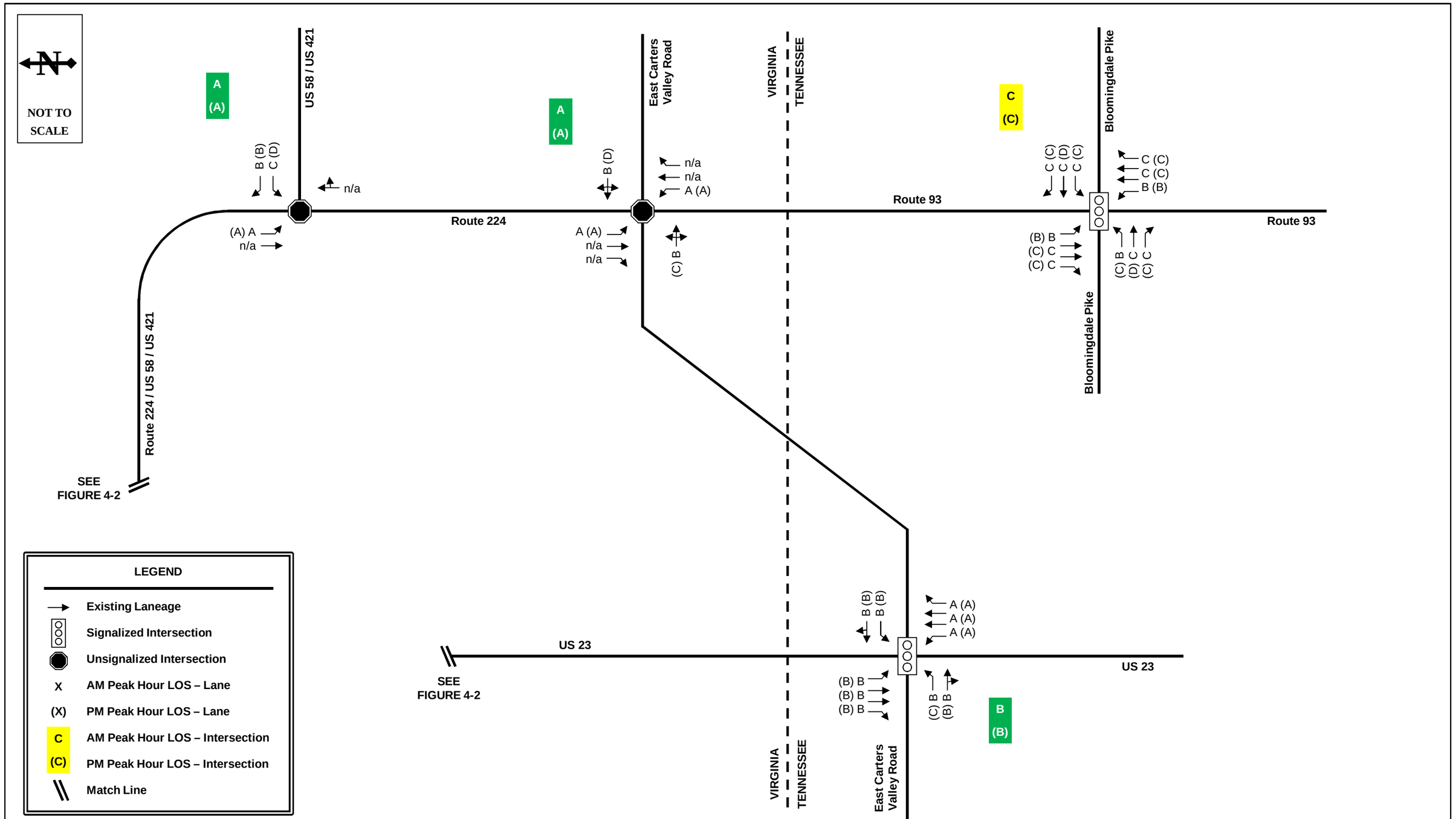
Route 224

1. Between Bloomingdale Pike and VA State Line
2. Between VA State Line and E Carters Valley Rd
3. Between E Carters Valley Rd and Route 614
4. Between Route 614 and US 58/US 421
5. On US 58/US 421 between Route 224 and US 23

US 23

1. Between Kane St and US 58/US 421
2. Between US 58/US 421 and Jennings St
3. Between Jennings St and Route 614
4. Between Route 614 and E/W Carters Valley Rd
5. On E Carters Valley Rd Between US 23 and Route 224

This report documents the LOS for the AM and PM peak hours for each of the aforementioned segments based on data collected. Table 4-4 summarizes the 2010 arterial link LOS based on the 2010 traffic volumes. The 2010 AM and PM arterial link LOS for both routes are shown on Figure 4-3. Arterial analysis for Route 224 indicates the corridor operates at LOS C or better with the exception of two sections indicating less than acceptable levels of service (LOS D). The two sections are between the Tennessee State Line and East Carters Valley Road and the section between US 58 and US 23. Arterial levels of service for US 23 indicate acceptable levels of service (LOS B or better). All of the study area segments operate at LOS D or better under existing (2010) conditions. Arterial link levels of service are provided in Appendix F.



Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Intersection LOS (1 of 2)

Figure 4-1

NOT TO SCALE

SEE FIGURE 4-1

Route 224 / US 58 / US 421

B (B)

C (C)
C (C)

B (B)
C (C)

A (B)

C (C)

Shopping Center Entrance

A (B)
A (C)

B (A)

C (C)

Jennings Street

B (A)

C (C)

D (C)

B (C)
D (D)

US 23

SEE FIGURE 4-1

(C) C
(A) A

(C) C
(A) A

(D) C
(A) A

(C) C
(C) B

D (D)
C (C)

Yuma Road (Route 614)

B (C)

A (A)
C (C)
D (D)

C (C)
D (D)

Kane Street

(C) C
(C) C
(B) B

D (D)
C (C)
C (C)

US 23

LEGEND

- Existing Laneage
- Signalized Intersection
- Unsignalized Intersection
- X — AM Peak Hour LOS – Lane
- (X) — PM Peak Hour LOS – Lane
- C — AM Peak Hour LOS – Intersection
- (C) — PM Peak Hour LOS – Intersection
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Intersection LOS (2 of 2)

Figure 4-2

NOT TO SCALE

US 58 / US 421

Route 614

Route 224

East Carters Valley Road

VIRGINIA

TENNESSEE

Bloomingdale Pike

Route 93

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

US 23

Yuma Road (Route 614)

East Carters Valley Road

US 23

Kane Street

US 23

C

C

D

D

A A

B B

B B

B A

B A

LEGEND

Travel Direction

Signalized Intersection

Unsignalized Intersection

C Arterial LOS

Match Line

VIRGINIA

TENNESSEE

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Existing 2010 Arterial LOS

Figure 4-3

Table 4-4: Arterial Link Level of Service Summary
US 23/Route 224 Corridors 2010 Existing Volumes

Road Segment	Level of Service
Route 224	
between Bloomingdale Pike and Virginia state Line[2]	NB: A (7.2) SB: A (4.9)
between TN/VA state Line and E. Carters Valley Road[1]	D (0.36)
between E. Carters Valley Road and Route 614[1]	C (0.30)
between Route 614 and US 58/US 421[1]	D (0.33)
US 58/US 421	
between Route 224 and US 23[1]	D (0.37)
US 23	
between Kane Street and US 58/US 421[2]	NB: B (15.9) SB: B (13.4)
between US 58/US 421 and Jennings Street[2]	NB: B (13.7) SB: B (11.2)
between Jennings Street and Route 614[2]	NB: B (12.0) SB: A (9.8)
between Route 614 and E. Carters Valley Road[2]	NB: B (12.6) SB: A (9.5)

[1] Multi-lane roads: LOS (density in passenger cars/mile/lane)
[2] Two-lane roads: LOS (volume/capacity ratio)

4.2. Crash Analysis

A visual geometric assessment of the existing roadway infrastructure was performed along Route 224 and US 23, including the identification of capacity constraints such as the number and width of lanes, horizontal alignment, grades, driveway locations, and sight distance. Reported crash data was obtained within the study corridor. A three (3) year evaluation of corridor safety was conducted based on crash summary information and field reconnaissance. For crash analysis purposes, the Route 224 corridor was divided between the two states: 1) in Tennessee it is Route 93 from Bloomingdale Pike to the Virginia State Line and 2) in Virginia from the Tennessee State Line to the intersection of US 58/US 421 and US 23. The US 23 crash analysis is divided into two sections, with the first in Tennessee from Lynn Garden Drive intersection with East / West Carters Valley Road to the Virginia State Line. The second section was in Virginia (US 23) from the Tennessee State line to the intersection of US 23 and Kane Street.

Using the available crash data, unsignalized intersections with at least 10 reported crashes and signalized intersections with at least five “angle” crashes were reviewed so that possible countermeasures could be determined and documented.

Of the 262 crash records provided, 165 (63%) were located along the US 23 corridor and 97 (37%) were located along the Route 224 corridor.

4.2.1. Route 93 from Bloomingdale Pike to the Virginia State Line:

- Crash data from 01/01/06 to 08/28/09 provided by TDOT
- 70 crashes in a three year period
- 82% occurring in the intersection
- 18% along the road between Bloomingdale Pike and Virginia State Line
- No adverse conditions were noted and 81% of the crashes occurred during daylight
- A majority, 67% were rear end crashes
- The results of the crash history review indicate inattentive drivers and exceeding posted speeds

4.2.2. Route 224 Tennessee State Line to the intersection of US 58/US 421 and US 23:

- Crash data from 04/01/06 to 04/30/09 provided by VDOT
- 27 crashes in a three year period
- 19% were rear end crashes and 19% angle accidents
- 78% of the crashes occurred during dry conditions
- 41% were attributed to driver inattention
- While crashes at given locations yielded concern there were no unsignalized intersections that exceed the study threshold
- Road section / intersection south of the Holston River indicate sight distance issues that should be addressed in the future analysis section

4.2.3. Lynn Garden Drive intersection with East / West Carters Valley Road to the Virginia State Line

- Crash data from 12/29/06 to 12/29/09
- 43 crashes in a three year period
- 42% rear end crashes
- 53% angle and 65% of total crashes occurred during the day with no adverse weather conditions
- Factors included sight distance and approach speed

4.2.4. US 23 from the Tennessee State line to the intersection of US 23 and Kane Street

- Crash data from 02/01/07 to 02/28/10
- 122 crashes in a three year period
- 56% rear end and 22% angle
- 91% of the crashes occurred during dry conditions
- 44% were attributed to driver inattention
- The following areas experienced the highest percentage of crashes along the corridor: US 23 and Routes 727, 737, adjacent to the Holston River, Route 614, Church Street, North Corporate Limits of Weber City and the Kane Street intersection
- Again 44% of the crashes were attributed to driver inattention and in the area of Route 727 and Route 737 ingress and egress movements into and out of commercial establishments
- The areas of Route 614 rear ends were prevalent because of road curvature and grades on the approach to the intersection on US 23
- The section of US 23 adjacent to Route 619 Filter Plant Road and Kane Street were stop / start crashes that occurred during peak periods. Crashes throughout the corridor indicate serious need for addressing possible sight distance issues, traffic operations and signal progression issues and enforcement of posted speeds

4.3. Transit

As reported earlier in this report, no public transit service is offered to the Weber City or Gate City communities; therefore, an existing conditions analysis of transit operations was not performed as part of this study.

4.4. Bicycles and Pedestrians

Over the past decade, interest in bicycling and walking has been rising nationally. This trend has been driven by a variety of influences including rising fuel prices, health concerns related to increased obesity in the general population (including children), rising traffic congestion, and the emergence of mixed-use developments that are designed at a bicycle- and pedestrian-friendly scale.

US 23 – Shared Use/Parking Lane

Accommodations and conditions for bicycling and walking vary along the 4.6 mile length of Route 224 and 4.2 mile length of US 23; however, based on feedback received from citizens during the study's public involvement process, there is significant interest in having additional mobility options along the study corridors, with strong preferences toward both bicycling and walking.

The following section documents existing accommodations for bicycle and pedestrian travel along the study corridor, including an analysis of public input related to these modes of travel.

Route 224

Route 224 presently has inadequate and incomplete pedestrian and bicycle facilities. Observation of the corridor confirmed little or no pedestrian use and limited bicycle use. Limited bicycle use is defined as observations of one or two avid bicyclist at any given time over a period of three days of observation. Limited usage may be directly attributable to minimal or lacking accommodations.

US 23

US 23 offers limited pedestrian facilities in the form of a sidewalk located on the east side of US 23 beginning approximately 1.5 miles from the intersection of Lynn Garden Drive and East / West Carters Valley Road. The sidewalk continues north for approximately 1.5 miles with connectivity to the east in Weber City and one pedestrian crosswalk at Jennings Street linking the east side of US 23 to the west side. The US 23 corridor does not have designated pedestrian facilities north of the US 23 and US 58/US 421/23 intersection. US 23 has limited bicycle facilities on the east side of the road. These facilities begin approximately 2.0 miles north of the intersection of Lynn Garden Drive and East / West Carters Valley Road. The facility is not marked as a bike lane and does not meet design standards but is used by local bicyclist because it offers varying width of paved lane / shoulder. The paved shoulder continues and increases in width to accommodate parking and shared use with bicycles and terminates approximately 3.0 miles from the intersection of Lynn Garden Drive and East / West Carters Valley Road.

4.4.1. Obstacles to Bicycling and Walking

The following physical obstacles to bicycling and walking were noted in the corridor during field observations:

Bicycling

- Lack of signed routes or designated bicycle lanes
- Lack of safe areas to ride
- Lack of bicycle amenities (i.e. bike racks or bike lockers)
- Moderate to steep grades along roadway profile

Walking

- Non-ADA curb ramps
- Lack of sidewalk connectivity or absence of sidewalks
- Moderate to steep grades along roadway profile
- Poor shoulder conditions or very limited shoulder width

US 23 – Wide Paved Shoulder Used by Bicycles and Pedestrians

4.5. Environmental Screening

A preliminary environmental screening of the project corridor was conducted in order to provide a cursory assessment of potential environmental constraints that may be relevant to the project. The screening consisted of a desktop review of data obtained from various standard environmental data sources related to wetlands and other surface waters, threatened and endangered species, cultural and historic resources, and hazardous materials. In order to conduct the screening, a study area was created by applying a 100 foot buffer to each side of the approximated US 23/Route 224 corridor centerline using Geographic Information System (GIS).

4.5.1. Potential Impacts to Wetlands and Other Surface Waters

The proposed project corridor is located within the North Fork Holsten watershed, which is denoted by U.S. Geological Service (USGS) hydrologic unit code (HUC) 060101. The North Fork Holsten watershed forms a portion of the Upper Tennessee River Basin, which is itself a tributary of the Ohio River.

A GIS review of National Wetlands Inventory (NWI) digital mapping indicates that a total of two wetland areas may be impacted by the US 23/Route 224 corridor study. The wetland types include a freshwater emergent (PEM) and a riverene (R2) wetlands (Cowardin et al. 1979). Digital stream mapping indicates that the project may impact North Fork Holsten River at two locations.

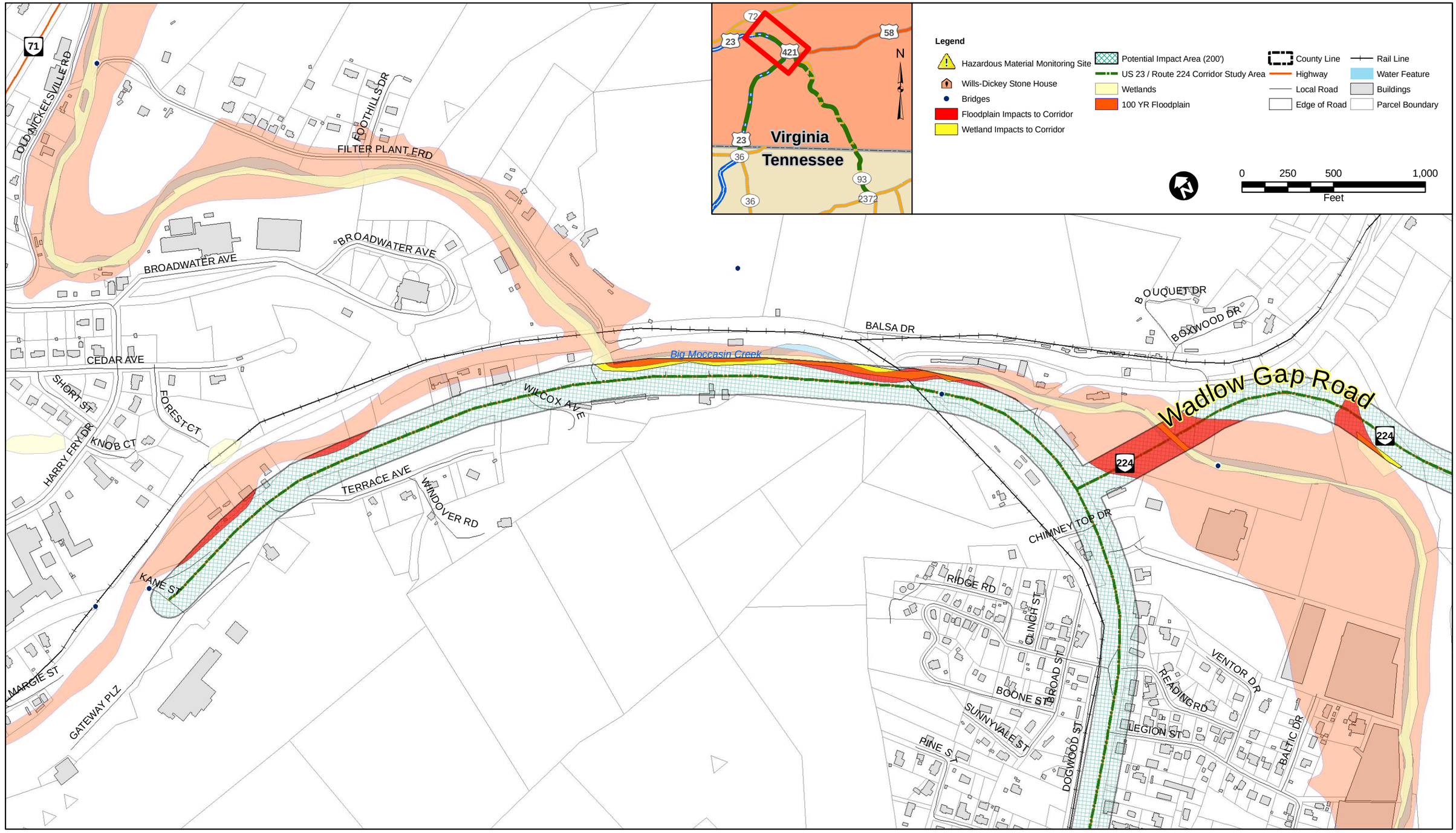
4.5.2. Floodplain

Locations where the study corridor is likely to cross the 100-year floodplain were determined by reviewing Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel numbers 5101460001B and 5101450001B, dated November 15, 1978 provided in Appendix G. Floodplain data was received from LENOWISCO Planning District Commission and the City of Kingsport. A GIS analysis was conducted intersecting the 100 year floodplain and the 200 foot buffer placed around the study corridor on US 23 and Route 224. Based on these sources, the project corridor segment crosses into the 100-year floodplain at seven locations, including five crossing US 23 and two crossing Route 224 (refer to Figures 4-4 through Figure 4-9).

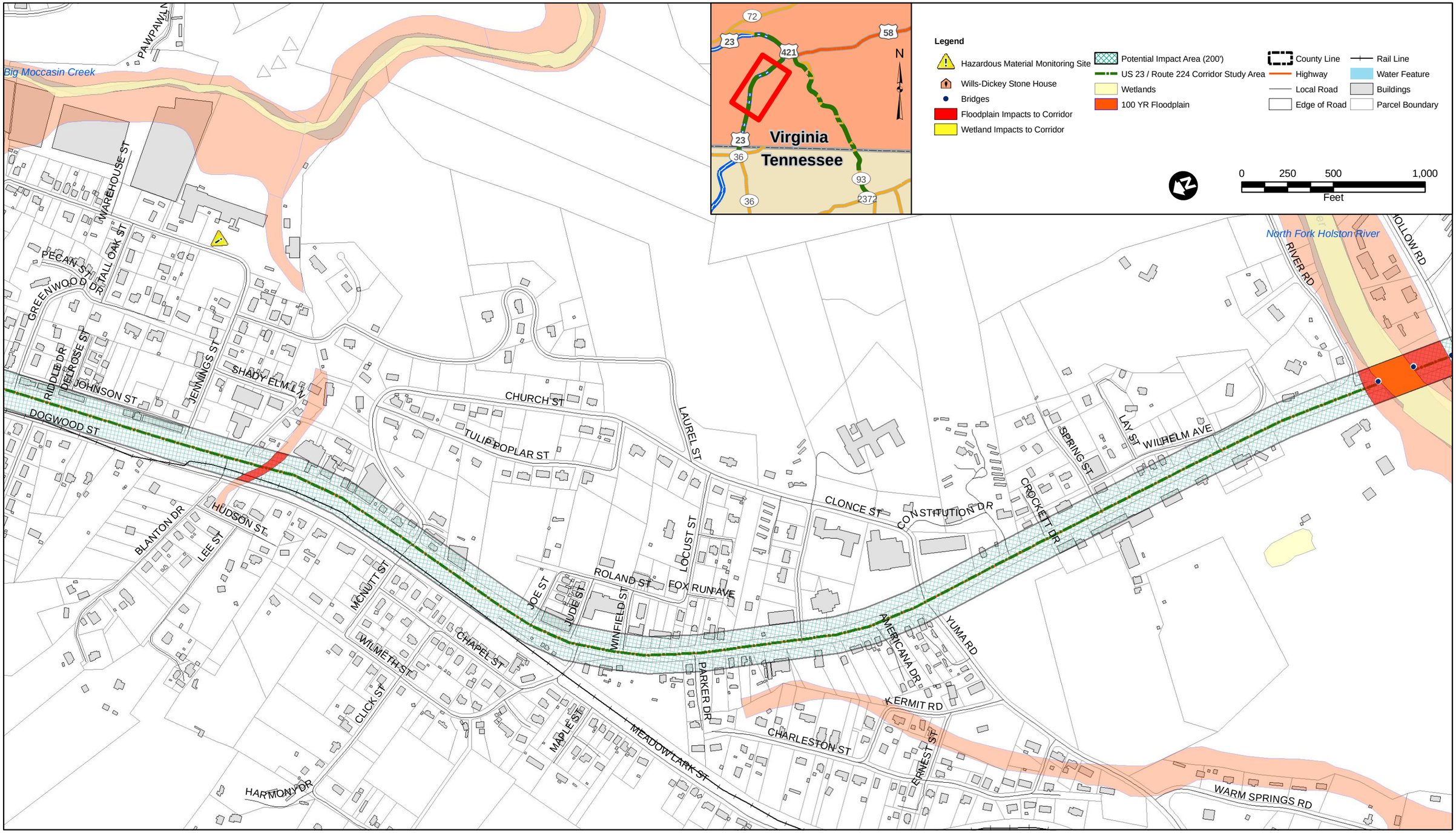
Impacts to the 100-year floodplain would be required to comply with the approved floodplain management ordinance and would likely require detailed hydraulic analyses and possible floodplain mitigation to replace lost floodplain volume.

4.5.3. Threatened and Endangered Species

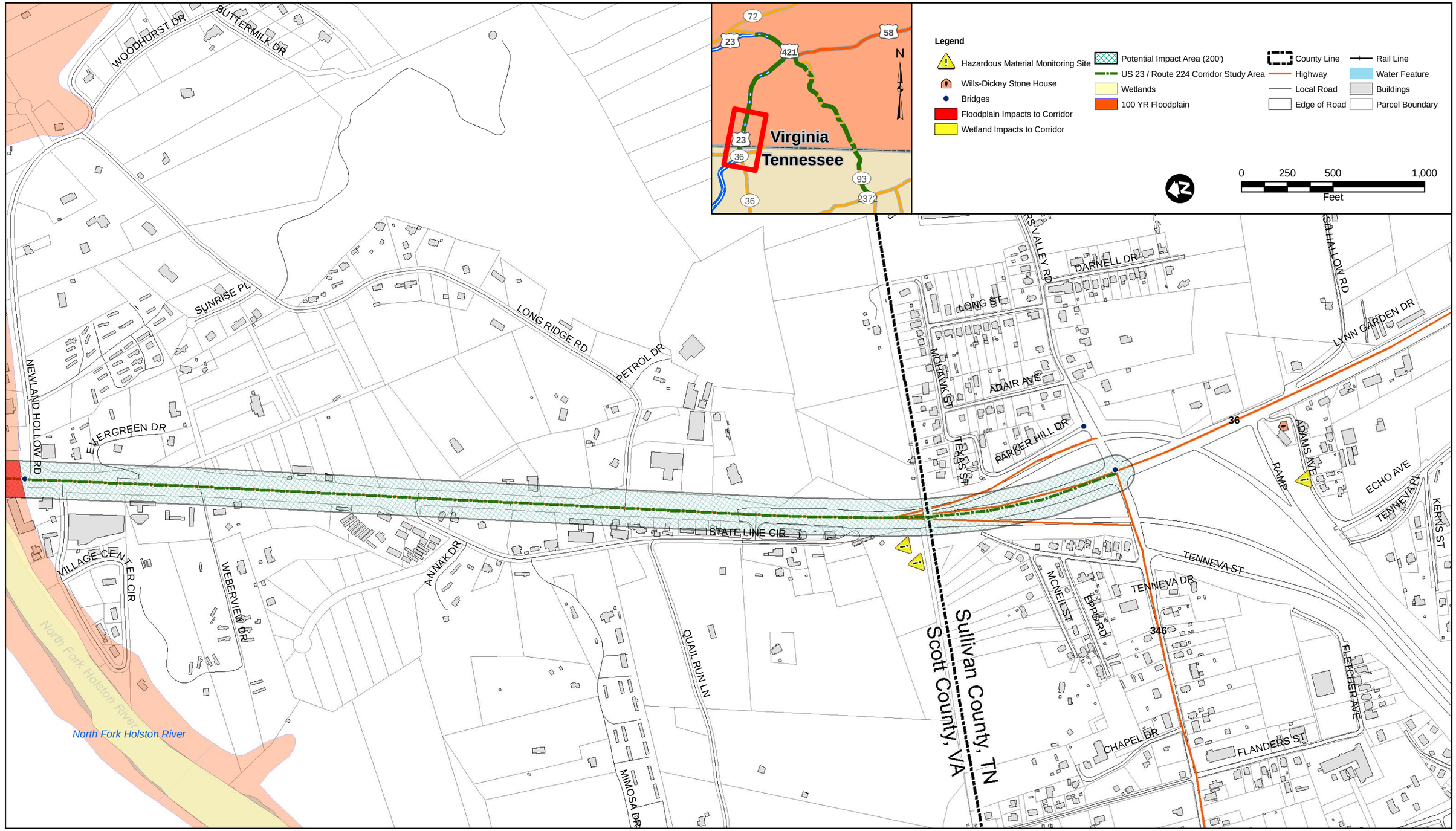
The Virginia Department of Game and Inland Fisheries (VDGIF) Virginia Fish and Wildlife Information Service (VAFWIS) were consulted to identify the presence of federal and state threatened or endangered species within the project limits. The VAFWIS compiles many different environmental databases. The Collections database is the only one of legal concern because it requires coordination with the federal and/or state agencies if threatened or endangered species are present in the corridor. The Collections database revealed eleven Federal Endangered, one Federal Threatened, twelve State Endangered, and seven State Threatened species in the corridor watershed within Virginia as shown in Table 4-5.



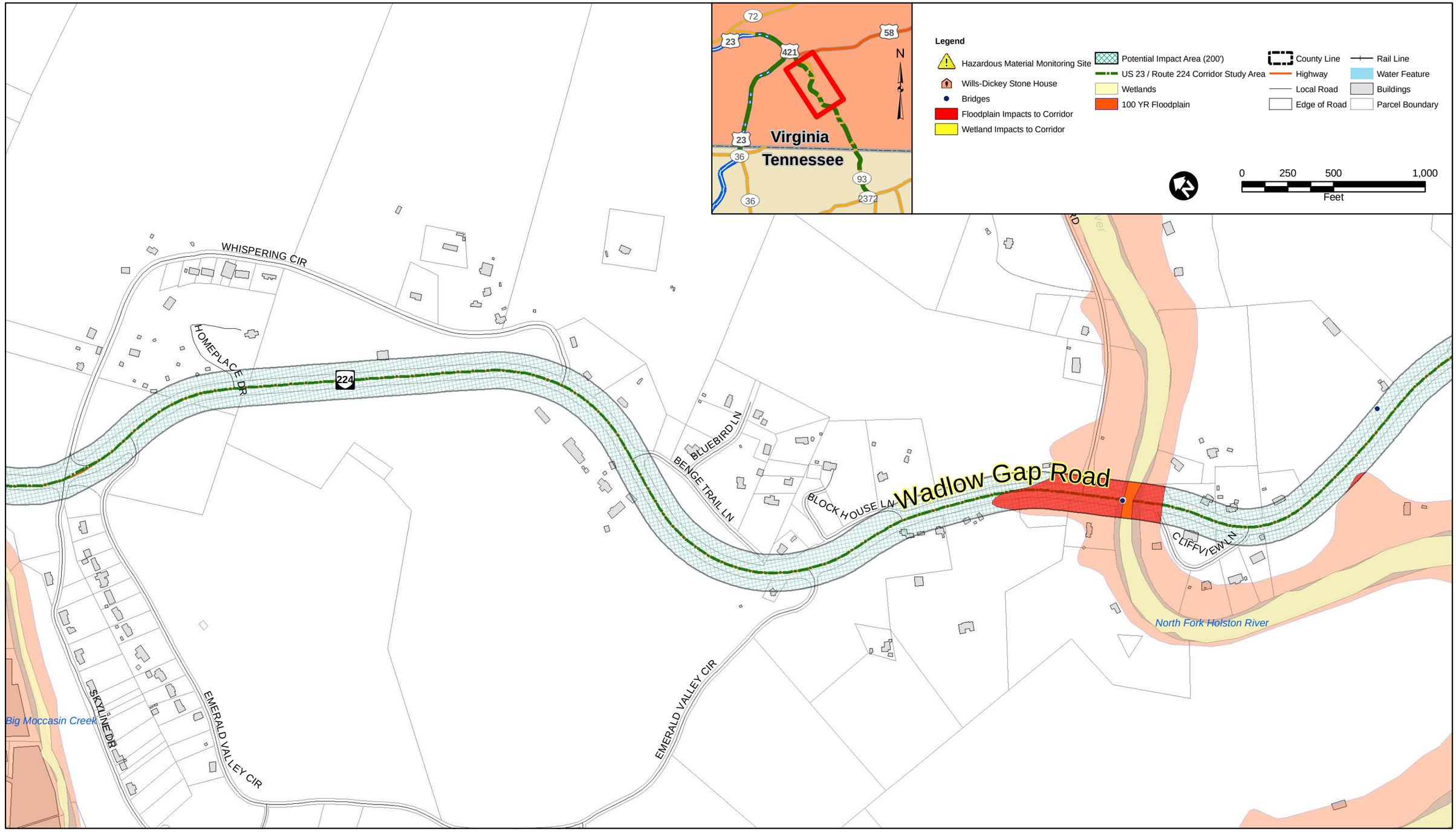
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 4



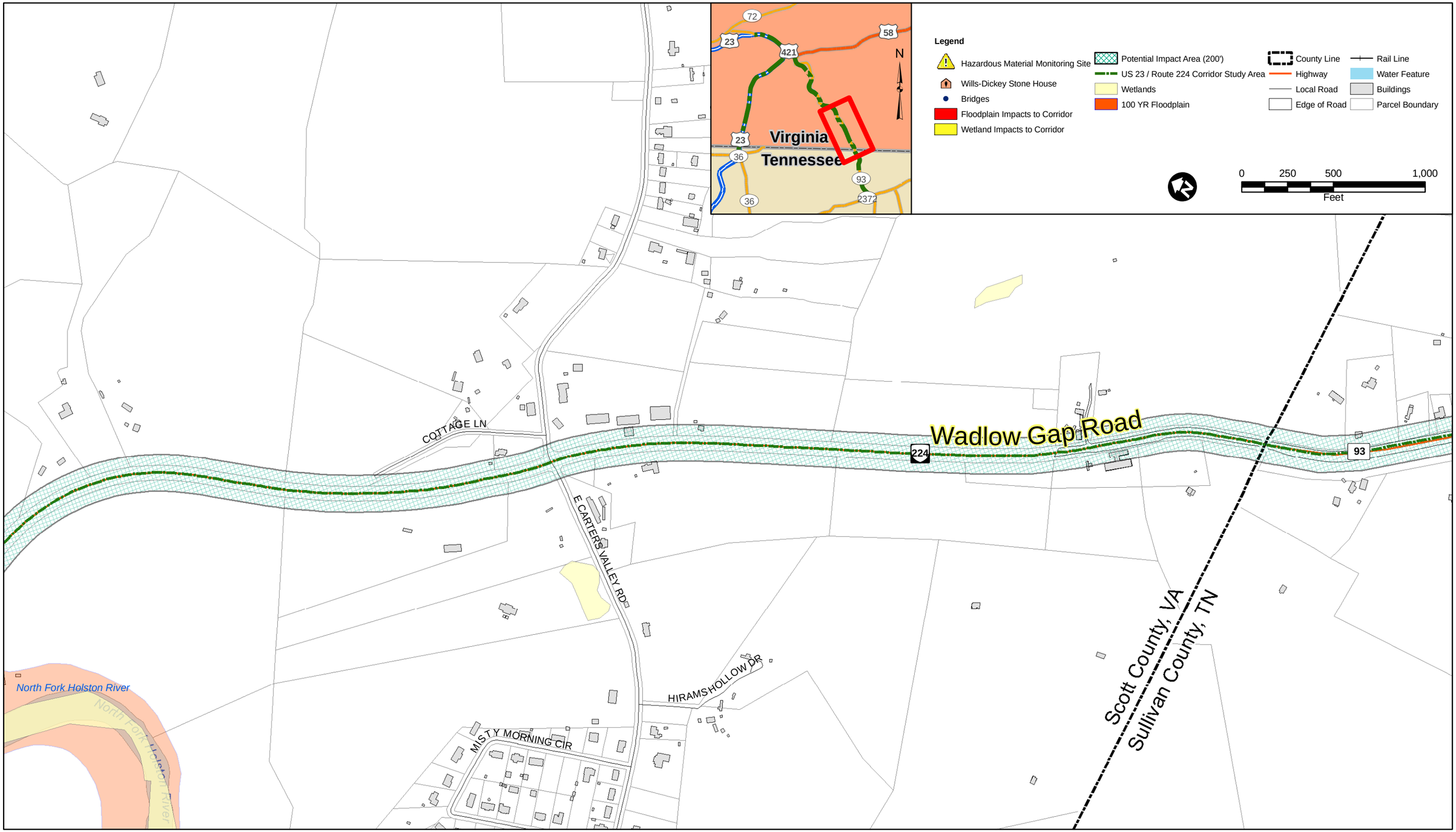
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 5



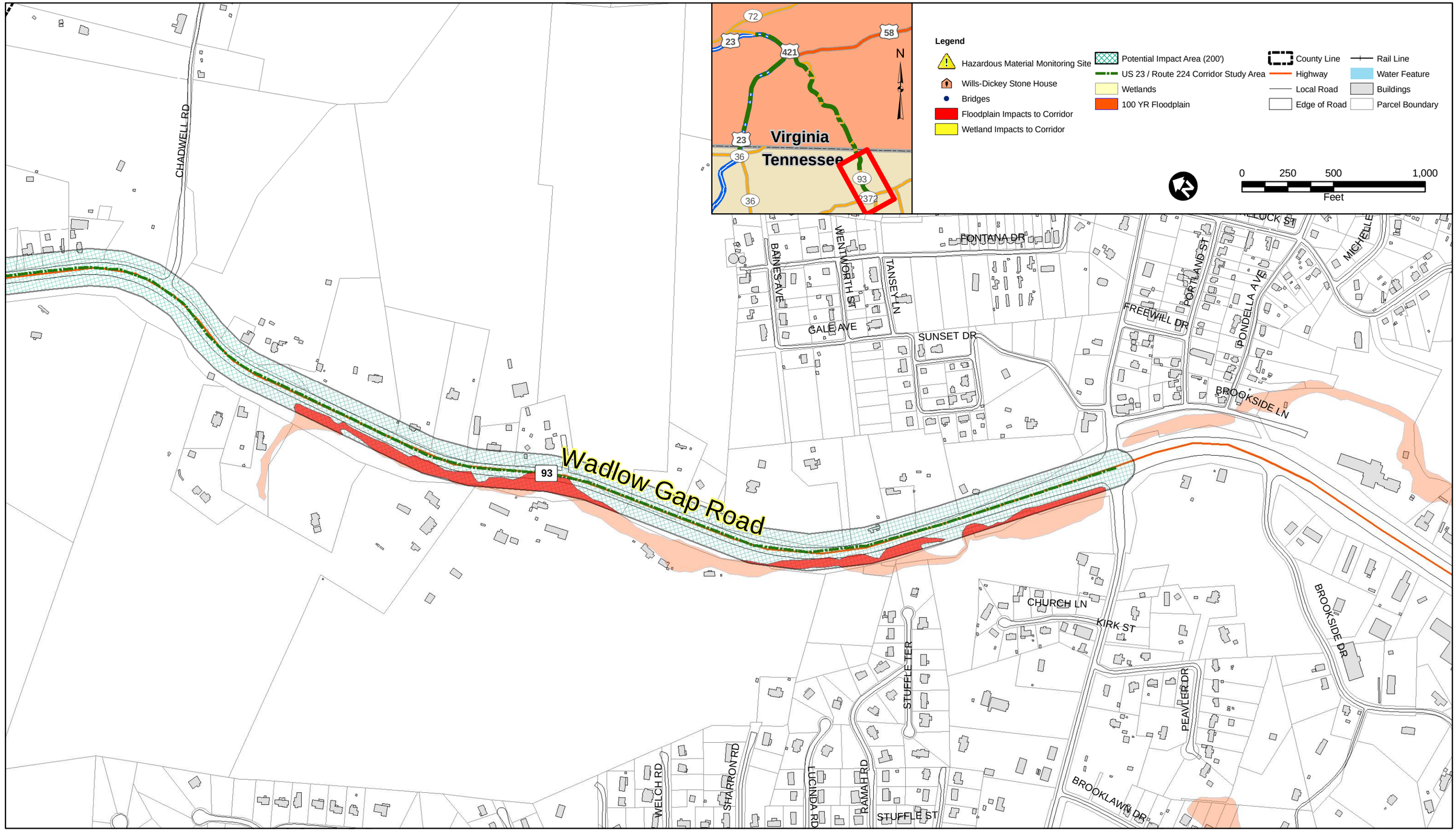
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 6



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 7



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 8



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Environmental Map	Figure 4 - 9

Table 4-5: Threatened and Endangered Species in Study Corridors Within Virginia

Status	Common Name	Scientific Name
Federally Endangered & State Endangered	Cumberland Bean Pearlymussel	*Villosa trabalis*
	Green Blossom Pearlymussel	*Epioblasma torulosa gubernaculum*
	Mussel	*Epioblasma capsaeformis*
	Birdwing Pearlymussel	*Conradilla caelata*
	Littlewing Pearlymussel	*Pegias fabula*
	Finerayed Pigtoe	*Fusconaia cuneolus*
	Shiny Pigtoe	*Fusconaia cor*
	Rough Rabbitsfoot	*Quadrula cylindrica strigillata*
	Gray Bat	*Myotis grisescens*
Federally Threatened & State Threatened	Spotfin Chub	*Erimonax monachus*
State Endangered	Tennessee Dace	*Chrosomus tennesseensis*
	Purple Lilliput	*Toxolasma lividus*
	Slippershell Mussel	*Alasmidonta viridis*
	Snuffbox	*Epioblasma triquetra*
	Long-Stalked Holly	*Ilex collina*
State Threatened	Peregrine Falcon	*Falco peregrinus*
	Loggerhead Shrike	*Lanius ludovicianus*
	Longhead Darter	*Percina macrocephala*
	Bald Eagle	*Haliaeetus leucocephalus*
	Slabside Pearlymussel	*Lexingtonia dolabelloides*
	Spiny Riversnail	*Io fluvialis*

The Tennessee Department of Environment and Conservation (TDEC) and Natural Heritage Inventory Program (NHIP) was also consulted for the presence of federal and state threatened or endangered species within the project limits. The inventory revealed four Federal Endagered, one (1) Federal Threatened, four State Endangered, and two State Threatened species in the corridor watershed within Tennessee as shown in Table 4-6.

Table 4-6: Threatened and Endangered Species in Study Corridors Within Tennessee

Status	Common Name	Scientific Name
Federally Endangered & State Endangered	Shiny Pigtoe	*Fusconaia cor*
	Finearyed Pigtoe	*Fusconaia cuneolus*
	Birdwing Pearlymussel	*Lemiox rimosus*
	Purple Bean	*Villosa perpurpurea*
Federally Threatened & State Threatened	Spotfin Chub	*Erimonax monachus*
State Threatened	Appalachian Bugbane	*Cimicifuga rubifolia*

SOURCE: TDEC Natural Heritage Program

Impacts to wetlands and streams along the study corridor would have to be coordinated with federal and state resource agencies to determine potential impacts to listed threatened and endangered species. Because of the multiple river crossings and presence of listed fish and mollusks, it is likely that surveys for the presence of these species at the project site and within two miles downstream of the project site could be required. If federally listed threatened or endangered species were determined to be present, formal coordination with the U.S. Fish and Wildlife Service and National Marine Fisheries Service would be required. If Tennessee or Virginia listed threatened or endangered species were found to be present, then coordination with the appropriate state resource agency would be required.

4.5.4. Cultural and Historic Resources

The Virginia Department of Historic Resources (VDHR) Data Sharing System (DSS) database was consulted on November 16, 2010 for the presence of documented archeological or architectural resources in the project corridor. The locations of historic resources documented in the database are depicted on DHR DSS (Appendix G). The database identified four (4) historical architectural features: DHR #221-5006, DHR #324-0007, DHR #084-5168, and DHR #324-0004 within the project corridor. According to available database information, DHR #221-5006 was evaluated in 1995 and determined ineligible for inclusion on the National Registry of Historic Places. DHR #084-5168 was evaluated in 2000 and determined ineligible as well. Locations DHR #324-0007 and DHR #324-0004 were not evaluated.

The National Park Service's National Register of Historic Places was reviewed to determine if any archeological or architectural are present along the project corridor in Tennessee. No sites were identified directly in the 200 foot buffer, but there was one site only 800 feet south of the study area to consider for potential impacts. The Wills-Dickey Stone House is located northwest of Kingsport, TN off of U.S. 23 on West Carter's Valley Rd. The site is mapped on Figure 4-9.

4.5.5. Hazardous Materials

The United States Environmental Protection Agency (EPA) EnviroMapper database consulted in order to obtain information related to hazardous material generation within the project corridor. The EnviroMapper database identifies facilities, sites or places subject to environmental regulations or of environmental interest. A total of seven sites were identified within the project corridor, including three active air emission sites, three waste sites, and one land site as listed in Table 4-7. Approximate locations are mapped in Figures 4-4 through Figure 4-9 above.

Table 4-7: Hazardous Materials Monitoring Sites along US 23 and Route 224 Corridors

Waste Sites	*Quality Cleaners*	US 23, Weber City, VA 24290
	Henard Metal Fabricators	241 East Carters Valley Rd., Kingsport, TN 37660
	Stateline Collision Repair	124 Adams Ave., Kingsport, TN 37660
Air Emissions Sites	*Quality Cleaners*	US 23, Weber City, VA 24290
	Scott Co. Public Schools	145 Jennings St., Weber City, VA 24290
	Roberts Tire and Recapping	US 23, Weber City, VA 24290
Land Sites	*Quality Cleaners*	US 23, Weber City, VA 24290

SOURCE: United States Environmental Protection Agency (EPA) EnviroMapper

5. MODELING AND FORECASTING

When planning ahead to address the future needs of a transportation network, it is important to project the level of traffic that is anticipated during the planning study period of 25 years to 2035. Socio-economic growth (i.e., population, households, retail employment, non-retail employment, and total employment), historical traffic growth trends, planned development, and a regional travel demand model (if available) all play a role in the development of traffic volume projections. Generally, an increase in socio-economic data equates into an increase in the use of transportation facilities, which means more automobiles on the roadways. Historical traffic volumes provide a comparable measure to gauge increases or decreases in traffic volumes against documented changes in socio-economic data; whereas, a regional model provides planners with future socio-economic data estimates to project future traffic volumes on the regional roadway network. The primary output from this analysis included an existing conditions traffic assignment, future conditions traffic assignment, and the corresponding annualized traffic growth rate (calculated by comparing the future traffic assignment with the existing traffic assignment) at which traffic is expected to increase during the planning period of the study. These annualized growth rates are then applied to current traffic volumes to develop future traffic projections that were consistent with existing volumes and patterns and more representative of anticipated future traffic conditions. This section of the report outlines the process and methodology used to develop future traffic volume projections within the US 23/Route 224 corridor study area.

5.1. Background

This corridor study was being conducted in southwest Virginia and northeast Tennessee in anticipation of future land development and resulting changes in travel patterns and traffic volumes. A key focal point of the project was to determine how future traffic volumes along Route 224 may change following the construction of Phase II and Phase III of the Moccasin Gap Interchange Project. When the Moccasin Gap Interchange Project is completed, Route 224 will potentially serve as the primary route between Gate City, Virginia and Kingsport, Tennessee (See - Figure 2-1: US 23/Route 224 Corridor - Study Area Map). The future traffic volume projection effort and the associated future conditions analysis will also assist in determining if the construction of the proposed Moccasin Gap Interchange is still a practical alternative to meeting the needs of future traffic demand. Route 224 is currently a two-lane roadway in the region that parallels US 23 to the east between Kingsport and Gate City. The construction of an interchange in the vicinity of the current intersection convergence of Route 224, US 58, US 421, and US 23, combined with additional capacity along this two-lane section of roadway, has the potential to alter travel patterns, traffic volumes, and land development in the study area. To gain a better understanding of future traffic demand and appropriate roadway capacity improvements to support this demand, future traffic volume projections were developed for the study area.

5.2. Analysis Scenarios

A future conditions analysis was required to evaluate how a proposed new facility or facility improvement (e.g., roadway widening, new interchange, interchange modification, etc.) would operate under future traffic conditions. The 25-year planning horizon provides the region with a long-range vision intended to be consistent with the goals and objectives of the 2030 Kingsport MPO Area Long Range Transportation Plan (LRTP). Both future analysis years (i.e., 2015 and 2035) were agreed to by the City of Kingsport, Kingsport MPO, LENOWISCO PDC, and the Virginia Department of Transportation (VDOT). Future traffic volume projections were developed to analyze average weekday AM and PM peak periods under baseline (2010), short-term (2015), and future (2035) traffic conditions:

2010 Baseline – evaluation of traffic demand on the existing roadway network with Route 224 as a two-lane facility and US 23 as a four-lane facility.

2015 Short-Term No Build – evaluation of 2015 future traffic demand on the existing plus committed (E+C) projects roadway network but without the Moccasin Gap – Phase II and Phase III improvements. E+C projects are proposed capacity improvement projects contained in the adopted 2030 LRTP.

2035 Future No Build – evaluation of 2035 future traffic demand on the E+C projects roadway network but without the Moccasin Gap – Phase II and Phase III improvements.

2035 Future Build – evaluation of 2035 future traffic demand on the improved E+C roadway network with Moccasin Gap Phase II and Phase III improvements constructed, and Route 224 as a four-lane facility. This scenario assumes the Moccasin Gap Interchange – Phase II and III improvements are completed by 2030.

AM and PM peak hour traffic volume projections were developed for each analysis scenario.

5.3. Growth Rate Methodology and Future Traffic Volume Circulation

The US 23/Route 224 study evaluated baseline (2010), short-term (2015), and long-term (2035) traffic conditions. To determine baseline, short-term, and long-term traffic demands, growth rates were established using a combination of historical traffic count data, socio-economic data, and traffic volume projections (i.e., 2004, 2015, and 2030) from the Kingsport Area Travel Demand Model.

5.3.1. Growth Rate Development Data Resources

Various traffic-related data resources were referenced and compared to assist in the development of annualized growth rates for future traffic operations analyses. Resources used in the development of the annualized growth rates include the following:

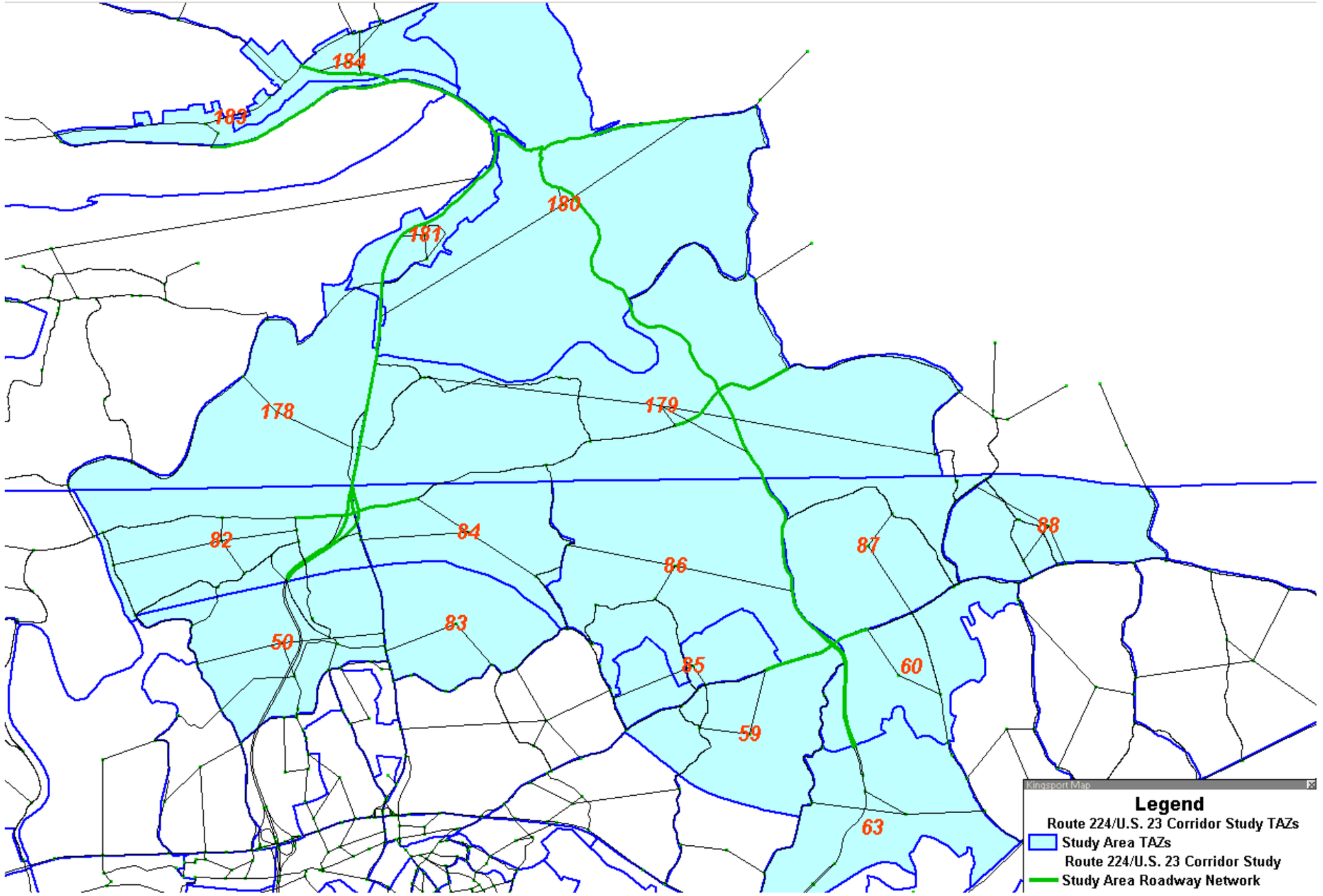
1. Historical VDOT Annual Average Daily Traffic (AADT) Volume Estimates (i.e., 2004 to 2008)[1].
2. 2010 Average Daily Traffic Volumes – Collected for this project
3. Data obtained from the 2004, 2015, and 2030 Kingsport Area Travel Demand Model:
   a. Traffic Analysis Zone (TAZ) Socio-Economic Data (e.g., Population, Households, Total Employment, Retail Employment, Non-Retail Employment)
   b. Daily Traffic Volume Projections

Figure 5-1 reflects the study area Traffic Analysis Zones (TAZs). Detailed data from each of the aforementioned data resources are included in Table 5-1 through Table 5-6.

Figure 5-2 reflects the Kingsport Area Travel Demand Model Network.

[1] 2009 VDOT AADT Volumes were not used as they reflected a negative trend in historic traffic volumes.

NOT TO SCALE



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Study Area Traffic Analysis Zones	Figure 5-1

NOT TO SCALE

US 23

US 58/Route 421

US 23

Model Centroid Connector

Route 224

Carters Valley Road

Carters Valley Road

Carters Valley Road

Route 224

Bloomingdale Road

Kingsport Map

Map layers

Network

Endpoints

Network selection sets

Centroid Connectors

Study Area Roadway Network

0 .25 .5 .75

Miles

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Kingsport Travel Demand Model Network

Figure 5-2

5.3.2. Historical VDOT Annual Average Daily Traffic Volume Estimates

Historical traffic count data from VDOT permanent count stations and/or AADT traffic volume estimates demonstrated negligible growth in study area traffic volumes between 2004 and 2008. US 23 historical traffic volume data reflected annual growth rates ranging from 0% growth along some segments to a high of approximately 1%. Traffic volume trends along the study area segments of US 58/US 421 reflected the similar trend of 0% to approximately 1.6% during this five-year period. Traffic growth rates along Route 224 ranged from 0% to negative growth between 2004 and 2008. As previously noted, 2009 VDOT AADT data were not used for this analysis as the inclusion of this data would have resulted in a negative growth trend for all study area facilities. Table 5-1 and Table 5-2 reflect historical traffic estimates and associated annualized growth rates between 2004 and 2008 along select segments of the corridor study area. Detailed VDOT AADT traffic volume data can be found in Attachment B – Enclosure 1 of the US 23/Route 224 Corridor Study – Traffic Volume Growth Rate Development Technical Memorandum included in the Appendix of this report.

Table 5-1: US 23 VDOT AADT Volume Estimates and Annualized Growth Rates

US 23	Year					VDOT Growth
	2004	2005	2006	2007	2008	
from Route 808 to US 58/US 421/NCL Weber City	24,000	23,000	24,000	24,000	24,000	0.00%
from SCL Weber City to Route 614 N	23,000	22,000	25,000	25,000	24,000	1.07%

Table 5-2: Route 224 VDOT AADT Volume Estimates and Annualized Growth Rates

Route 224	Year					VDOT Growth
	2004	2005	2006	2007	2008	
from TN/VA state line to Route 907	8,200	8,100	8,100	8,300	8,200	0.00%
from Route 907 to US 58/US 421	8,200	8,100	7,900	8,100	8,000	-0.62%

Table 5-3 – US 58/US 421 VDOT AADT Volume Estimates and Annualized Growth Rates

US 58/US 421	Year					VDOT Growth
	2004	2005	2006	2007	2008	
from NCL Weber City to Route 224	11,000	11,000	11,000	11,000	11,000	0.00%
from Route 224 to Route 709	3,000	3,000	3,100	3,100	3,200	1.63%

5.3.3. Kingsport Area Travel Demand Model

The last two data sources used for growth rate development included traffic assignment and socio-economic data from the 2004 Base Year, 2015 Interim, and 2030 Long Range Kingsport Area Regional Travel Demand Models (TDM). Data extracted from these models included pertinent model network files for the 2004 Base Year, 2015 No-Build (without the Moccasin Gap Interchange), 2015 Build (with the Moccasin Gap Interchange), 2030 No-Build (without the Moccasin Gap Interchange), and 2030 Build (with the Moccasin Gap Interchange) along with 2004, 2015, and 2030 TAZ socio-economic data. The use of the Kingsport Area TDM to develop annualized growth rates and associated long-range traffic volume projections is a part of the industry state-of-the-practice methodology. The Kingsport Area TDM provided insight regarding anticipated long-term growth and is a tool used to help identify future network deficiencies and determine network capacity improvements necessary to meet future traffic demands.

The practice of using of the regional travel demand model to extrapolate and establish annualized growth rates is consistent with that process outlined in *NCHRP 255 – Highway Traffic Data for Urbanized Area Project Planning and Design.* The model takes into account existing number of lanes (i.e., from the base year model), future roadway improvements (in the future year model), and anticipated changes in socio-economic data, which translates into trip generation (i.e., traffic volumes), as it relates to growth within the region.

Socio-economic data for 2010 was interpolated from 2004 and 2015 TAZ data to reflect a current or base year condition. The 2010 interpolated socio-economic data served as “starting point” for growth, and when compared to 2015 and 2030 data values, reflected anticipated growth trends for the region.

Table 5-4 reflects growth rates among the socio-economic data categories across several time period intervals. The socio-economic data indicated that a slightly faster rate of growth is expected to occur in the near term between 2004 to 2015 while growth is then expected to slow down and become almost stagnant during the following fifteen-year interval between 2015 and 2030. Total employment is expected to decline almost 1% over the 26-year period, with much of the loss occurring in the non-retail category.

These socio-economic trends indicated an approximate 0.5% to 0.75% traffic growth rate between 2010 and 2015 and then an approximate 0.25% to 0.5% traffic growth rate between 2015 and 2030.

Table 5-4: Traffic Analysis Zone (TAZ) Growth Rates for 2004, 2010, 2015 and 2030

Traffic Analysis Zone (TAZ)	2004 - 2010	2004 - 2015	2010 - 2015	2010 - 2030	2015 - 2030
Population	0.45%	0.44%	0.42%	-0.01%	-0.15%
Households	0.49%	0.47%	0.47%	0.29%	0.23%
Retail Employment	1.76%	1.56%	1.93%	1.83%	1.80%
Non-Retail Emp.	-0.09%	-0.11%	-0.13%	-0.59%	-0.74%
Total Employment	1.10%	0.89%	0.65%	0.34%	0.23%

It should be noted that the Kingsport Area TDM only projects future average daily traffic (ADT) volumes, and does not output peak hour traffic volumes or actual traffic growth rates. Rather, the traffic growth rate must be calculated by comparing model traffic assignments from 2004, 2015 No-Build conditions with 2030 No-Build and Build traffic assignments. Figure 5-3 through Figure 5-6 reflect the traffic assignment results from the various network and analysis year scenarios. This approach also allowed the consultant team to determine when, and to what extent, notable changes in socio-economic characteristics of the region are expected to impact the roadway network. For the Route 224/US 23 Corridor Study, the available 2015 model traffic assignments were closest to the 2010 base year.

Traffic volumes for 2010 were interpolated from the 2004 and 2015 model assignments to reflect a current or base year condition. These interpolated traffic volumes served to validate model assignment results. Additionally, by establishing the 2010 interpolated model traffic assignments as the "starting point" of growth, a comparison was made to both the 2015 and 2030 model traffic volume projections to determine the rate of regional travel growth rate (See Table 5-5). Traffic growth rates were assessed under both the no-build and build network conditions.

Table 5-5: Future Travel Demand Growth Rates Comparison

	2004 - 2010	2010 - 2015 No-Build	2010 - 2015 Build	2010 - 2030 Build	2015 - 2030 Build
Route 224	0.81%	0.77%	1.45%	0.72%	0.42%
US 23	1.07%	1.01%	0.82%	0.93%	1.02%
US 58/421/224	0.99%	0.95%	1.25%	1.68%	1.82%

Traffic volume trends did not directly mirror the patterns observed from the socio-economic data. On Route 224, a moderate increase in traffic volume growth reached approximately 1.5% in 2015 at which point the growth rate decreased to approximately 0.5% between 2010 and 2030. Growth along US 23 stayed relatively flat at approximately 1%. Whereas, US 58/US 421/ Route 224 reflects the highest trend in annual traffic volume growth increasing from approximately 1% between 2004 and 2015 to almost 2% between 2015 and 2030. The notable change along this roadway segment reflected the influence of the proposed Moccasin Gap Interchange on the two build networks.

The socio-economic and annual traffic growth rates from the traffic model were derived using the following equation:

$$g = e^{\left[\frac{(\ln(x) - \ln(y))}{2030\text{-}2011}\right]} - 1$$

Where:

g = average annual growth rate

x = future year value

y = base year value

Z = number of years

e = exponential function, and

ln = natural logarithm function

5.4. Growth Rate Calibration Process and Methodology

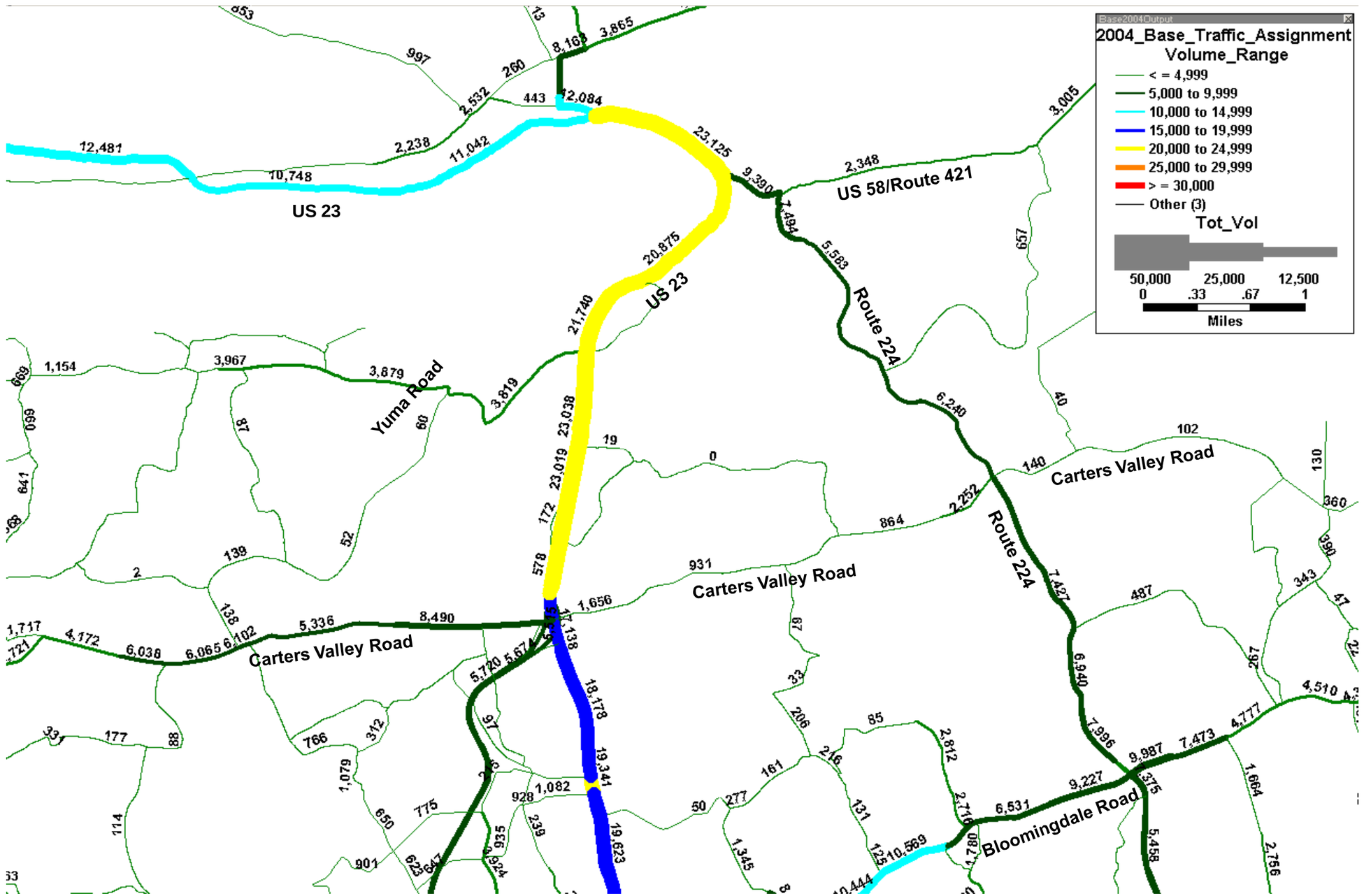
A standard growth rate calibration process was considered so that various data sources were referenced and compared to identify trends and confirm consistency between socio-economic growth and future traffic volume projections. Detailed data sources are provided in Attachment B – Enclosures 1, 2, and 3 of the US 23/Route 224 Corridor Study – Traffic Volume Growth Rate Development Technical Memorandum included in the Appendix of this report.

As previously noted, the 2004, 2015, and 2030 Kingsport Area TDM traffic volumes were used to develop an annualized traffic growth rate. These traffic growth rates were applied to existing 2010 daily and peak hour traffic volumes to develop future traffic volume projections for detailed analysis of the study area corridor. A review of VDOT historic AADT volume data, model related socio-economic data, and traffic volume projections for 2004, 2015, and 2030, resulted in the proposed annualized traffic growth rates presented in Table 5-6. These growth rates provided a conservative approach to developing future traffic volume projections based data evaluations, model findings, and professional judgment.

Table 5-6: Proposed Annualized Traffic Growth Rates

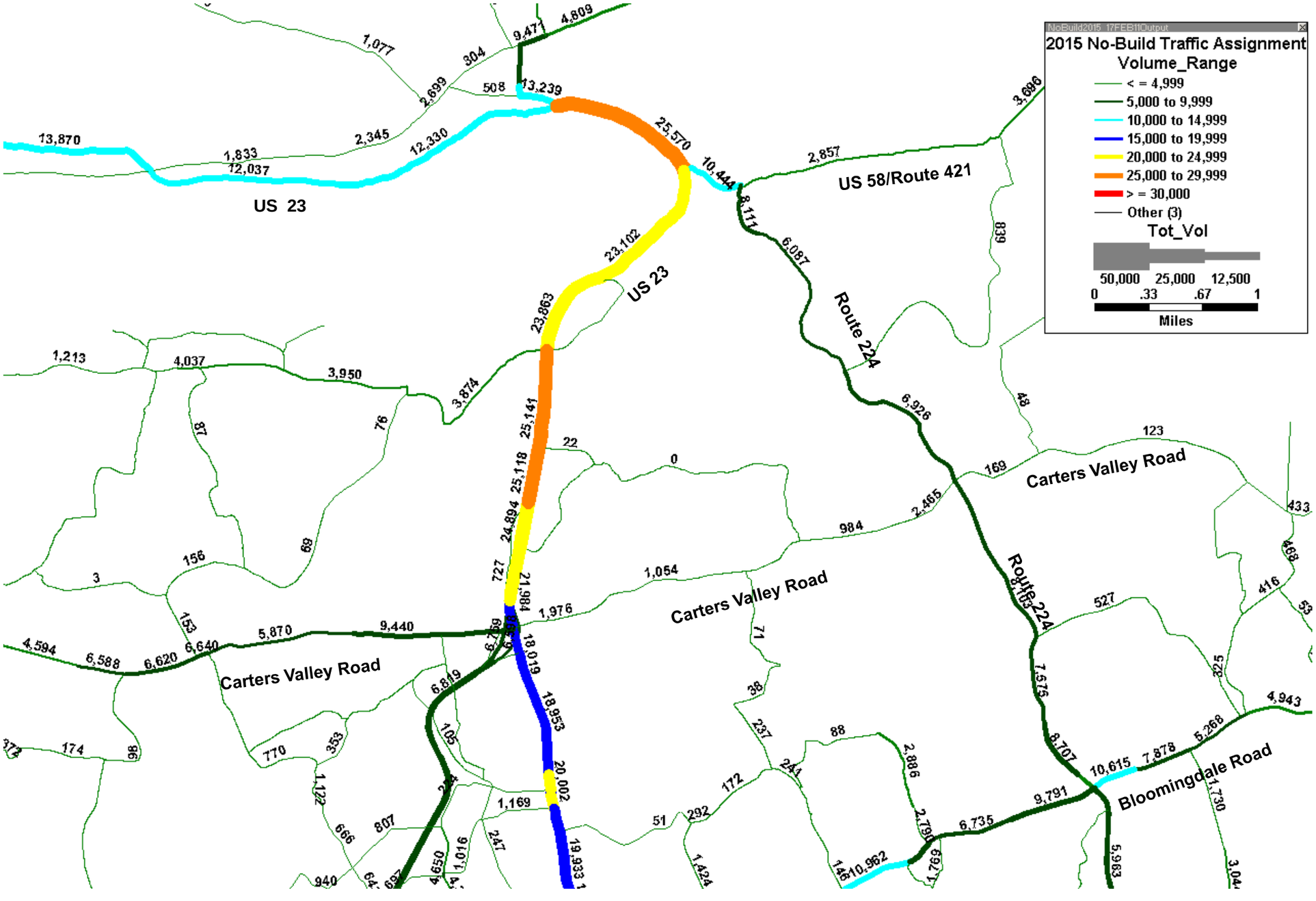
	Route 224	US 23	US 58/421/224
2010-2015	1.0%	1.0%	1.0%
2015-2035	1.25%	1.0%	1.50%

NOT TO SCALE



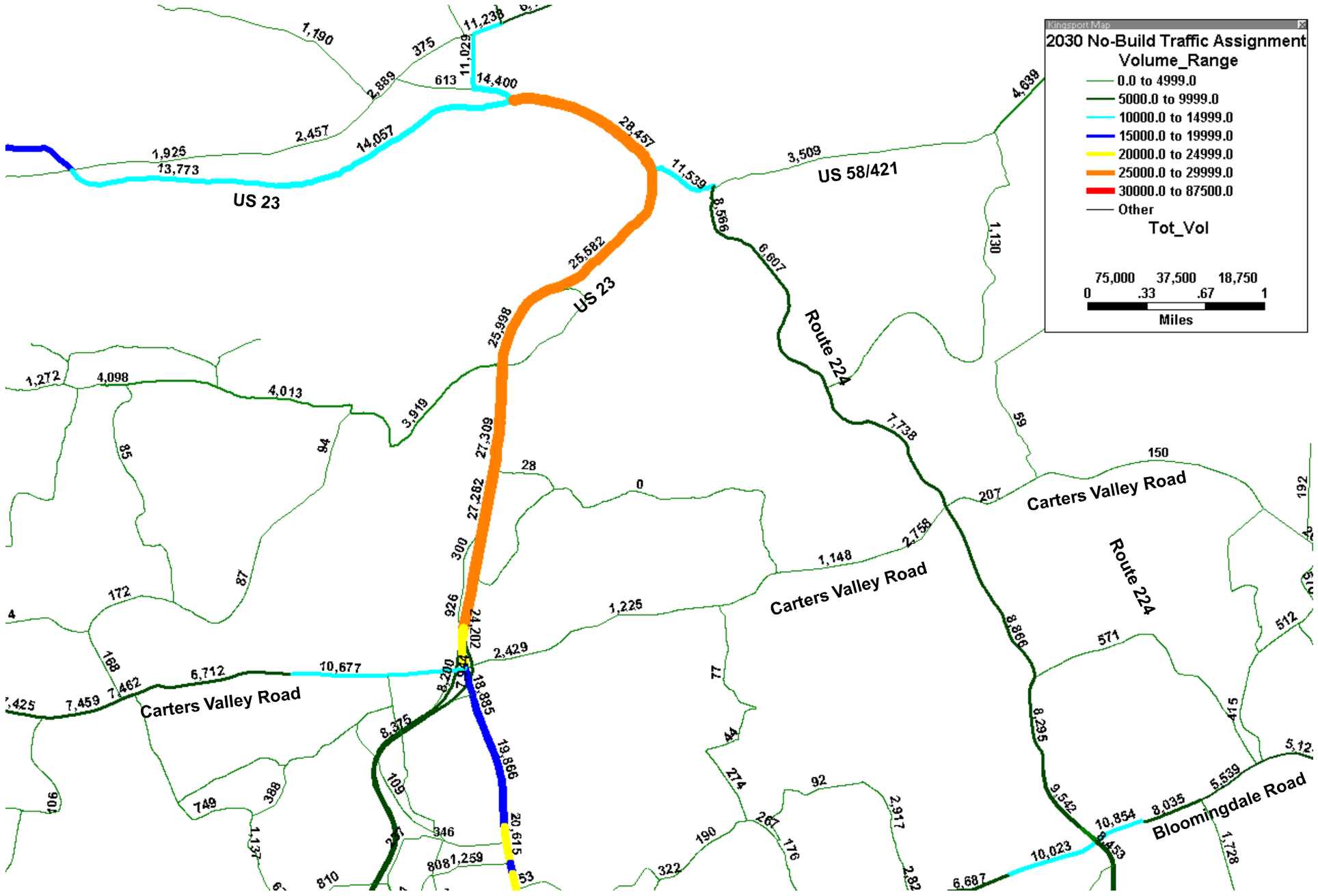
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Kingsport Travel Demand Model 2004 Base Year Traffic Assignment	Figure 5-3

NOT TO SCALE



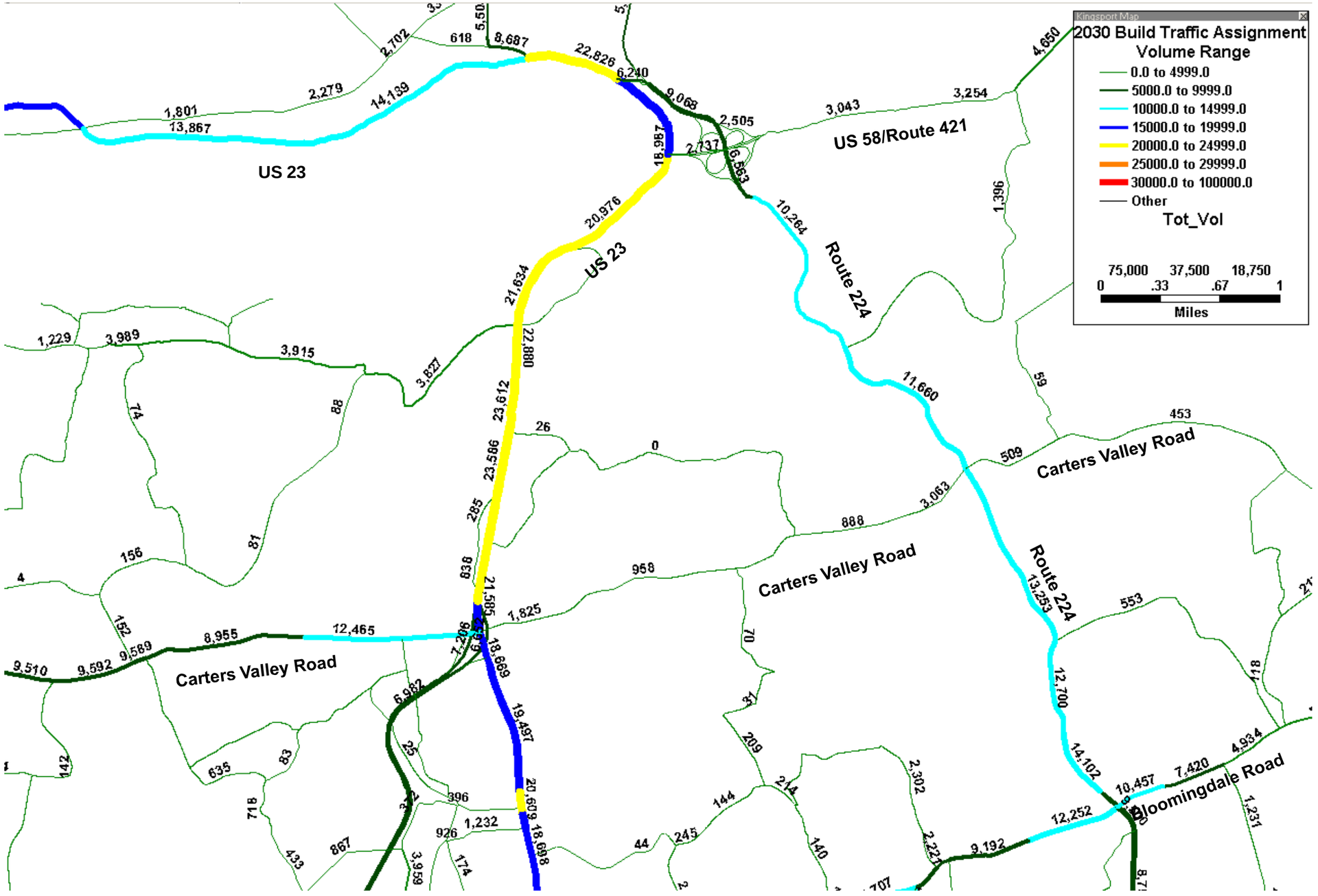
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Kingsport Travel Demand Model 2015 No-Build Traffic Assignment	Figure 5-4

NOT TO SCALE



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Kingsport Travel Demand Model 2030 No-Build Traffic Assignment	Figure 5-5

NOT TO SCALE



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Kingsport Travel Demand Model 2030 Build Traffic Assignment	Figure 5-6

Additionally, to address side street traffic volume projections, it was proposed that an annualized traffic growth rate of 1.0% be applied to existing intersecting/side street peak hour turning movement volumes. This traffic growth rate was also based on data from the regional TDM for the side streets (i.e., secondary roadways) intersecting the primary corridors. Detail secondary roadway traffic assignment data are found in Attachment B – Enclosure 3 of the US 23/Route 224 Corridor Study – Traffic Volume Growth Rate Development Technical Memorandum included in the Appendix.

5.5. Future Traffic Volume Calculation

To develop future traffic volume forecasts, KHA used of the traffic growth rates presented in Tables 5-6, projected exponentially from the base year of 2010 to the interim year of 2015, and then out to the horizon year of 2035. Traffic growth rates calculated in an exponential manner can often over estimate anticipated growth or projections, particularly over longer periods of time (i.e., the higher the growth rate the quicker the base year number will double in its initial value). However, the proposed traffic growth rates for this analysis are suitable for the proposed methodology. Although a linear methodology may ideally address interim fluctuations in the economy or population, the exponential methodology is more conservative in determining how or where traffic volume values may be at the end of a particular time period (e.g., 2010 to 2035) despite changes (i.e., slowdowns, downturns, etc.) in economic growth or development.

The exponential growth rate methodology will reflect a steady yet constant level of growth over the 25-year analysis period. For comparison purposes, the two growth projection methodology equations are shown below using an example 2.5% annual traffic growth rate.

Equation 1: Linear Annual Growth Rate Equation

(((0.025 * (2035-2010)) +1) * 10,000 = *16,250*

16,250 – 10,000 = 6,250/10,000 = 0.625/(2035-2010) = 0.025

Equation 2: Exponential Annual Growth Rate Equation

(1.025 ^ (2035-2010)) = 1.8539 * 10,000 = *18,539*

18,539-10,000=8,539/10,000=0.8539/(2035-2010) = 0.034

(0.34 becomes the average annual growth after compounding 2.5% for 25 years)

The linear equation approach showed that traffic volumes are expected to increase approximately 62.5 percent over the defined 25 year period (2010 to 2035); whereas the exponential equation approach indicated that traffic volumes would increase slightly more than 85 percent during the same time period. In addition to background traffic, specific development-related traffic may also need to be added to the future traffic volume projections associated with the secondary roads intersecting Route 224, US 23, and/or US 58/US 421. Adding development-related trips to the calculated projections for the secondary roadways and then balancing the study area intersections to account for known development would also result in more conservative traffic volume projections.

It was recommended that the traffic growth rates presented in Tables 5-6 be used, which are based on the exponential calculation methodology shown in Equation 2 for the development of the US 23/Route 224 Corridor Study future traffic volume projections.

6. FUTURE CONDITIONS

The US 23/Route 224 Corridor Study included the collection of existing roadway geometry, existing intersection geometry, volume data, crash data, and public input. This information was examined to analyze proposed conditions and recommended improvements.

The proposed modifications and recommended short-term and long-term improvements included in this study are intended to be used as a detailed planning tool by the Kingsport MPO, VDOT, and TDOT. This study is expected to assist these agencies in continuing to manage planned growth along both corridors, quantifying the associated transportation network impacts, creating a comprehensive plan, and strategically implementing the necessary improvements along and adjacent to the Route 224 and US 23 corridors.

6.1. LEVELS OF SERVICE – FUTURE CONDITIONS

Intersection capacity analyses, consistent with the HCM and methodology described in Chapter 4, were performed for the AM and PM peak hours at the following intersections on both corridors:

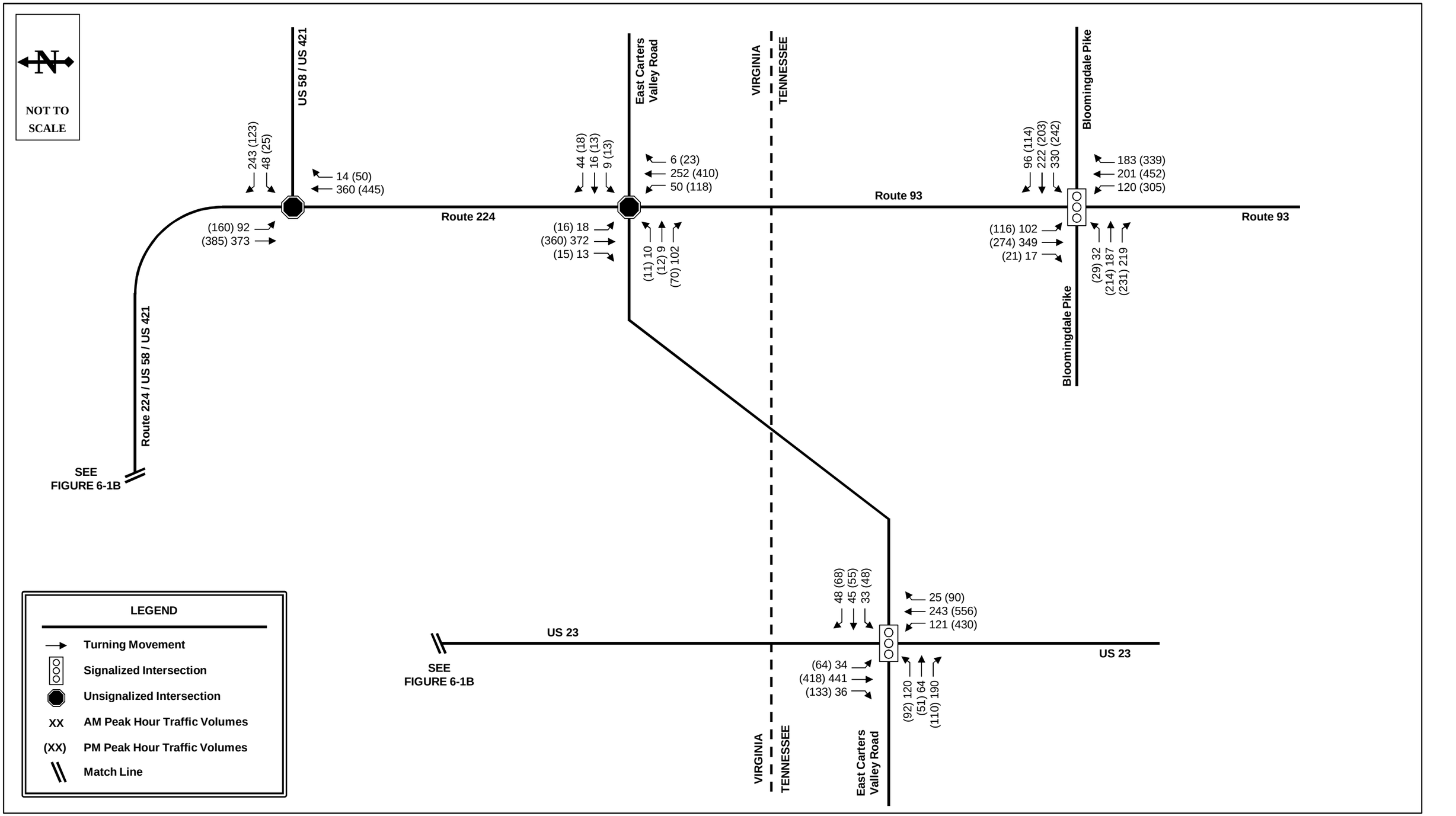
- US 23 at Kane Street (US 23 Business)
- US 23 at US 58/US 421/Route 224
- US 23 at Shopping Center Entrance
- US 23 at Jennings Street
- US 23 at Yuma Road (Route 614)
- US 23 at East Carters Valley Road
- Route 224 at US 58/US 421
- Route 224 at East Carters Valley Road
- SR 93 at Bloomingdale Pike

Analyses were performed for Existing 2010, No-Build 2015, No-Build 2035, and Build 2035 scenarios. To determine some of the short-term impacts to the roadway network, the 2015 no-build network was analyzed. The no-build conditions represent no changes to the roadway network when compared to the existing conditions. No-Build 2015 projected AM and PM peak hour turning movement traffic volumes are provided in Figure 6-1A and Figure 6-1B and No-Build 2015 projected ADT volumes are shown in Figure 6-2. No-Build 2015 intersection LOS results are shown in Figure 6-3A and Figure 6-3B. Table 6-1 summarizes No-Build 2015 intersection LOS and delay (in seconds per vehicle) during both the AM and PM peak hours for each study intersection as well as each of the study intersections' approaches. Intersection level of service calculations are provided in Appendix F.

Table 6-1: Intersection Level of Service Summary – US 23/Route 224 Corridors 2015 No-Build Volumes

	Lane Group	Eastbound				Westbound				Northbound				Southbound				Intersection Overall	
		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak			
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	AM	PM
Route 224/SR 93 at Bloomingdale Pike (signalized)	Left	B	16.6	C	22.1	C	23.7	C	29.3	C	20.0	C	20.5	B	19.6	B	17.0	LOS C 27.5	LOS C 29.4
	Through	C	32.6	D	40.9	D	35.0	D	39.8	C	27.5	C	29.5	C	29.3	C	27.4		
	Right	C	28.8	C	33.4	C	28.1	C	32.6	C	26.6	C	27.1	C	25.7	C	25.0		
	Approach	C	29.5	D	36.1	C	28.2	C	33.8	C	25.4	C	26.2	C	27.0	C	24.4		
Route 224 at E. Carters Valley Road (unsignalized)	Left		-		-		-		-	A	8.3	A	8.6	A	7.9	A	8.4		
	Through	B	14.6	C	19.2	C	15.6	D	28.9		-		-		-		-		
	Right		-		-		-		-		-		-		-		-		
	Approach	B	14.6	C	19.2	C	15.6	D	28.9	A	1.4	A	1.8	A	0.4	A	0.3		
Route 224 at US 58/US 421 (unsignalized)	Left		-		-	C	24.6	E	35.4		-		-	A	8.5	A	9.3		
	Through		-		-		-		-		-		-		-		-		
	Right		-		-	B	14.6	B	13.6		-		-		-		-		
	Approach		-		-	C	16.2	C	17.3		-		-	A	1.7	A	2.7		
US 23 at Kane Street (signalized)	Left	D	36.5	D	48.4	D	43.3	D	41.3		-		-	C	24.1	C	28.2	LOS B 17.6	LOS C 21.5
	Through	C	24.0	C	29.5	C	27.1	C	25.9	D	38.5	D	43.7	C	23.7	C	27.9		
	Right	C	20.7	C	24.6	A	1.5	A	1.2	D	36.0	D	35.8	B	15.2	B	19.9		
	Approach	C	25.4	C	30.1	A	9.5	B	12.8	D	37.5	D	41.4	C	23.7	C	27.7		
US 23 at US 58/US 421 (signalized)	Left		-		-	C	30.4	C	32.9		-		-	C	31.4	C	33.8	LOS B 18.9	LOS C 20.3
	Through		-		-		-		-	C	21.7	C	22.2	A	7.1	A	6.1		
	Right		-		-	C	26.7	C	29.1	B	15.5	B	15.2		-		-		
	Approach		-		-	C	27.8	C	30.1	C	21.0	C	21.1	B	13.8	B	15.0		
US 23 at Shopping Center Entrance (signalized)	Left		-		-	C	25.0	C	33.5		-		-	C	27.6	C	33.6	LOS A 7.9	LOS B 19.5
	Through		-		-		-		-	A	9.6	C	23.7	A	4.2	A	8.0		
	Right		-		-		-		-	A	6.9	B	16.4		-		-		
	Approach		-		-	C	25.0	C	33.5	A	9.5	C	22.6	A	5.2	B	11.4		
US 23 at Jennings Street (signalized)	Left		-		-	C	28.0	C	30.7		-		-	C	33.0	D	53.1	LOS B 15.8	LOS A 7.9
	Through		-		-		-		-	B	19.5	A	8.9	A	7.9	A	4.1		
	Right		-		-		-		-		-		-		-		-		
	Approach		-		-	C	28.0	C	30.7	B	19.5	A	8.9	A	10.0	A	5.1		
US 23 at Route 614 (signalized)	Left		-		-		-		-	D	38.4	D	46.5	C	30.7	C	33.0	LOS C 22.1	LOS C 27.0
	Through	D	40.1	C	34.6	D	39.5	D	38.3	C	20.3	C	24.4	B	17.1	C	22.7		
	Right	C	27.8	C	31.1		-		-		-		-		-		-		
	Approach	D	35.6	C	33.3	D	39.5	D	38.3	C	21.2	C	27.9	B	17.4	C	23.2		
US 23 at E. Carters Valley Road (signalized)	Left	B	17.3	C	21.9	B	15.4	C	20.2	A	6.7	B	11.1	B	13.3	B	18.4	LOS B 13.1	LOS B 13.3
	Through	B	17.0	C	20.4	B	15.3	C	20.3	A	6.0	A	5.4	B	15.1	B	18.7		
	Right		-		-		-		-	A	5.6	A	4.6	B	12.8	B	16.2		
	Approach	B	17.1	C	21.0	B	15.3	C	20.3	A	6.2	A	7.6	B	14.8	B	18.1		

NOT TO SCALE



LEGEND

- Turning Movement
- Signalized Intersection
- Unsignalized Intersection
- XX — AM Peak Hour Traffic Volumes
- (XX) — PM Peak Hour Traffic Volumes
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2015 Traffic Volumes (1 of 2)

Figure 6-1A

NOT TO SCALE

SEE FIGURE 6-1A

Route 224 / US 58 / US 421

363 (382)
153 (141)

110 (188)
832 (957)

(365) 350
(768) 918

Shopping Center Entrance

51 (184)
34 (108)

33 (174)
889 (975)

(124) 45
(824) 1,021

Jennings Street

40 (22)
138 (34)

106 (15)
776 (995)

(16) 74
(798) 844

2 (28)
5 (26)
25 (60)

19 (43)
658 (854)
38 (166)

(43) 23
(681) 827
(130) 80

(93) 209
(13) 4
(61) 122

US 23

SEE FIGURE 6-1A

Yuma Road (Route 614)

821 (739)
332 (530)
20 (58)

17 (41)
22 (75)
3 (28)

Kane Street

(598) 781
(59) 26
(29) 17

(20) 56
(475) 412
(17) 12

US 23

LEGEND

- Turning Movement
- Signalized Intersection
- Unsignalized Intersection
- XX — AM Peak Hour Traffic Volumes
- (XX) — PM Peak Hour Traffic Volumes
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2015 Traffic Volumes (2 of 2)

Figure 6-1B

NOT TO SCALE

US 58 / US 421

Route 614

East Carters Valley Road

VIRGINIA

TENNESSEE

Bloomingdale Pike

Route 93

9,500
11%

Route 224

8,400
11%

10,700
37%

11,500
7%

13,100
11%

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

28,400
7%

23,400
7%

US 23

21,700
31%

22,800
21%

US 23

Yuma Road (Route 614)

East Carters Valley Road

Kane Street

US 23

VIRGINIA

TENNESSEE

LEGEND

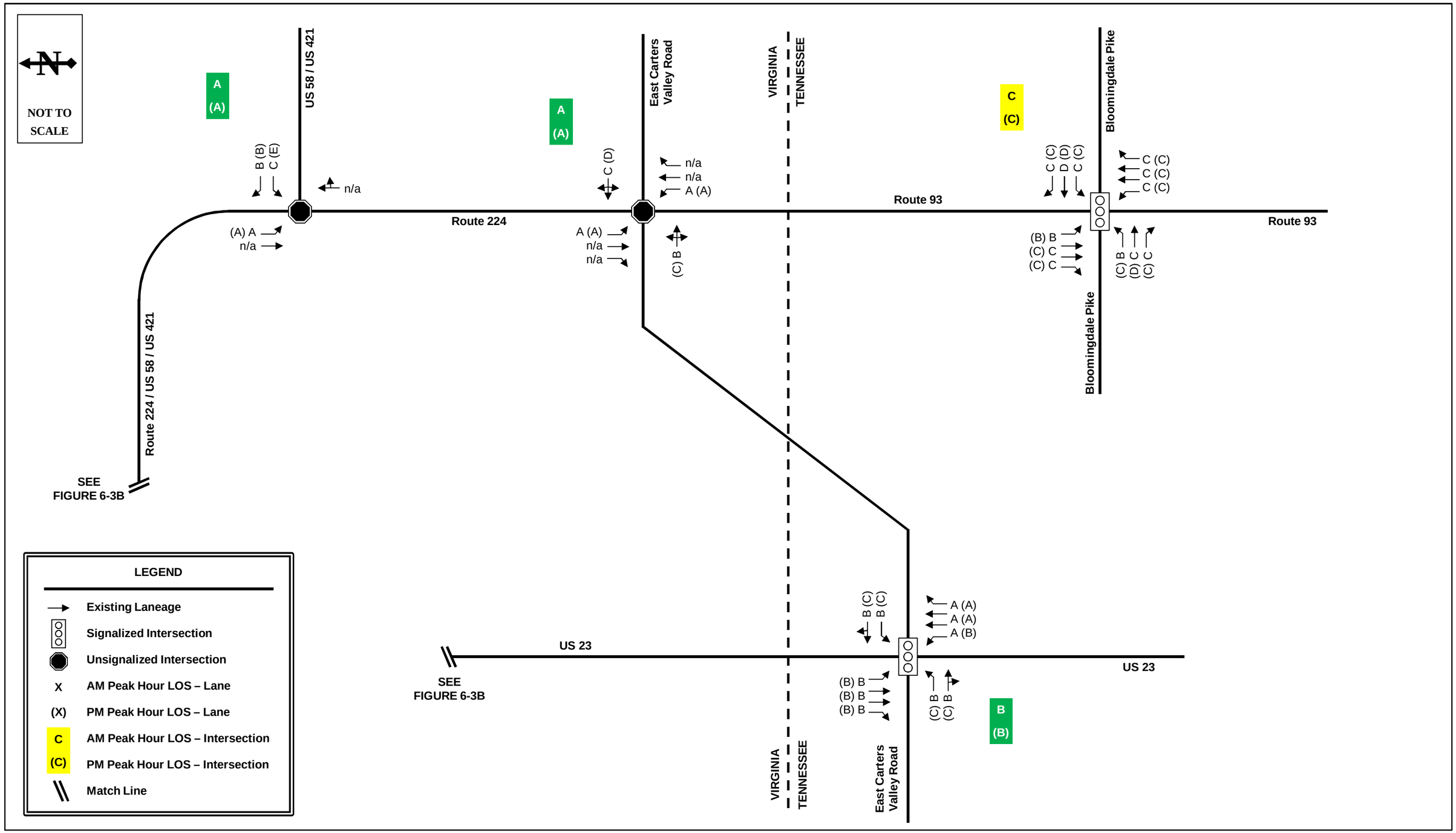
- Travel Direction
- Signalized Intersection
- Unsignalized Intersection
- X,XXX / XX% — Average Daily Traffic (ADT) / Heavy Vehicle %

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2015 Average Daily Traffic (ADT)

Figure 6-2



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	No-Build 2015 Intersection LOS (1 of 2)	Figure 6-3A

NOT TO SCALE

SEE FIGURE 6-3A

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

B (C)

A (B)

B (A)

C (C)

C (C) C (C)

B (B)
C (C)

C (C)

A (B)
A (C)

C (C)

B (A)

D (D)

C (C)
D (D)

(C) C
(A) A

(C) C
(A) A

(D) C
(A) A

(C) C
(C) B

(C) D
(C) C

US 23

SEE FIGURE 6-3A

Yuma Road (Route 614)

B (C)

A (A) C (C) D (D)

D (D)
D (D)

Kane Street

(C) C
(C) C
(B) B

D (D) C (C) C (C)

US 23

LEGEND

- Existing Laneage
- Signalized Intersection
- Unsignalized Intersection
- X — AM Peak Hour LOS – Lane
- (X) — PM Peak Hour LOS – Lane
- C — AM Peak Hour LOS – Intersection
- (C) — PM Peak Hour LOS – Intersection
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2015 Intersection LOS (2 of 2)

Figure 6-3B

No-Build 2035 conditions represent the construction of a new roadway that intersects US 23 just south of Kane Street, creates a vehicular overpass above the railroad, intersects US 58/US 421 and continues south along existing alignment of Route 224 as part of Phase II of the Moccasin Gap project. No-Build 2035 projected AM and PM peak hour turning movement traffic volumes are provided in Figure 6-4A and Figure 6-4B and No-Build 2035 projected ADT volumes are shown in Figure 6-5. No-Build 2035 intersection LOS results are shown in Figure 6-6A and Figure 6-6B. Table 6-2 summarizes No-Build 2035 intersection LOS and delay (in seconds) during both the AM and PM peak hours for each study intersection.

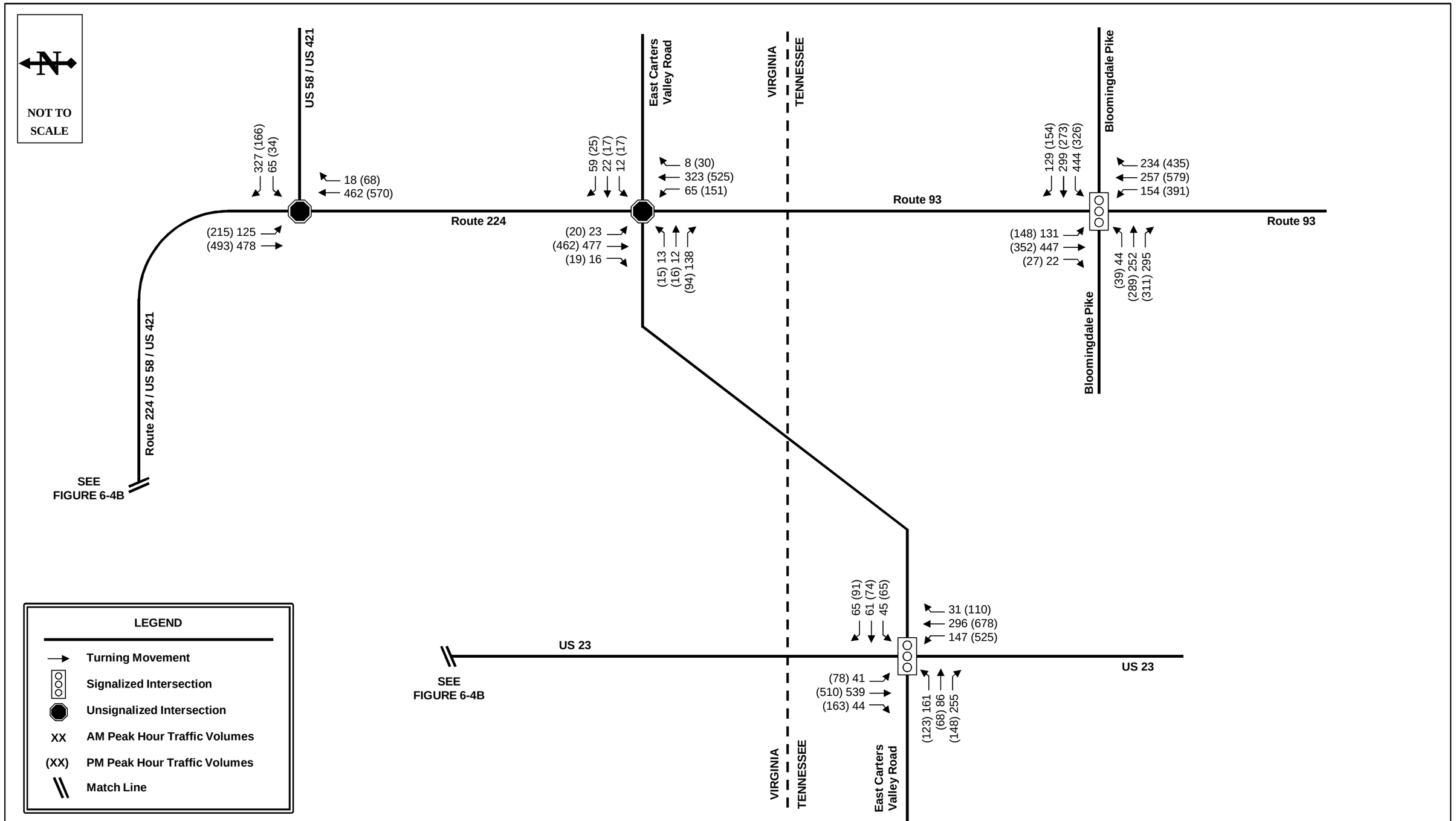
Table 6-2: Intersection Level of Service Summary – US 23/Route 224 Corridors 2035 No-Build Volumes

	Lane Group	Eastbound				Westbound				Northbound				Southbound				Intersection Overall	
		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak			
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	AM	PM
Route 224/SR 93 at Bloomingdale Pike (signalized)	Left	B	18.8	C	25.8	F	81.3	F	94.3	C	22.1	C	32.3	C	21.2	B	19.5	LOS D 39.8	LOS D 42.6
	Through	D	37.6	E	60.3	D	42.9	E	55.3	C	29.6	C	33.5	C	32.1	C	30.3		
	Right	C	31.0	D	38.8	C	29.9	D	37.7	C	28.5	C	30.1	C	27.2	C	27.0		
	Approach	C	32.9	D	47.7	E	60.6	E	68.6	C	27.4	C	32.1	C	29.6	C	27.1		
Route 224 at E. Carters Valley Road (unsignalized)	Left		-		-		-		-	A	8.8	A	9.2	A	8.1	A	8.8		
	Through	C	21.6	E	42.7	C	24.6	F	78.7		-		-		-		-		
	Right		-		-		-		-		-		-		-		-		
	Approach	C	21.6	E	42.7	C	24.6	F	78.7	A	1.4	A	2.0	A	0.4	A	0.4		
Route 224 at US 58/US 421 (unsignalized)	Left		-		-	F	51.0	F	95.3		-		-	A	9.0	B	10.5		
	Through		-		-		-		-		-		-		-		-		
	Right		-		-	C	23.0	C	18.1		-		-		-		-		
	Approach		-		-	D	27.7	D	31.3		-		-	A	1.9	A	3.2		
US 23 at Kane Street (signalized)	Left	D	47.9	D	53.3	D	48.5	D	53.5		-		-	C	29.6	D	39.6	LOS C 23.4	LOS C 29.4
	Through	D	35.1	D	40.0	D	36.8	D	36.5	D	45.4	D	51.3	C	28.9	D	39.1		
	Right	C	27.9	C	30.0	A	3.1	A	2.2	D	42.8	D	40.9	B	15.7	C	22.9		
	Approach	D	36.4	D	40.2	B	13.4	B	18.1	D	44.3	D	48.4	C	29.0	D	38.7		
US 23 at US 58/US 421 (signalized)	Left		-		-	D	36.3	D	36.8		-		-	D	38.5	D	40.2	LOS C 23.6	LOS C 26.5
	Through		-		-		-		-	C	28.6	C	34.2	A	8.7	A	7.5		
	Right		-		-	C	30.4	C	31.7	B	17.8	B	18.2		-		-		
	Approach		-		-	C	32.2	C	33.1	C	27.3	C	31.4	B	17.2	B	18.4		
US 23 at Shopping Center Entrance (signalized)	Left		-		-	C	28.1	D	47.7		-		-	C	34.0	D	43.0	LOS A 9.8	LOS C 29.2
	Through		-		-		-		-	B	11.6	D	38.4	A	5.6	B	11.0		
	Right		-		-		-		-	A	7.4	B	20.0		-		-		
	Approach		-		-	C	28.1	D	47.7	B	11.5	D	35.6	A	6.8	B	15.2		
US 23 at Jennings Street (signalized)	Left		-		-	D	36.8	C	33.9		-		-	D	41.6	E	78.0	LOS B 19.5	LOS A 9.0
	Through		-		-		-		-	C	23.4	B	10.1	A	9.5	A	4.4		
	Right		-		-		-		-		-		-		-		-		
	Approach		-		-	D	36.8	C	33.9	C	23.4	B	10.1	B	12.0	A	5.8		
US 23 at Route 614 (signalized)	Left		-		-		-		-	D	42.8	F	113.9	C	34.5	D	39.4	LOS C 29.2	LOS D 36.4
	Through	F	83.1	D	43.4	D	44.3	E	62.2	C	21.5	C	27.9	B	19.6	C	24.9		
	Right	C	30.0	C	34.4		-		-		-		-		-		-		
	Approach	E	63.8	D	40.1	D	44.3	E	62.2	C	22.6	D	41.3	B	20.0	C	25.7		
US 23 at E. Carters Valley Road (signalized)	Left	C	21.4	C	25.9	B	18.9	C	23.6	A	8.2	D	35.6	B	15.9	C	22.1	LOS B 16.5	LOS C 20.2
	Through	C	22.7	C	23.9	B	17.6	C	23.3	A	6.9	A	6.5	B	18.9	C	21.9		
	Right		-		-		-		-	A	6.3	A	5.4	B	15.1	B	18.3		
	Approach	C	22.3	C	24.6	B	18.0	C	23.4	A	7.3	B	18.0	B	18.4	C	21.2		

Build 2035 conditions represent the construction of a new roadway that intersects US 23 just south of Kane Street, creates a vehicular overpass above the railroad, intersects US 58/US 421, and continues south along existing alignment of Route 224 as part of the Phase II Moccasin Gap project. Build 2035 projected AM and PM peak hour turning movement traffic volumes are provided in Figure 6-7A and Figure 6-7B and Build 2035 projected ADT volumes are shown in Figure 6-8. Build 2035 intersection LOS results are shown in Figure 6-9A and Figure 6-9B. Table 6-3 summarizes Build 2035 intersection LOS and delay (in seconds) during both the AM and PM peak hours for each study intersection.

Table 6-3: Intersection Level of Service Summary – US 23 / Route 224 Corridors 2035 Build Volumes

	Lane Group	Eastbound				Westbound				Northbound				Southbound				Intersection Overall	
		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak			
		LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	Delay	AM	PM
Route 224/SR 93 at Bloomingdale Pike (signalized)	Left	B	18.8	C	25.8	F	81.3	F	94.3	C	22.1	C	32.3	C	21.2	B	19.5	LOS D 39.8	LOS D 42.6
	Through	D	37.6	E	60.3	D	42.9	E	55.3	C	29.6	C	33.5	C	32.1	C	30.3		
	Right	C	31.0	D	38.8	C	29.9	D	37.7	C	28.5	C	30.1	C	27.2	C	27.0		
	Approach	C	32.9	D	47.7	E	60.6	E	68.6	C	27.4	C	32.1	C	29.6	C	27.1		
Route 224 at E. Carters Valley Road (unsignalized)	Left		-		-		-		-	A	8.8	A	9.2	A	8.1	A	8.8		
	Through	C	21.6	E	42.7	C	24.6	F	78.7		-		-		-		-		
	Right		-		-		-		-		-		-		-		-		
	Approach	C	21.6	E	42.7	C	24.6	F	78.7	A	1.4	A	2.0	A	0.4	A	0.4		
Route 224 at US 58/US 421 (unsignalized)	Left		-		-		-		-		-		-		-		-		
	Through		-		-		-		-		-		-		-		-		
	Right		-		-		-		-		-		-		-		-		
	Approach		-		-		-		-		-		-		-		-		
US 23 at Kane Street (signalized)	Left	D	47.9	D	53.3	D	48.5	D	53.5		-		-	C	29.6	D	39.6	LOS C 23.4	LOS C 29.4
	Through	D	35.1	D	40.0	D	36.8	D	36.5	D	45.4	D	51.3	C	28.9	D	39.1		
	Right	C	27.9	C	30.0	A	3.1	A	2.2	D	42.8	D	40.9	B	15.7	C	22.9		
	Approach	D	36.4	D	40.2	B	13.4	B	18.1	D	44.3	D	48.4	C	29.0	D	38.7		
US 23 at US 58/US 421 (signalized)	Left		-		-	C	26.7	C	29.8		-		-	D	38.9	D	40.2	LOS B 12.2	LOS B 11.7
	Through		-		-		-		-	B	13.0	B	12.9	A	8.9	A	7.1		
	Right		-		-	C	21.2	C	23.7	A	8.9	A	8.5		-		-		
	Approach		-		-	C	26.4	C	29.5	B	12.5	B	12.1	A	9.3	A	7.6		
US 23 at Shopping Center Entrance (signalized)	Left		-		-	C	28.1	D	47.7		-		-	C	34.0	D	43.0	LOS A 9.8	LOS C 29.2
	Through		-		-		-		-	B	11.6	D	38.4	A	5.6	B	11.0		
	Right		-		-		-		-	A	7.4	B	20.0		-		-		
	Approach		-		-	C	28.1	D	47.7	B	11.5	D	35.6	A	6.8	B	15.2		
US 23 at Jennings Street (signalized)	Left		-		-	D	36.8	C	33.9		-		-	D	41.6	E	78.0	LOS B 19.5	LOS A 9.0
	Through		-		-		-		-	C	23.4	B	10.1	A	9.5	A	4.4		
	Right		-		-		-		-		-		-		-		-		
	Approach		-		-	D	36.8	C	33.9	C	23.4	B	10.1	B	12.0	A	5.8		
US 23 at Route 614 (signalized)	Left		-		-		-		-	D	42.8	F	113.9	C	34.5	D	39.4	LOS C 29.2	LOS D 36.4
	Through	F	83.1	D	43.4	D	44.3	E	62.2	C	21.5	C	27.9	B	19.6	C	24.9		
	Right	C	30.0	C	34.4		-		-		-		-		-		-		
	Approach	E	63.8	D	40.1	D	44.3	E	62.2	C	22.6	D	41.3	B	20.0	C	25.7		
US 23 at E. Carters Valley Road (signalized)	Left	C	21.4	C	25.9	B	18.9	C	23.6	A	8.2	D	35.6	B	15.9	C	22.1	LOS B 16.5	LOS C 20.2
	Through	C	22.7	C	23.9	B	17.6	C	23.3	A	6.9	A	6.5	B	18.9	C	21.9		
	Right		-		-		-		-	A	6.3	A	5.4	B	15.1	B	18.3		
	Approach	C	22.3	C	24.6	B	18.0	C	23.4	A	7.3	B	18.0	B	18.4	C	21.2		



Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2035 Traffic Volumes (1 of 2)

Figure 6-4A

NOT TO SCALE

SEE FIGURE 6-4A

Route 224 / US 58 / US 421

465 (489)
197 (181)

141 (241)
1,016 (1,168)

(468) 449
(937) 1,120

68 (248)
46 (145)

Shopping Center Entrance

40 (213)
1,085 (1,190)

(151) 55
(1,005) 1,245

54 (29)
186 (46)

Jennings Street

130 (18)
946 (1,214)

(19) 90
(973) 1,030

3 (38)
7 (35)
33 (81)

23 (53)
803 (1,043)
46 (203)

(53) 28
(831) 1,009
(159) 97

US 23

SEE FIGURE 6-4A

(125) 281
(17) 6
(83) 164

Yuma Road (Route 614)

1,052 (947)
426 (679)
26 (74)

23 (55)
29 (102)
4 (38)

Kane Street

(767) 1,001
(80) 35
(39) 23

(26) 71
(609) 528
(22) 15

US 23

LEGEND

- Turning Movement
- Signalized Intersection
- Unsignalized Intersection
- XX — AM Peak Hour Traffic Volumes
- (XX) — PM Peak Hour Traffic Volumes
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2035 Traffic Volumes (2 of 2)

Figure 6-4B

NOT TO SCALE

US 58 / US 421

Route 614

Route 224

East Carters Valley Road

VIRGINIA

TENNESSEE

Bloomingdale Pike

Route 93

12,200
11%

10,800
11%

13,700
37%

13,700
7%

17,600
11%

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

US 23

34,700
7%

28,600
7%

26,500
31%

27,800
21%

Yuma Road (Route 614)

East Carters Valley Road

US 23

Kane Street

US 23

VIRGINIA

TENNESSEE

LEGEND

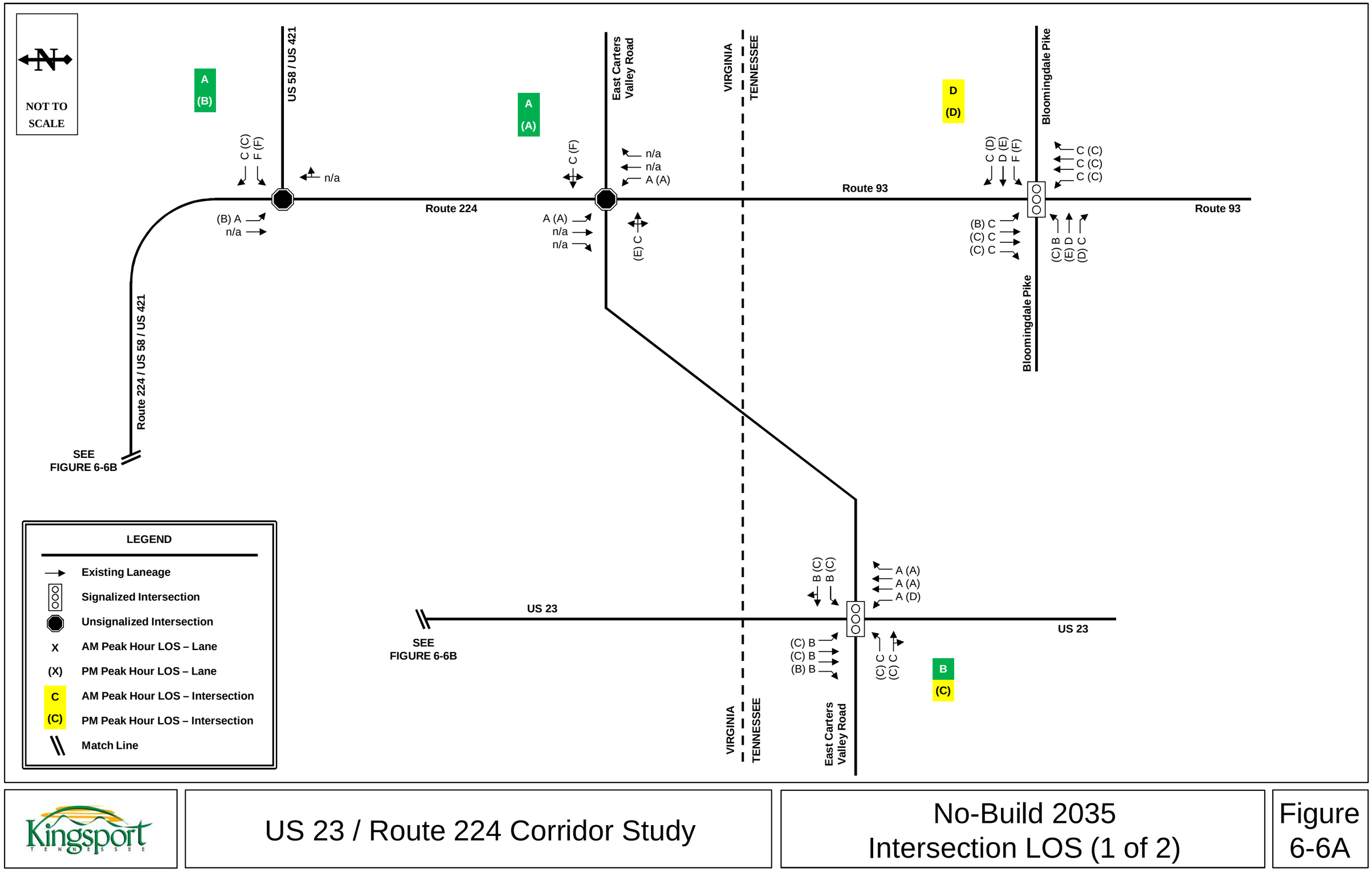
- Travel Direction
- Signalized Intersection
- Unsignalized Intersection
- X,XXX / XX% — Average Daily Traffic (ADT) / Heavy Vehicle %

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2035 Average Daily Traffic (ADT)

Figure 6-5



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	No-Build 2035 Intersection LOS (1 of 2)	Figure 6-6A

NOT TO SCALE

SEE FIGURE 6-6A

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

US 23

SEE FIGURE 6-6A

Yuma Road (Route 614)

Kane Street

US 23

C (C)

A (C)

B (A)

C (D)

C (C)

(D) C
(D) C
(C) B

D (D)
D (D)

(A) D
D D

D D C
(D) (D) (C)

C (C)
D (D)

B (B)
C (C)

(D) D
(A) A

A (B)
B (D)

(D) C
(B) A

C (B)

D (C)

(E) D
(A) A

D (E)

(D) C
(C) B

C (C)
D (F)

(D) F
(C) C

LEGEND

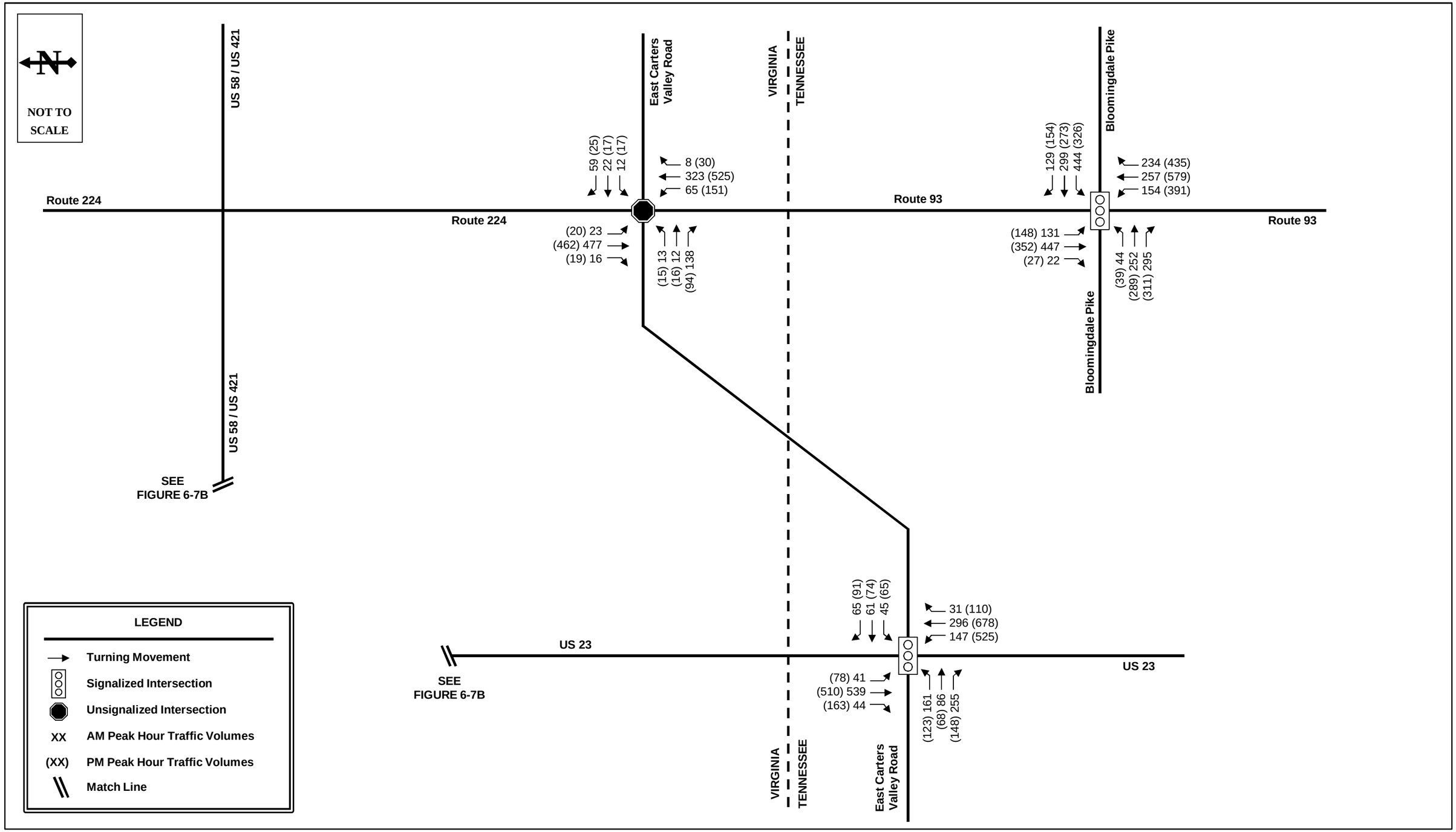
- Existing Laneage
- Signalized Intersection
- Unsignalized Intersection
- X — AM Peak Hour LOS – Lane
- (X) — PM Peak Hour LOS – Lane
- C — AM Peak Hour LOS – Intersection
- (C) — PM Peak Hour LOS – Intersection
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2035 Intersection LOS (2 of 2)

Figure 6-6B



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Build 2035 Traffic Volumes (1 of 2)	Figure 6-7A

NOT TO SCALE

SEE FIGURE 6-7A

US 58 / US 421

Route 224

10 (10)
197 (181)

141 (241)
1,016 (1,168)

(15) 15
(937) 1,120

68 (248)
46 (145)

Shopping Center Entrance

40 (213)
1,085 (1,190)

(151) 55
(1,005) 1,245

54 (29)
186 (46)

Jennings Street

130 (18)
946 (1,214)

(19) 90
(973) 1,030

3 (38)
7 (35)
33 (81)

23 (53)
803 (1,043)
46 (203)

(53) 28
(831) 1,009
(159) 97

(125) 281
(17) 6
(83) 164

US 23

SEE FIGURE 6-7A

Yuma Road (Route 614)

1,052 (947)
426 (679)
26 (74)

23 (55)
29 (102)
4 (38)

Kane Street

(767) 1,001
(80) 35
(39) 23

(26) 71
(609) 528
(22) 15

US 23

LEGEND

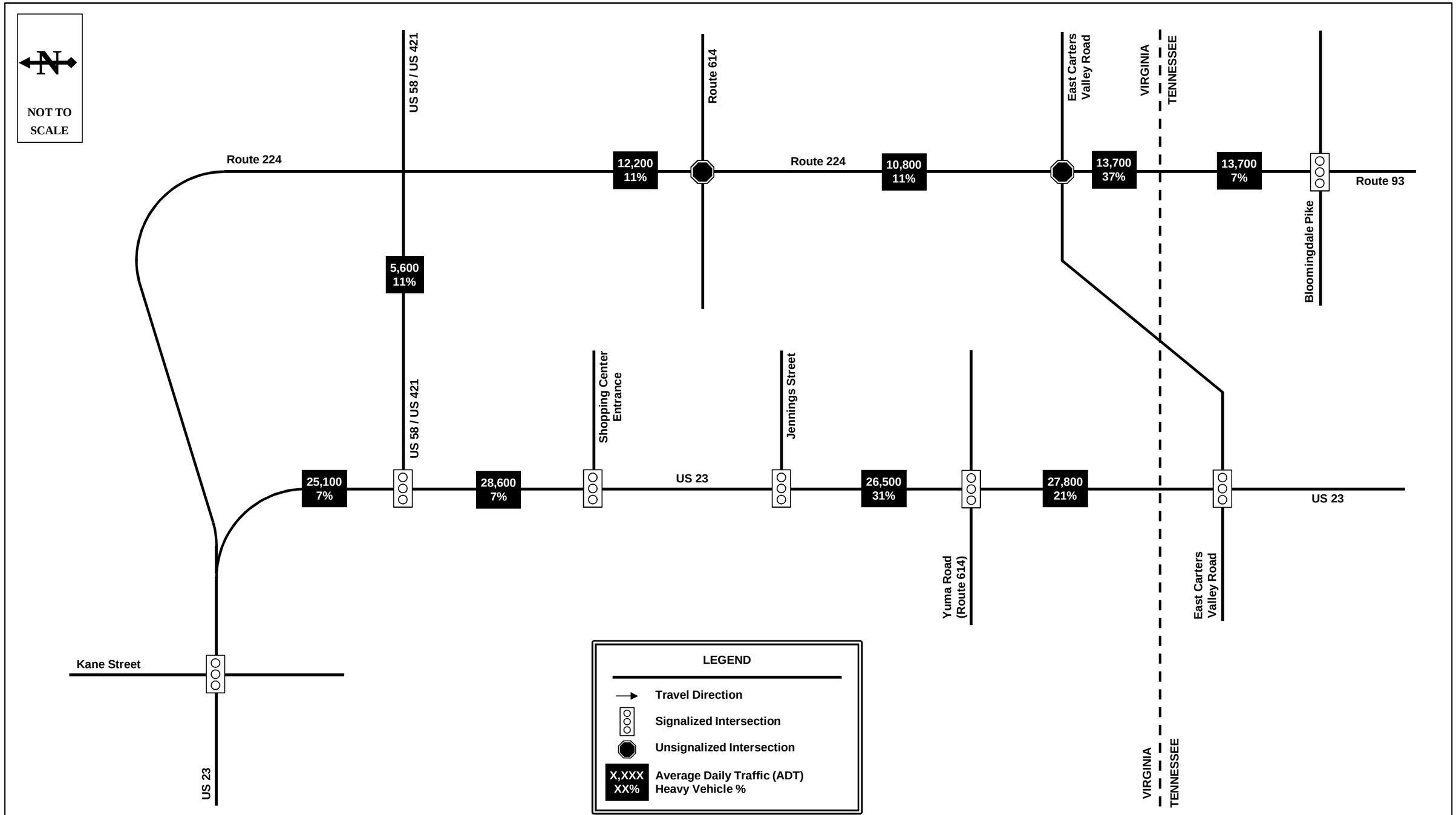
- Turning Movement
- Signalized Intersection
- Unsignalized Intersection
- XX — AM Peak Hour Traffic Volumes
- (XX) — PM Peak Hour Traffic Volumes
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Build 2035 Traffic Volumes (2 of 2)

Figure 6-7B

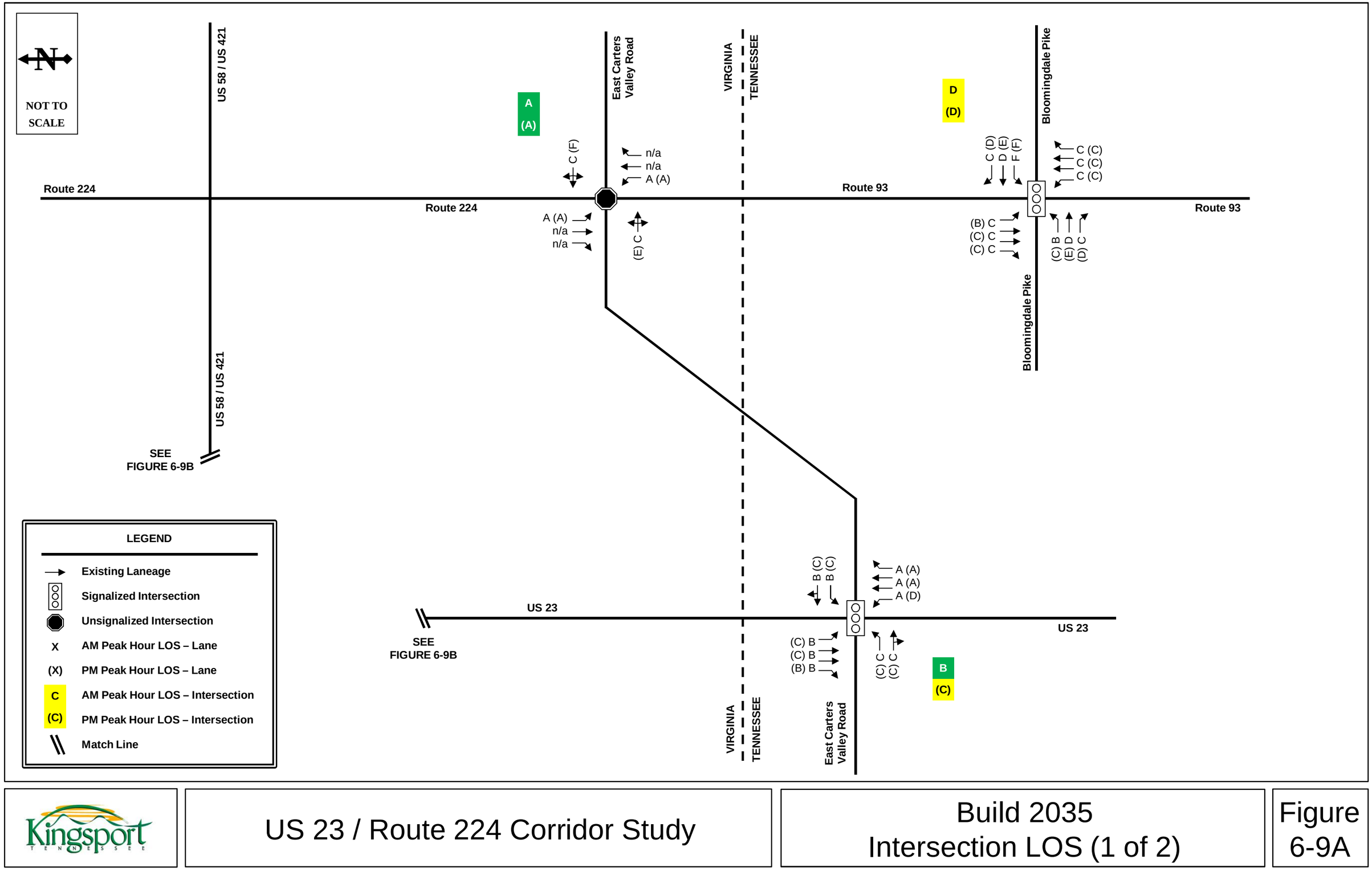


Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Build 2035 Average Daily Traffic (ADT)

Figure 6-8



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Build 2035 Intersection LOS (1 of 2)	Figure 6-9A

NOT TO SCALE

SEE FIGURE 6-9A

US 58 / US 421

Route 224

B (B)

C (C)
C (C)
(D) D
(A) A

A (A)
B (B)

A (C)

C (D)
(D) C
(B) A

Shopping Center Entrance

A (B)
B (D)

B (A)

D (C)
(E) D
(A) A

Jennings Street

C (B)

C (D)

D (E)
(D) C
(C) B

C (C)
D (F)
(D) F
(C) C

US 23

SEE FIGURE 6-9A

Yuma Road (Route 614)

C (C)

(A) A
(D) D
(D) D

D (D)
D (D)

Kane Street

(D) C
(D) C
(C) B

D (D)
D (D)
C (C)

US 23

LEGEND

- Existing Laneage
- Signalized Intersection
- Unsignalized Intersection
- X — AM Peak Hour LOS – Lane
- (X) — PM Peak Hour LOS – Lane
- C — AM Peak Hour LOS – Intersection
- (C) — PM Peak Hour LOS – Intersection
- Match Line

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Build 2035 Intersection LOS (2 of 2)

Figure 6-9B

The traffic analysis tool used for the existing conditions analysis, Highway Capacity Software (HCS), was used to analyze the future year arterial levels of service for the suburban and rural portions of the corridor. For two-lane highways, level of service is defined in terms of percent time-spent following (the average percent of total travel time that vehicles must travel in platoons behind slower vehicles due to the inability to pass on a two-lane highway) and average travel speed. The HCM defines two classes of two-lane highways based on driver expectations, functional classification, length of trip (long or short), purpose of trip (commuting or sight-seeing/recreational) and connectivity with other facilities. The following links were analyzed:

US 23

- Multi-lane: between US 58/US 421/Route 224 and Kane Street (US 23 Business)
- Multi-lane: between Jennings Street and US 58/US 421/Route 224
- Multi-lane: between Route 614 and Jennings Street
- Multi-lane: between East Carters Valley Road and Route 614

Route 224

- Two-lane: between US 23 and US 58/US 421
- Two-lane: between US 58/US 421 and Route 614
- Two-lane: between Route 614 and East Carters Valley Road
- Two-lane: between East Carters Valley Road and Virginia/Tennessee state line
- Multi-lane: between Virginia/Tennessee state line and Bloomingdale Pike

Capacity analyses were conducted for Existing 2010, No-Build 2015, No-Build 2035, and Build 2035 scenarios. Arterial link LOS results are shown in Figure 6-10 through Figure 6-12. Table 6-4 summarizes the arterial link LOS and delay (in seconds) for all of the scenarios listed above.

Long range plans for Route 224 may include the widening of the existing facility from 2-lane undivided to a 4-lane divided facility with a median. An alternative link analysis was performed assuming Route 224/SR 93 was a 4-lane facility between US 23 and Bloomingdale Pike. Capacity analyses were also conducted to determine how Route 224 would operate with four lanes in the Build 2035 scenario. These results are summarized in Table 6-5.

Table 6-4: Arterial Link Level of Service Summary

Road Segment	Level of Service			
	Existing 2010	No-Build 2015	No-Build 2035	Build 2035
Route 224/SR 93				
between US 23 and US 58/US 421	D (0.37)	D (0.39)	D (0.50)	B (0.16)
between US 58/US 421 and Route 614	D (0.33)	D (0.34)	D (0.41)	D (0.41)
between Route 614 and E. Carters Valley Road	C (0.30)	D (0.32)	D (0.38)	D (0.38)
between E. Carters Valley Road and TN/VA state line	D (0.36)	D (0.35)	D (0.45)	D (0.45)
between TN/VA state line and Bloomingdale Pike	NB: A (7.2) SB: A (4.9)	NB: A (7.4) SB: A (5.2)	NB: A (9.6) SB: A (6.7)	NB: A (9.6) SB: A (6.7)
US 23				
between US 58/US 421/Route 224 and Kane Street (US 23 Business)	NB: B (15.9) SB: B (13.4)	NB: B (16.7) SB: B (14.1)	NB: C (21.2) SB: B (17.8)	NB: C (21.2) SB: B (17.8)
between Jennings Street and US 58/US 421/Route 224	NB: B (13.7) SB: B (11.2)	NB: B (14.4) SB: B (11.8)	NB: B (17.9) SB: B (14.4)	NB: B (17.9) SB: B (14.4)
between Yuma Road (Route 614) and Jennings Street	NB: B (12.0) SB: A (9.8)	NB: B (12.6) SB: B (10.4)	NB: B (15.4) SB: B (12.7)	NB: B (15.4) SB: B (12.7)
between E. Carters Valley Road and Yuma Road (Route 614)	NB: B (12.6) SB: A (9.5)	NB: B (13.3) SB: A (10.0)	NB: B (16.2) SB: B (12.4)	NB: B (16.2) SB: B (12.4)

NOT TO SCALE

US 58 / US 421

Route 614

Route 224

East Carters Valley Road

VIRGINIA

TENNESSEE

Bloomingdale Pike

Route 93

Route 224 / US 58 / US 421

Shopping Center Entrance

Jennings Street

US 23

Yuma Road (Route 614)

East Carters Valley Road

US 23

Kane Street

US 23

D

C

B

A

LEGEND

Travel Direction

Signalized Intersection

Unsignalized Intersection

Arterial LOS

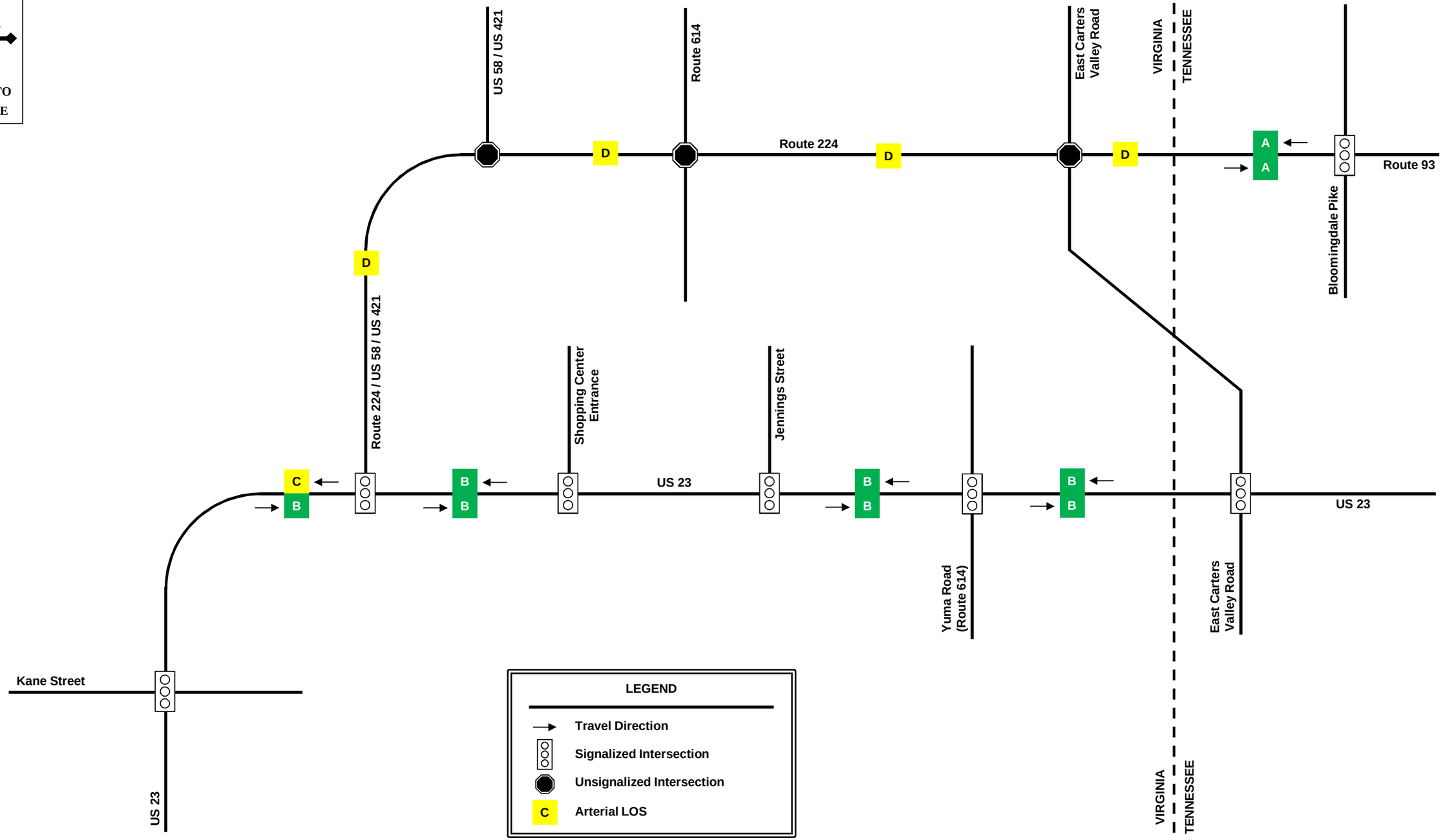
Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

No-Build 2015 Arterial LOS

Figure 6-10

NOT TO SCALE



Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	No-Build 2035 Arterial LOS	Figure 6-11

NOT TO SCALE

Route 224

US 58 / US 421

Route 614

Route 224

East Carters Valley Road

VIRGINIA

TENNESSEE

Route 93

Bloomingdale Pike

US 58 / US 421

Shopping Center Entrance

Jennings Street

US 23

US 23

Yuma Road (Route 614)

East Carters Valley Road

Kane Street

US 23

VIRGINIA

TENNESSEE

LEGEND

- Travel Direction
- Signalized Intersection
- Unsignalized Intersection
- C — Arterial LOS

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Build 2035 Arterial LOS

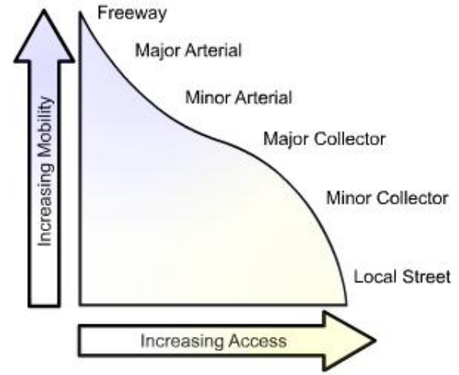
Figure 6-12

Table 6-5: Arterial Link Level of Service
Route 224 / SR 93 as 4-lane Divided Facility – Build 2035

Road Segment	Level of Service (seconds)
between US 23 and US 58/US 421	EB: A (3.1) WB: A (2.3)
between US 58/US 421 and Route 614	NB: A (7.9) SB: A (6.3)
between Route 614 and E. Carters Valley Road	NB: A (6.9) SB: A (6.0)
between E. Carters Valley Road and TN/VA state line	NB: A (8.6) SB: A (6.9)
between TN/VA state line and Bloomingdale Pike	NB: A (9.6) SB: A (6.7)

6.2. ACCESS MANAGEMENT

The definition of access management from the Federal Highway Administration (FHWA) is "the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding system in terms of safety, capacity, and speed." Per the Transportation Research Board *Access Management Manual*, access management is defined as "systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway". US 23 and Route 224 are functionally classified by VDOT as an urban principal arterial and an urban minor arterial, respectively. According to the illustration below, the purpose of US 23 is more for mobility and less for access while Route 224 is intended for more for access to properties.



Source: USDOT FHWA - Office of Operations, "What is Access Management?"
http://ops.fhwa.dot.gov/access_mgmt/what_is_accsmgmt.htm

While access management proposals may be received with opposition, the continued impacts of poor access management, such as excessive conflict points and short traffic signal spacing, can result in drivers avoiding the unsafe and/or congested roadway. The functional classification characteristics are described in detail in Table 6-6. Implementation of the VDOT access management standards may require property owners to lose convenient access to their property. Options for alternate, safer access to the state highway system should be investigated. The implementation of proven access management strategies can attain the following positive results:

- Lower automobile and pedestrian crash rates
- More efficient roads
- Decreased cut-through traffic in residential areas
- Shorter commute times
- Lower fuel consumption and emissions

Access management can be an alternative solution to the loss of overall mobility along a major arterial highway, which can allow for preservation of the existing roadway corridor while maintaining traffic flow by improving the ability to enter into and exit from destinations along the roadway. Strategies for US 23 should include providing raised medians to manage access and limiting the number of access points via shared access, cross-access agreements, and reverse frontage roads. Raised medians have been proven to improve traffic flow, reduce congestion, and lower crash rates. These benefits are mostly a result of managing the left-turn and u-turn movements along a corridor. Although two-way left-turn lanes can also be considered "medians", to be beneficial for access management, medians are typically raised or depressed and provide better control of vehicle crossings along the arterial.

Table 6-6: Functional Classification System Characteristics

CLASSIFICATION	LOCATION	CHARACTERISTICS
Principal Arterial	Rural	Trip lengths for statewide or interstate travel. Integrated movement generally without stub connections. Accommodates movement between (virtually) all areas with pop. 50,000. Two design types: freeways and other principal arterials.
	Urban	Serves major centers of activity with the highest traffic volumes and longest trip lengths. Integrated internally and between major rural connections. Service to abutting lands is subordinate to travel service to major traffic movements. Design types are interstate, other freeways and other principal arterials.
Minor Arterial	Rural	Links cities, large towns and other traffic generators attracting traffic over long distances. Intercounty service. Designs should be expected to provide for relatively high speeds and minimum interference to through movements.
	Urban	Trips of moderate length at a lower level of mobility than principal arterials. Some emphasis on land access. May carry local bus routes and provide intracommunity continuity but does not penetrate neighborhoods.
Collector	Rural	Serve intracounty travel with travel distances shorter than on arterial system. More moderate speeds. Divided into major and minor system.
	Urban	Provides both land access and traffic circulation within all areas. Penetrates neighborhoods and communities collecting and distributing traffic between neighborhoods and the arterial streets.
Local	Rural	Local roads primarily provide access to adjacent land and the collector network. Travel is over short distances.
	Urban	Primarily permits direct land access and connections to other streets. Lowest level of mobility. Long distance through traffic is usually discouraged.

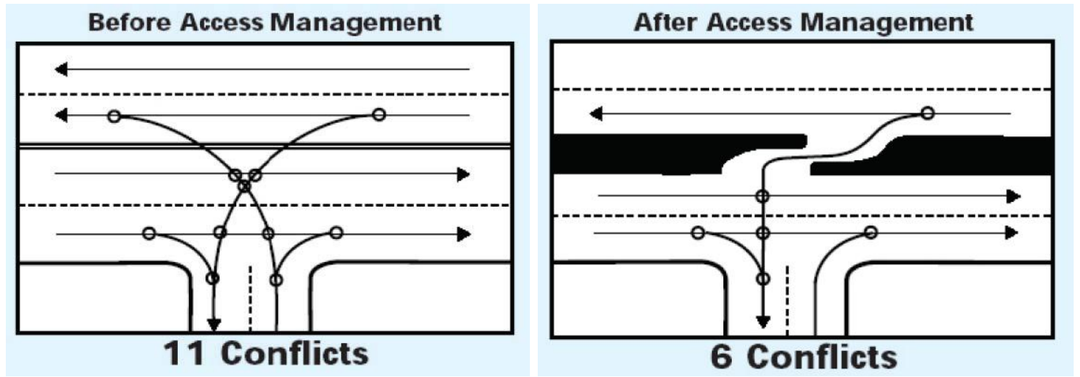
US23 Route 224

Source: Transportation Research Board (TRB) Circular E-C019, December 2010

Access management reduces traffic conflicts by:

- Minimizing the number of conflict points;
- Maximizing the distance between conflict points; and
- Providing inter-parcel connectivity, especially for slow turning vehicles.

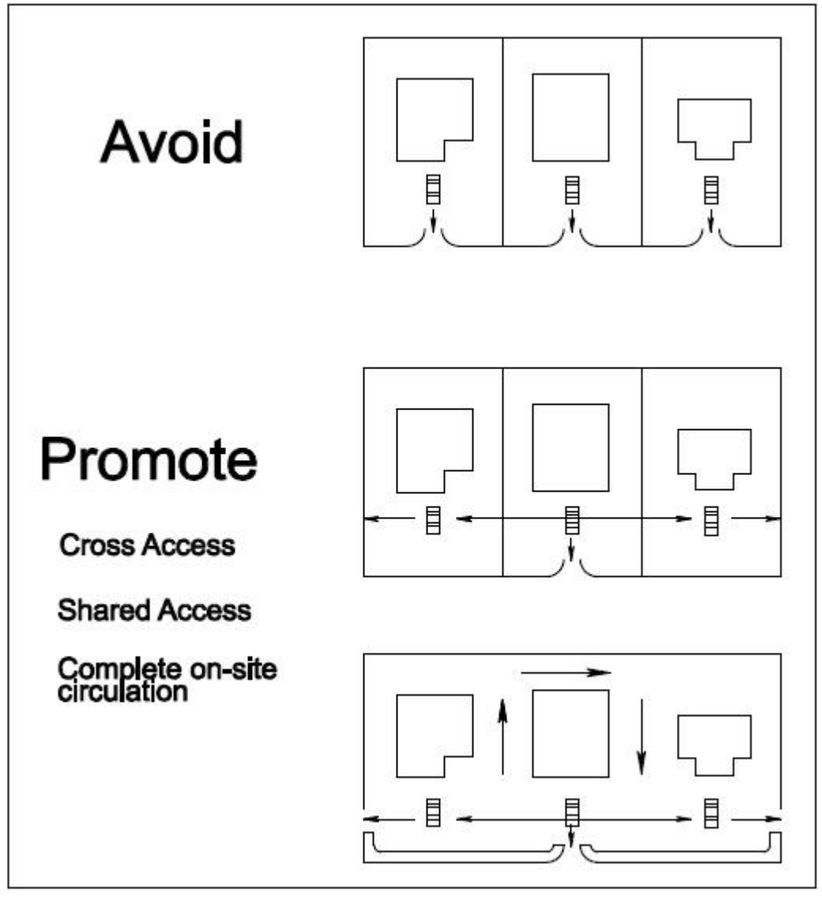
The diagram below illustrates the fewer number of conflict points that are provided as a result of a raised median on a four-lane roadway.



Source: National Cooperative Highway Research Program (NCHRP)

Providing medians along a major arterial is one way to improve access management; another method is establishing cross-access agreements, which are legal agreements that allow one property owner to access a public road via a driveway/access that is located +on an adjacent property owner's land. Cross-access agreements between multiple land parcels can reduce vehicle conflict points, which in turn reduces automobile crashes. Promoting these agreements between neighboring land owners can limit the number of access points along a corridor. These connections can be provided via frontage roads (between the roadway and the buildings) or reverse frontage roads (on the opposite side of the buildings from the roadway). The exhibit on the next page shows an example of multiple parcels sharing access along the major street, which thereby increases the spacing between driveways.

Frontage roads (i.e., inter-parcel connectivity at the front of the development) can sometimes be detrimental to alternative modes of transportation. The presence of frontage roads typically increases the distance and sometimes adds obstacles between the major roadway and the buildings, which results in more challenging trips for pedestrians, bicyclists, and users of transit. An alternative to frontage roads are a reverse frontage road, which can still provide inter-parcel access while concurrently allowing for a shorter and easier route for walking, cycling, and local transit. The reverse frontage roads can increase street connectivity, reduce the amount of traffic on regional thoroughfares, and supply a better design for alternative modes of transportation.



Source: FDOT – Driveway Handbook, March 2005

VDOT instituted access management standards in 2009 called "Access Management Design Standards for Entrances and Intersections". These regulations and standards apply to all functionally classified highways were adopted on October 14, 2009 and provide standards for the design of roads and intersections along state highways. The standards include minimum design criteria for the spacing of driveways, intersections, median openings, and traffic signals as shown in Table 6-7.

Table 6-7: VDOT Access Management Design Standards

Highway Functional Classification	Legal Speed Limit (mph)①	Centerline to Centerline Spacing in Feet		
		Signalized Intersections/ Crossovers②	Unsignalized Intersections/ Crossovers & Full Access Entrances③	Partial Access One or Two Way Entrances④
Urban ⑤ Principal Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	1,760 2,640 2,640	1,050 1,320 1,320	270 325 510
Urban ⑤ Minor Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	880 1,050 1,320	660 660 1,050	270 305 425
Urban ⑤⑦ Collector	≤ 30 mph 35 to 45 mph ≥ 50 mph	DIVIDED / UNDIVIDED 660 / 425 660 / 425 1,050 / 495	DIVIDED / UNDIVIDED 440 / 200 440 / 305 660 / 425	155 250 360
Rural ⑥ Principal Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	2,640 2,640 2,640	1,320 1,320 1,760	270 440 585
Rural ⑥ Minor Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	1,050 1,320 1,760	880 1,050 1,320	270 360 495
Rural ⑥⑦ Collector	≤ 30 mph 35 to 45 mph ≥ 50 mph	DIVIDED / UNDIVIDED 880 / 570 1,050 / 570 1,320 / 645	DIVIDED / UNDIVIDED 660 / 305 660 / 425 1,050 / 570	200 305 425

Source: VDOT Road Design Manual, Appendix F – Access Management Design Standards for Entrances and Intersections

Footnotes to Table 6-7:

① Legal Speed Limit – Use legal speed limit unless the design speed is available and approved for use by VDOT.

② Signalized Intersection/Crossover Spacing – Spacing is allocated in fractions of a mile: (1/2 mile, 2,640 ft); (1/3 mile, 1,760 ft); (1/4 mile, 1,320 ft); (1/5 mile, 1,050 ft); (1/6 mile, 880 ft), (1/8 mile, 660 ft). It is based on (i) the Signalized Intersection Spacing section and Table 2-1 and (ii) *Transportation and Land Development* by Vergil Stover and Frank Koepke, Institute of Transportation Engineers: "Traffic signal control applied in a sequential pattern according to specific spacing criteria optimize traffic efficiency" …"to reduce fuel consumption, reduce delay, reduce vehicular emissions and improve safety." Undivided collector spacing is based on stopping sight distance to assure

motorists have sufficient distance to see/react to a vehicle exiting an entrance or to a vehicle slowing down to turn into an entrance and stop in time to avoid a collision.

③ Unsignalized Intersection/Crossover and Full Access Entrance Spacing – These operate in a similar manner so the spacing standards can apply to these intersections/entrances equally. Spacing is allocated in fractions of a mile (see Footnote 2) or the length of a right auxiliary turn lane needed for a safe deceleration to turn into an entrance from *Geometric Design of Highways and Streets 2004*, AASHTO, pages 713 to 716. Undivided collector spacing is based on stopping sight distance (see Footnote 2).

④ Partial Access One or Two Way Entrance Spacing – Left turn movements are limited (right in/right out with or without left in movement). Spacing is based on sufficient stopping sight distance for motorists to be able to see/react to a vehicle slowing down to turn into an entrance or a vehicle exiting an entrance and stop in time to avoid a collision.

⑤ Urban Minor Arterials and Collectors – "Urban" is an abbreviation of "urban area" as defined in the Introduction to this document.

⑥ Rural Minor Arterials and Collectors – "Rural" is an abbreviation for "rural area" as defined in the Introduction to this document. Rural minor arterial and collector spacing standards are greater than their urban counterparts. Rural areas generally have lower land use density, larger parcel sizes, and higher speed limits. Distances between destinations are longer requiring greater mobility.

⑦ Divided and Undivided Collectors – Spacing between intersections is greater on median divided multi-lane collectors because they carry higher traffic volumes, offer opportunities for greater mobility, and as a result are more likely to evolve to minor arterial status.

US 23 is classified as an Urban Principal Arterial and has a posted speed limit of 45 MPH. The majority of Route 224 is classified as an Urban Minor Arterial and has a posted speed limit of 50 MPH. The section of Route 224 that is also designated US 58/US 421 between US 23 and US 58/US 421 is classified as an Urban Principal Arterial with a posted speed limit of 50 MPH.

Table 6-8 shows the spacing criteria for commercial driveways, median openings, and traffic signals. This information was obtained from Table 2-2 in VDOT's "Access Management Design Standards for Entrances and Intersections". These standards were used as guidance when recommending access management strategies along US 23 and Route 224. Since TDOT has not adopted formal access management design standards, VDOT standards were applied to both routes.

Table 6-8: Spacing Criteria for Traffic Signals

Cycle Length (s)	Spacing			
	1/8 mi (600 ft)	1/4 mi (1,320 ft)	1/3 mi (1,760 ft)	1/2 mi (2,640 ft)
	Progression Speed (mph)			
60	15	30	40	60
70	13	26	34	51
80	11	22	30	45
90	10	20	27	40
100	9	18	24	36
110	8	16	22	33
120	7.5	15	20	30

Source: VDOT Road Design Manual, Appendix F – Access Management Design Standards for Entrances and Intersections

7. RECOMMENDATIONS

Analysis of results of the future conditions analysis in Chapter 6, review of input received from the public at two public meetings, alignment with project goals established at the beginning of the project, and feedback from the project team members lead to the development of recommendations for transportation improvements in both corridors. All project goals were used to guide the development of recommendations; however, there was more concentrated focus on the following three goals than any of the other goals.

- Determine the safety and integrity of existing transportation infrastructure for automobiles, bicycles, and pedestrians
- Enhance safety for all modes of transportation
- Address increases in travel by all modes

7.1. GENERAL CORRIDOR IMPROVEMENTS

A number of corridor-wide improvement recommendations were developed for the US 23 and Route 224 corridors within the study area. These improvements were developed based on field observations, results of the project analyses, and input received from the public. The overall recommended improvements to the US 23 and Route 224 corridors are identified below.

US 23 Improvements

- Develop an access management plan on US 23 corridor beginning at the Tennessee/Virginia state line, continuing north through Weber City, and ending at Kane Street in Gate City.
- Construct a raised median and implement several driveway modifications along US 23 within Weber City to manage access along this segment of the corridor.
- Construct a curb and gutter section, including sidewalks, along portions of US 23 to better define driveway limits and provide pedestrian access.
- Upgrade turn lane storage and taper lengths to meet current VDOT and TDOT standards, where warranted, based on projected traffic volumes.
- Install stop bars and stop signs on all publically-maintained side street approaches at intersections on US 23.
- Coordinate traffic signals throughout the US 23 corridor to improve travel time and reduce delay.
- Install overhead street name signs on mast arms at all signalized intersections.
- Improve and/or consolidate railroad crossings that intersect US 23.
- Develop intersection and spot improvements based on safety and operational results.
- Update all traffic signals and signing to meet current federal and state standards.

Route 224 Improvements

- Straighten two horizontal curves south of the bridge over the North Fork of the Holston River to improve sight distance.
- Pave shoulders on the east and west sides of Route 224 from the intersection of US 58/US 421 south to the Virginia/Tennessee state line.
- Replace damaged or install missing guardrail and upgrade guardrail end treatments along Route 224 from the intersection of US 58/US 421 south to the Virginia/Tennessee state line to meet latest VDOT and TDOT standards.
- Widen SR 93 to a 5-lane facility with a center two-way left-turn lane from the Virginia/Tennessee state line to Bloomingdale Pike.
- Construct left- and right-turn lanes at intersections where they are warranted based on state standards.
- Install stop bars and stop signs to all public maintained side street approaches at intersections with Route 224.
- Upgrade turn lane storage and taper lengths to meet current VDOT and TDOT standards, where needed.
- Update all traffic signals and signing to meet current federal and state standards.
- Develop intersection and spot improvements based on crash and operational analysis results.
- Install overhead street name signs on mast arms at all signalized intersections.

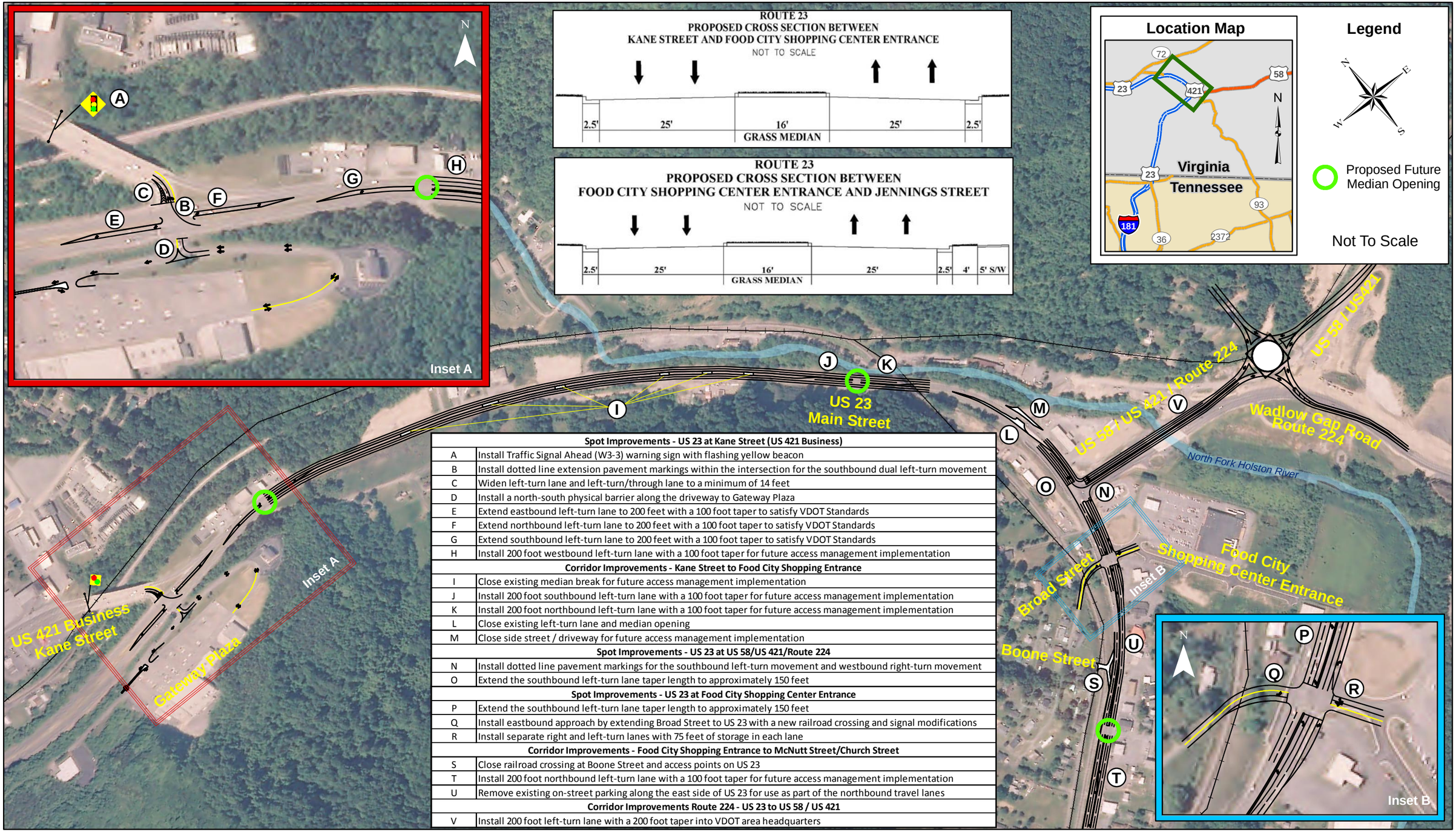
Several segments in both corridors were analyzed during the future year conditions (2035) to determine potential improvements that would be required to achieve levels of service that adequately service the future year traffic volumes. Each route was divided into multiple segments based on the existing corridor characteristics (similar to the methodology in Chapter 4 – Existing Conditions). The corridor-wide and spot improvements recommended in each segment are described in more detail in this section of the report. Recommendations are shown graphically in Figure 7-1 through Figure 7-6.

7.2. US 23 Improvements

7.2.1. US 23 – Access Management

US 23 is an urban principal arterial within the study area and, based on public feedback, is characterized as unsafe by 60% of respondents and congested by 30% of respondents. An access management plan, based on principles detailed in Chapter 6, was recommended for this corridor to improve mobility, increase safety and reduce congestion. Types of access management recommendations included modifications to the roadway cross section, reduction of median openings, consolidation of driveways and access points, and improvement to turn lanes. Specific recommendations within the US 23 corridor are described throughout Section 7.2 as they are applied to each corridor study segment described hereafter.

Table 7-1 summarizes the overall number of existing median openings and proposed median openings on US 23 after applying access management guidelines to existing median openings. The table also includes the average spacing between median openings under existing and proposed conditions. A 30% reduction in the number of median openings is possible along US 23 after implementation based on the recommendations, resulting in an increase of 56% in the average spacing (expressed in feet) between median openings. Some of the spacing would not meet VDOT access management design standards, but it would be a significant improvement when compared to the existing situation.



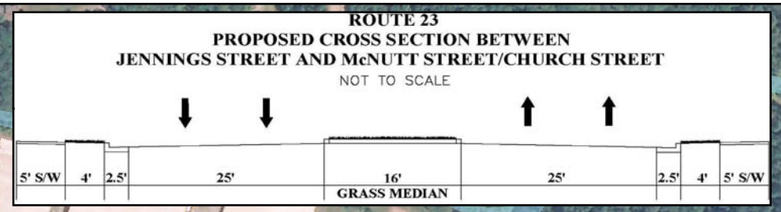
Spot Improvements - US 23 at Kane Street (US 421 Business)	
A	Install Traffic Signal Ahead (W3-3) warning sign with flashing yellow beacon
B	Install dotted line extension pavement markings within the intersection for the southbound dual left-turn movement
C	Widen left-turn lane and left-turn/through lane to a minimum of 14 feet
D	Install a north-south physical barrier along the driveway to Gateway Plaza
E	Extend eastbound left-turn lane to 200 feet with a 100 foot taper to satisfy VDOT Standards
F	Extend northbound left-turn lane to 200 feet with a 100 foot taper to satisfy VDOT Standards
G	Extend southbound left-turn lane to 200 feet with a 100 foot taper to satisfy VDOT Standards
H	Install 200 foot westbound left-turn lane with a 100 foot taper for future access management implementation
Corridor Improvements - Kane Street to Food City Shopping Entrance	
I	Close existing median break for future access management implementation
J	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
K	Install 200 foot northbound left-turn lane with a 100 foot taper for future access management implementation
L	Close existing left-turn lane and median opening
M	Close side street / driveway for future access management implementation
Spot Improvements - US 23 at US 58/US 421/Route 224	
N	Install dotted line pavement markings for the southbound left-turn movement and westbound right-turn movement
O	Extend the southbound left-turn lane taper length to approximately 150 feet
Spot Improvements - US 23 at Food City Shopping Center Entrance	
P	Extend the southbound left-turn lane taper length to approximately 150 feet
Q	Install eastbound approach by extending Broad Street to US 23 with a new railroad crossing and signal modifications
R	Install separate right and left-turn lanes with 75 feet of storage in each lane
Corridor Improvements - Food City Shopping Entrance to McNutt Street/Church Street	
S	Close railroad crossing at Boone Street and access points on US 23
T	Install 200 foot northbound left-turn lane with a 100 foot taper for future access management implementation
U	Remove existing on-street parking along the east side of US 23 for use as part of the northbound travel lanes
Corridor Improvements Route 224 - US 23 to US 58 / US 421	
V	Install 200 foot left-turn lane with a 200 foot taper into VDOT area headquarters

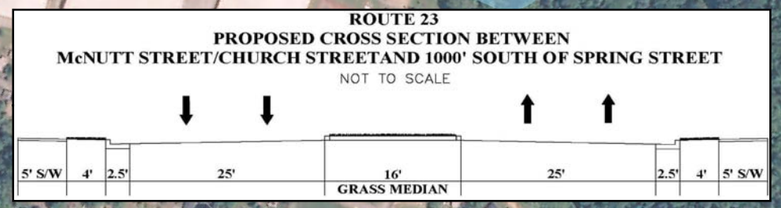
Kingsport Tennessee

US 23 / Route 224 Corridor Study

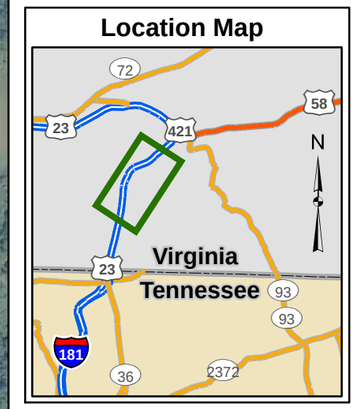
Recommended Improvements
for US 23 - Kane Street to Food City Shopping Center

Figure 7 - 1





	Spot Improvements - US 23 at Jennings Street (Route 744)
A	Install pedestrian signal heads, push buttons, crosswalks, and ADA ramps
B	Update left-turn signal heads to current MUTCD guidelines
C	Widen westbound approach for separate left and right-turn lanes
	Corridor Improvements - McNutt Street/Church Street to North Fork Holston River
D	Close Blanton Drive railroad crossing
E	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
F	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
G	Install 200 foot northbound left-turn lane with a 100 foot taper for future access management implementation
H	Close existing median opening
I	Relocate the Chapel Street railroad crossing to align with Jude Street
J	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
K	Relocate and extend northbound left-turn lane to 200 feet with a 100 foot taper
L	Extend southbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
M	Extend northbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
	Spot Improvements - US 23 at Yuma Road
N	Extend southbound and northbound left-turn lane to 200 feet with a 100 foot taper
O	Install pedestrian signal heads, push buttons, crosswalks, and ADA ramps
P	Update left-turn signal heads to meet current MUTCD guidelines
Q	Remove uncontrolled cemetary access at intersection
	Corridor Improvements - McNutt Street/Church Street to North Fork Holston River
R	Extend southbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
S	Extend northbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
T	Construct sidewalk along west side of US 23 for pedestrian connectivity
U	Install left-turn lane and median closure
V	Extend southbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation



Legend

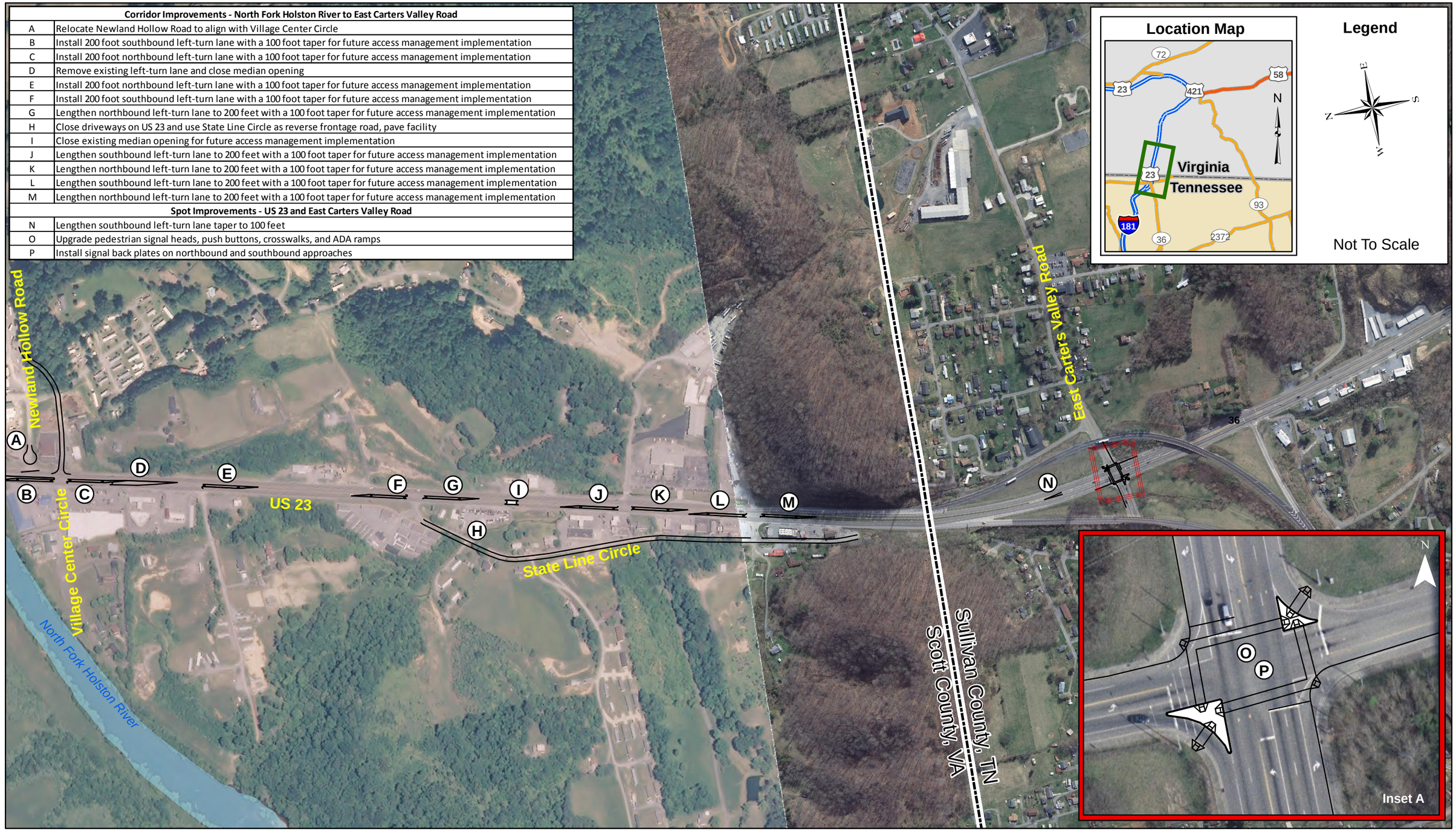
Proposed Future Median Opening

Not To Scale

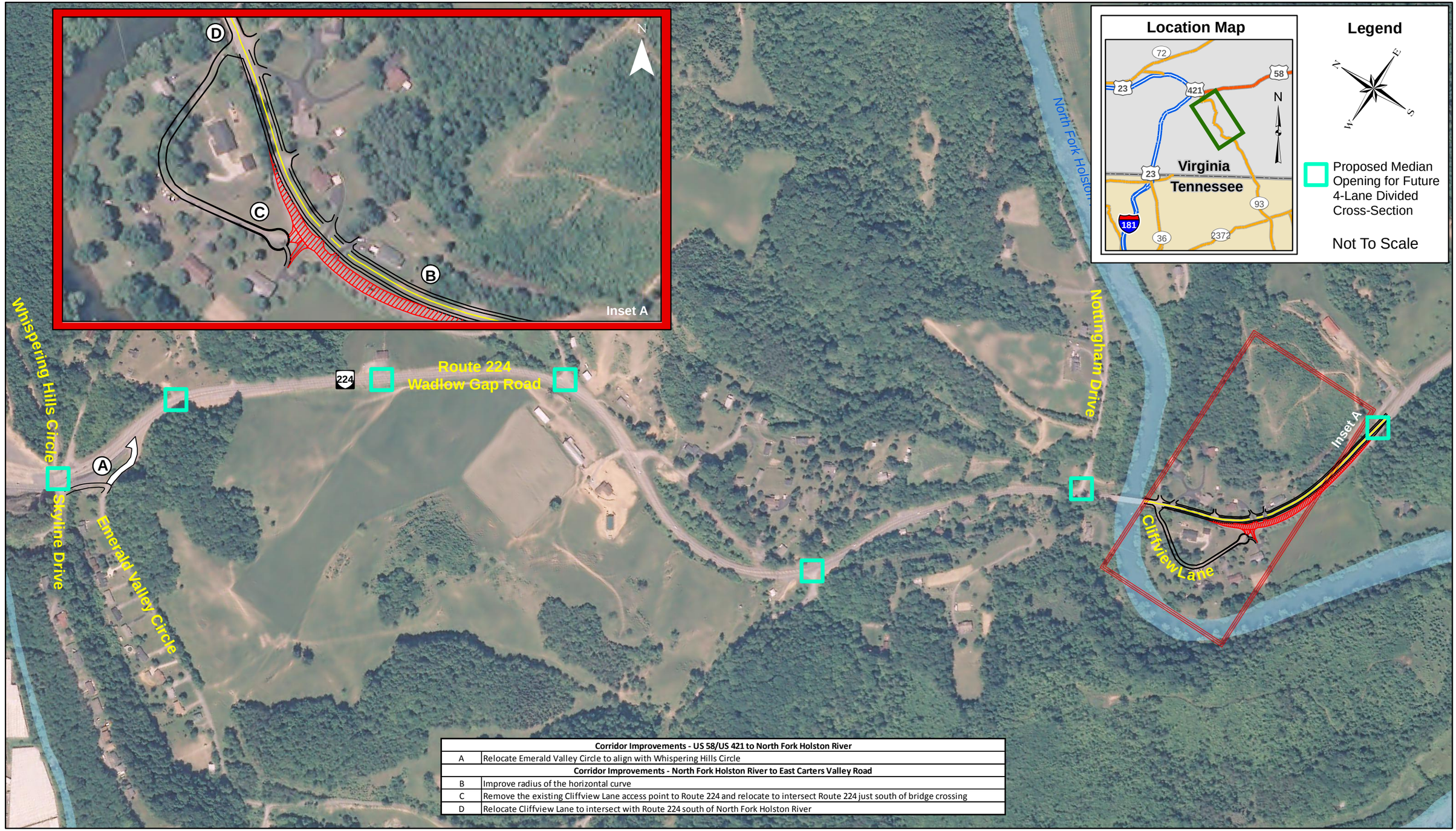
Kingsport TENNESSEE	US 23 / Route 224 Corridor Study	Recommended Improvements for US 23 - Jennings Street to North Fork Holston River

Figure 7 - 2

Corridor Improvements - North Fork Holston River to East Carters Valley Road	
A	Relocate Newland Hollow Road to align with Village Center Circle
B	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
C	Install 200 foot northbound left-turn lane with a 100 foot taper for future access management implementation
D	Remove existing left-turn lane and close median opening
E	Install 200 foot northbound left-turn lane with a 100 foot taper for future access management implementation
F	Install 200 foot southbound left-turn lane with a 100 foot taper for future access management implementation
G	Lengthen northbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
H	Close driveways on US 23 and use State Line Circle as reverse frontage road, pave facility
I	Close existing median opening for future access management implementation
J	Lengthen southbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
K	Lengthen northbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
L	Lengthen southbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
M	Lengthen northbound left-turn lane to 200 feet with a 100 foot taper for future access management implementation
Spot Improvements - US 23 and East Carters Valley Road	
N	Lengthen southbound left-turn lane taper to 100 feet
O	Upgrade pedestrian signal heads, push buttons, crosswalks, and ADA ramps
P	Install signal back plates on northbound and southbound approaches



Kingsport Tennessee	US 23 / Route 224 Corridor Study	Recommended Improvements for US 23 - North Fork Holston River to East Carters Valley Road	Figure 7 - 3



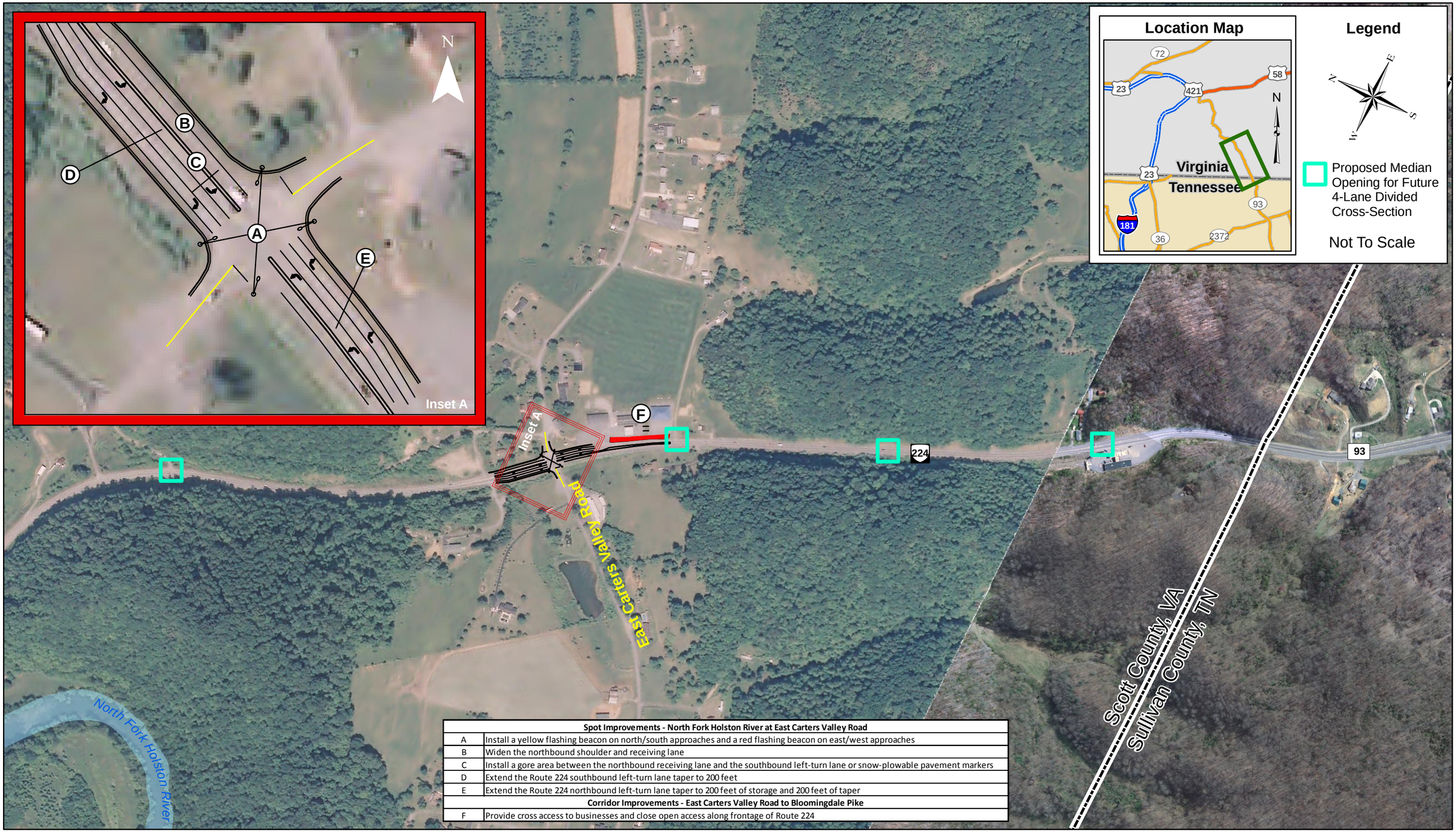
Corridor Improvements - US 58/US 421 to North Fork Holston River	
A	Relocate Emerald Valley Circle to align with Whispering Hills Circle
Corridor Improvements - North Fork Holston River to East Carters Valley Road	
B	Improve radius of the horizontal curve
C	Remove the existing Cliffview Lane access point to Route 224 and relocate to intersect Route 224 just south of bridge crossing
D	Relocate Cliffview Lane to intersect with Route 224 south of North Fork Holston River

Kingsport
TENNESSEE

US 23 / Route 224 Corridor Study

Recommended Improvements
for Route 224 - Emerald Valley Circle to Cliffview Lane

Figure 7 - 4



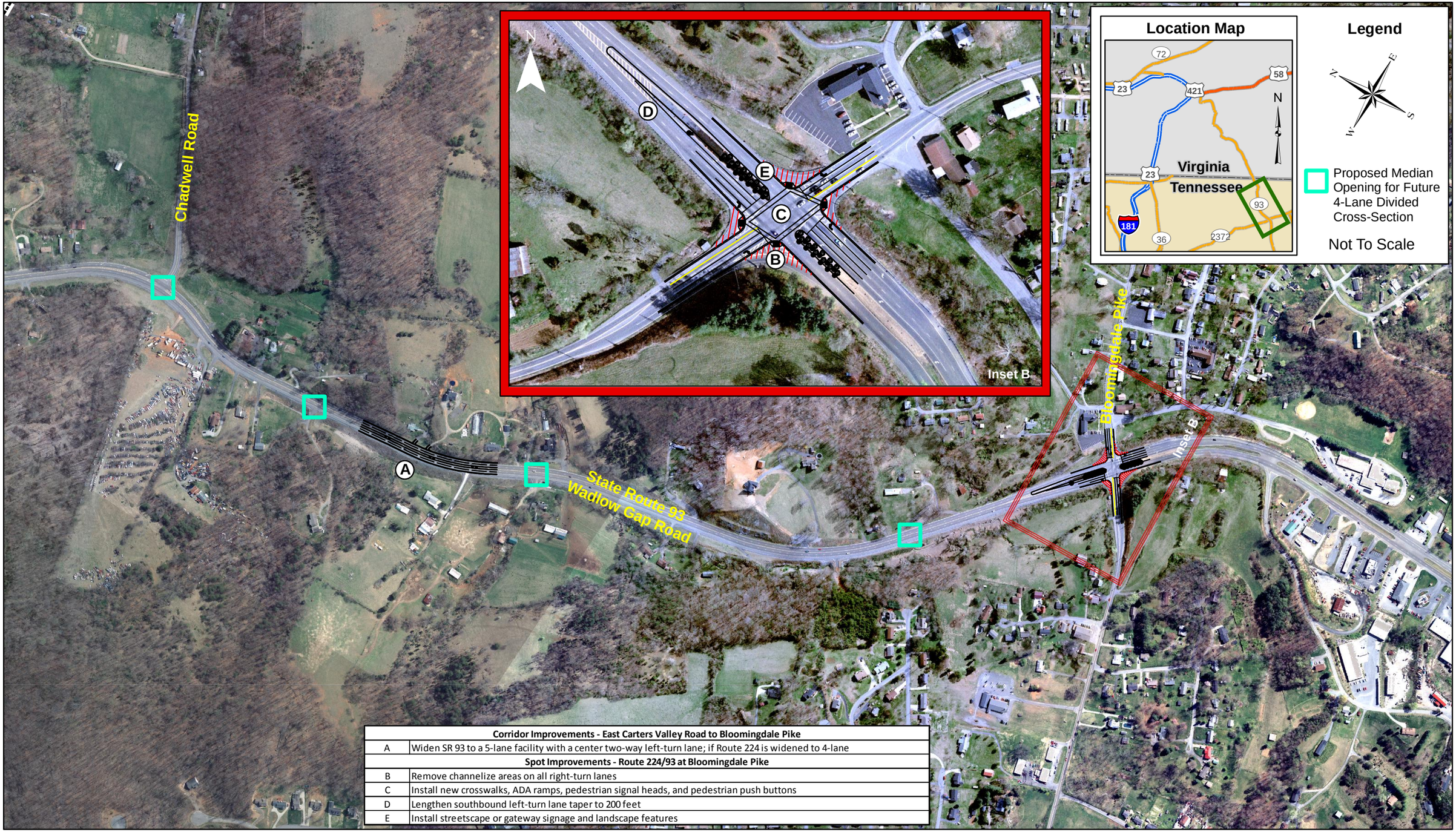
Spot Improvements - North Fork Holston River at East Carters Valley Road	
A	Install a yellow flashing beacon on north/south approaches and a red flashing beacon on east/west approaches
B	Widen the northbound shoulder and receiving lane
C	Install a gore area between the northbound receiving lane and the southbound left-turn lane or snow-plowable pavement markers
D	Extend the Route 224 southbound left-turn lane taper to 200 feet
E	Extend the Route 224 northbound left-turn lane taper to 200 feet of storage and 200 feet of taper
Corridor Improvements - East Carters Valley Road to Bloomingdale Pike	
F	Provide cross access to businesses and close open access along frontage of Route 224

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Recommended Improvements
for Route 224 - East Carters Valley Road to VA/TN Line

Figure 7 - 5



Corridor Improvements - East Carters Valley Road to Bloomingdale Pike	
A	Widen SR 93 to a 5-lane facility with a center two-way left-turn lane; if Route 224 is widened to 4-lane
Spot Improvements - Route 224/93 at Bloomingdale Pike	
B	Remove channelize areas on all right-turn lanes
C	Install new crosswalks, ADA ramps, pedestrian signal heads, and pedestrian push buttons
D	Lengthen southbound left-turn lane taper to 200 feet
E	Install streetscape or gateway signage and landscape features

Kingsport TENNESSEE

US 23 / Route 224 Corridor Study

Recommended Improvements

State Route 93 - East Carters Valley Road to Bloomingdale Pike

Figure 7 - 6

Table 7-1: Access Management – Existing and Proposed Median Openings along US 23

Road Segment	Median Opening Type	Number of Median Openings		Average Spacing (in Feet)	
		Existing	Proposed	Existing	Proposed
Between Food City Shopping Center Entrance and Kane Street	Signalized	2	2	550	1,200
	Unsignalized	9	3		
	Total	11	5		
Between McNutt Street/Church Street and Food City Shopping Center Entrance	Signalized	2	2	-	955
	Unsignalized	*	2		
	Total	*	4		
Between North Fork Holston River and McNutt Street/Church Street	Signalized	1	1	785	1,070
	Unsignalized	8	5		
	Total	9	6		
Between East Carters Valley Road and North Fork Holston River	Signalized	1	1	850	1,155
	Unsignalized	7	5		
	Total	8	6		
TOTAL	Signalized	6	6	705	1,100
	Unsignalized	24	15		
	Total	30	21		

* Median does not exist at this time - striped-out asphalt exists which allows turning movements to occur continuously throughout this segment of US 23

7.2.2. At-Grade Railroad Crossings near US 23 within Weber City

Between Yuma Road (Route 614) and US 58/US 421/Route 224, there are five at-grade railroad crossings that extend to intersect US 23. These intersections have unsignalized full-movement access with US 23 and are located at the following five roads from south to north: Chapel Street, McNutt Street/Church Street, Blanton Drive, Boone Street, and Chimney Top Drive. The following changes were recommended:

- Relocate the Chapel Street crossing slightly to the north to improve alignment with US 23 to be directly across from Jude Street. The need for a traffic signal at this location should be periodically monitored, particularly if railroad crossings are removed as recommended in this study.
- No changes proposed to the McNutt Street/Church Street crossing.
- Close the Blanton Drive crossing.
- Close the Boone Street crossing and construct a new crossing by extending Broad Street to US 23. This would create the eastbound approach to the intersection and align directly across from Shopping Center Driveway.

These proposed changes would result in four at-grade railroad crossings that intersect US 23 or a net loss of one crossing.

7.2.3. US 23 – Kane Street to Food City Shopping Center Entrance

US 23 is a 4-lane divided facility with a mixture of raised concrete and center grass medians within this study segment. There are two signalized and nine unsignalized existing median openings in this segment. A wider center median of 16 feet was proposed from Kane Street to the Food City Shopping Center Entrance to match the typical section of the US 23 segments to the south. Exhibit 7-1 shows the proposed typical cross section.

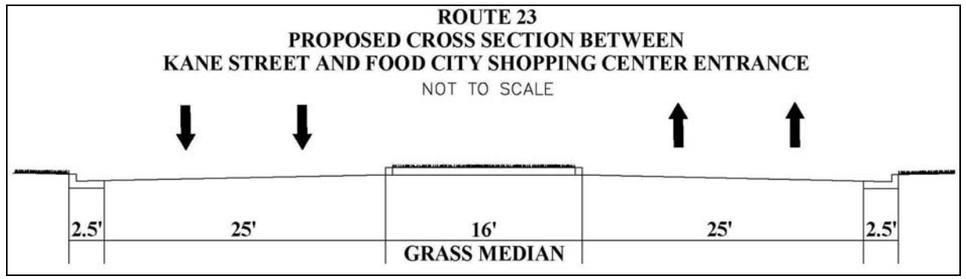


Exhibit 7-1: Proposed Cross Section Between Kane Street and Food City Shopping Center Entrance

Seven median openings were proposed to be closed and one new median opening was proposed. These proposed changes would result in having two signalized and three unsignalized median openings, or a net loss of six median openings along this segment of US 23. The purpose of these recommended geometric modifications is to improve mobility, access management, and corridor safety by attempting to comply with the VDOT standards. Table 7-1 summarizes the proposed median opening modifications within this section. Figure 7-1 illustrates the recommended improvements in this segment.

7.2.3.1. Spot Improvement - US 23 at Kane Street (US 421 Business)

- The southbound Kane Street approach includes a left-turn lane, a shared left-turn/through lane, and a right-turn lane. To improve the dual-left turn movement, positive guidance lane markings (i.e., 'mini-skips') should be installed within the intersection to identify the proper vehicle path from each approach lane to each receiving lane. This improvement follows guidance language found in the 2009 MUTCD, Section 3B.08. The objective of this improvement was to decrease the chance of driver confusion and improve the visibility of each vehicle path for the dual turning lanes.
- There are two southbound approach lanes that allow left-turn movements (a separate left-turn lane and a shared left-turn/through lane). To make this left-turn movement, vehicles must travel straight on Kane Street, turn right onto Kane Street, and then turn left onto eastbound US 23. Several "near miss", side-swipe crashes occurred at this location. The two approach lanes on Kane Street should be widened to a minimum of 14 feet to increase the spacing between vehicles making this maneuver.

- The existing roadway geometry of the southbound Kane Street approach makes it difficult for vehicles to see the US 23 intersection and traffic signal well in advance. A Signal Ahead (MUTCD W3-3) warning sign and flashing yellow beacon should be installed to provide more advance warning of the traffic signal.
- The south leg of this intersection is the driveway to Gateway Plaza. Gateway Plaza has an internal access road that circles the site and intersects Gateway Plaza driveway. The distance between the edges of pavement for US 23 and the Gateway Plaza internal access road is approximately 40 feet. This intersection of the driveway to Gateway Plaza and the internal access road currently operates without any traffic control devices. The close proximity of these two intersections creates driver confusion regarding who has the right-of-way and also decreases the efficiency of traffic signal operations when the signalized approach is given "green time". A proposed alternative to improve traffic operations would be to convert the Gateway Plaza internal access road to one-way travel. Under this alternative, a north-south physical barrier would be constructed along the driveway and through Gateway Plaza, prohibiting eastbound and westbound through movements on the Gateway Plaza access road at the Gateway Plaza driveway. Vehicles entering the shopping center from the signal would be routed to make a right turn to travel westbound along Gateway Plaza (the western segment), and vehicles exiting the shopping center to the signal would be directed to travel westbound along Gateway Plaza (the eastern segment). Improvements within the property limits of the Gateway Plaza shopping center would be the responsibility of the private owner or developer.
- Extend the eastbound left-turn lane taper length on US 23 to 100 feet to satisfy current VDOT standards.

Figure 7-1 illustrates the recommended improvements at this intersection.

7.2.3.2. Spot Improvement - US 23 at US 58/US 421/Route 224 Intersection

- The signalized intersection of US 23 and US 58/US 421/Route 224 functions as the major intersection in Weber City, creating a junction of multiple federal routes, and is critically important to traffic flow on US 23. The intersection is located approximately 350 feet north of the signalized intersection at the Shopping Center Entrance on US 23. Congestion and signal timings documented during field observations, as well as the close proximity of the two signals, support the recommendations to implement signal timing enhancements. It was recommended that the two signals be coordinated and adjusted to optimize traffic flow and the efficiency of the US 23 signal network in this vicinity.
- The southbound approach along US 23 includes dual left-turn lanes and the westbound approach along US 58/US 421/Route 224 includes dual right-turn lanes. Dotted line extension pavement markings (i.e., 'mini-skips') should be installed within the intersection to identify the proper vehicle path from each approach lane to each receiving lane. This improvement follows guidance language found in the 2009 MUTCD, Section 3B.08. The objective of this improvement was to reduce the chance for driver confusion and improve the definition of each vehicle path as it pertains to dual turning lanes.
- Extend the southbound left-turn lane taper length on US 23 to 150 feet to satisfy current VDOT standards. Since this location is a critical intersection along this corridor and there are few access points between these two signalized intersections, a northbound left-turn lane was not recommended.

Figure 7-1 illustrates the recommended improvements at this intersection.

7.2.4. US 23 – Food City Shopping Center Entrance to McNutt Street/Church Street

US 23 is a 4-lane, divided facility in this segment of roadway with a narrow striped traversable median that allows full movement access at every driveway. A 16 foot wide center grass median was proposed along this segment to manage access and match the typical section of the US 23 segments to the south and the north. To accommodate an increase in median width, the existing on-street parking along the east side of US 23 should be removed and used as part of the northbound travel lanes. There is an existing sidewalk along the east side of US 23 between the Food City Shopping Center Entrance and Jennings Street, which measures approximately 0.3 miles. Exhibit 7-2 shows the proposed typical cross section between the Food City Shopping Center Entrance and Jennings Street, which assumes the existing sidewalk will remain.

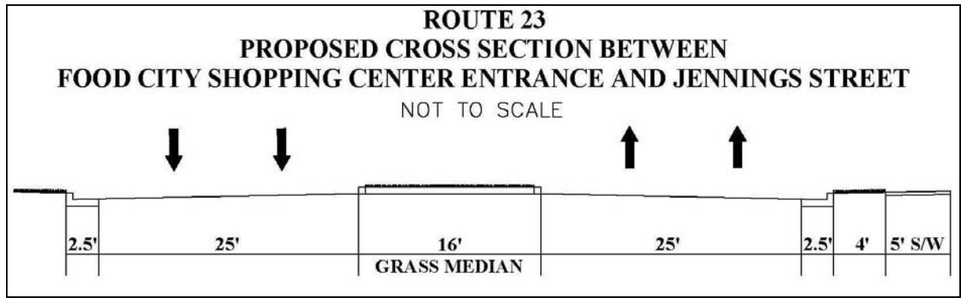


Exhibit 7-2: Proposed Cross Section Between Food City Shopping Center Entrance and Jennings Street

There is no sidewalk along the west side of US 23. Pedestrian access should be enhanced by extending the southern terminus of the eastern sidewalk along US 23 from Jennings Street to approximately 1,000 feet south of Spring Street. Additional sidewalk should be constructed along the west side of US 23 from Jennings Street to approximately 1,000 feet south of Spring Street, a total length of approximately 1.2 miles. This sidewalk construction should be coupled with an access management plan aimed at properly defining driveway width and spacing in this vicinity along US 23. Exhibit 7-3 shows the proposed typical cross section (including sidewalks) between Jennings Street and McNutt Street/Church Street.

Should a median cross section be constructed, only two unsignalized median opening closures were proposed along this segment of US 23. The purpose of these recommended geometric modifications was to improve mobility, access management, and corridor safety by attempting to comply with the VDOT standards. Table 7-1 summarizes the proposed median opening modifications within this segment of US 23.

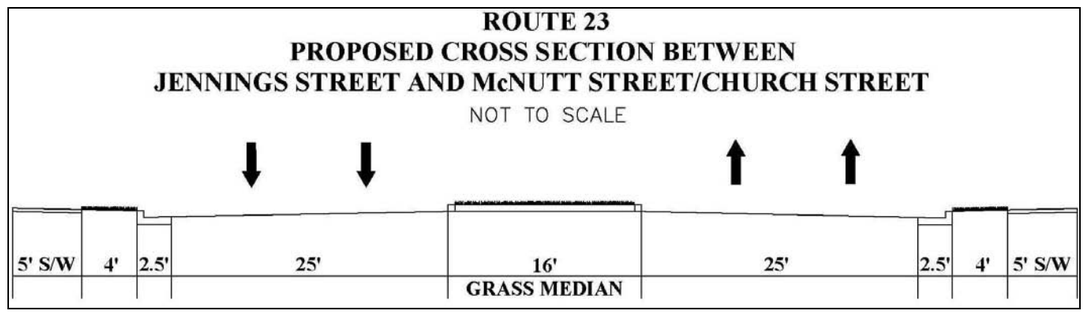


Exhibit 7-3: Proposed Cross Section Between Jennings Street and McNutt Street/Church Street

As described in Section 7.2.2, the Boone Street at-grade railroad crossing was recommended for closure, and a new crossing was proposed via an extension of Broad Street. This extension would create access along US 23 at the traffic signal directly across from Food City Shopping Center Driveway. This improvement would consolidate access points along US 23 and tie into an existing traffic signal.

The advanced signing for the federal/state route designations are confusing to drivers traveling northbound along US 23. Just south of the traffic signal at the Shopping Center Entrance, there are six signs clustered together that identify upcoming directions for US 23 North, US 58 West, US 421 North, US 58 East, Route 224 South, and US 421 South. The arrows located beneath these signs cause some drivers to mistakenly turn at the Shopping Center Entrance traffic signal to travel along US 58 East, Route 224 South, and US 421 South. Replace these signs and arrows with those that better communicate the intended turning locations.

Figures 7-1 and Figure 7-2 illustrate the recommended improvements.

7.2.4.1. Spot Improvement - US 23 at Food City Shopping Center Entrance

- The Boone Street railroad crossing was proposed to be closed as described in Section 7.2.2. As an alternative, a new crossing was proposed to be located between Broad Street and US 23 to replace the existing Boone Street railroad crossing. This extension of Broad Street would create the 4th leg at this signalized intersection and would form an eastbound approach. The traffic signal should be modified to properly control this proposed eastbound approach.
- The westbound Food City Shopping Center Entrance approach is currently striped as a single shared left-turn/right-turn lane. Field observations indicated that this approach operates as separate left-turn and right-turn lanes for approximately 70-80 feet to accommodate approximately three vehicles, after which the lanes narrow to accommodate only one vehicle. The westbound approach should be striped to clearly delineate a two-lane approach with separate left-turn and right-turn lanes, providing approximately 75 feet of storage for each lane. Improvements located within the Food City Shopping Center property would be the responsibility of the private owner.
- This signalized intersection recently constructed; however, it appears the existing southbound left-turn lane taper length is less than the 100 foot VDOT standard. Due to the close proximity of this taper to the intersection of US 58/US 421/ Route 224, 100 feet of taper cannot be obtained without sacrificing storage length within the southbound left-turn lane. Additionally, a northbound left-turn lane along US 23 should be constructed with 200 feet of storage and 100 feet of taper to satisfy current VDOT standards and accommodate potential future traffic that will use the eastbound approach.

Figure 7-1 illustrates the recommended improvements at this intersection.

7.2.4.2. Spot Improvement - US 23 at Jennings Street (Route 744)

- One crosswalk exists across the northbound approach (south leg) of US 23; however, neither of the endpoints are ADA accessible. Additionally, the crosswalk in the southwest quadrant currently terminates into a guardrail. Pedestrian accessibility at the intersection should be improved with the installation of new crosswalks, ADA ramps, pedestrian signal heads, and pedestrian push buttons. This improvement should also include the relocation of the guardrail that currently creates a physical obstruction for pedestrians on the southwest quadrant.
- The westbound approach along Jennings Street currently consists of one shared left-turn/right-turn lane. This approach should be widened to provide for two lanes to accommodate separate left-turn and right-turn lanes. This improvement would also accommodate school bus traffic and allow a higher percentage of the green time for the traffic signal to be allocated to US 23. In addition, the westbound stop bar should be relocated closer to the intersection (it is currently 36 feet from the tangent point of US 23) to improve sight distance for the approach. This project should also include constructing a sidewalk along the south side of Jennings Street from US 23 to Shady Elm Lane (approximately 350 feet).
- The existing southbound left-turn signal head is protected-only; however, the signal head consists of a ‘green arrow’, ‘yellow arrow’, and ‘red ball’. To satisfy the 2009 MUTCD, Section 4D.19 standard, the ‘red ball’ should be replaced with a ‘red arrow’.

Figure 7-2 illustrates the recommended improvements at this intersection.

7.2.5. US 23 – McNutt Street/Church Street to North Fork Holston River

US 23 is a 4-lane, divided facility with a variable width grass median in this segment of roadway. There is an existing sidewalk network along the east side of US 23 between the Food City Shopping Center Entrance and Jennings Street, which measures approximately 0.3 miles. However, there is no sidewalk along the west side of US 23. Pedestrian access should be enhanced by extending the southern terminus of the eastern sidewalk along US 23 from Spring Street to approximately 1,000 feet south of Spring Street. New sidewalk should be constructed along the west side of US 23 from approximately 1,000 feet south of Spring Street to Jennings Street, a total length of approximately 1.2 miles. This sidewalk construction should be coupled with an access management plan aimed at properly defining driveway width and spacing in this vicinity. To provide consistency with the cross sections to the north and south of this segment, and to provide pedestrian connectivity in the corridor, the cross section shown in Exhibit 7-4 is proposed between McNutt Street/Church Street and Yuma Road. There are no proposed changes to the cross section from Yuma Road to the North Fork Holston River.

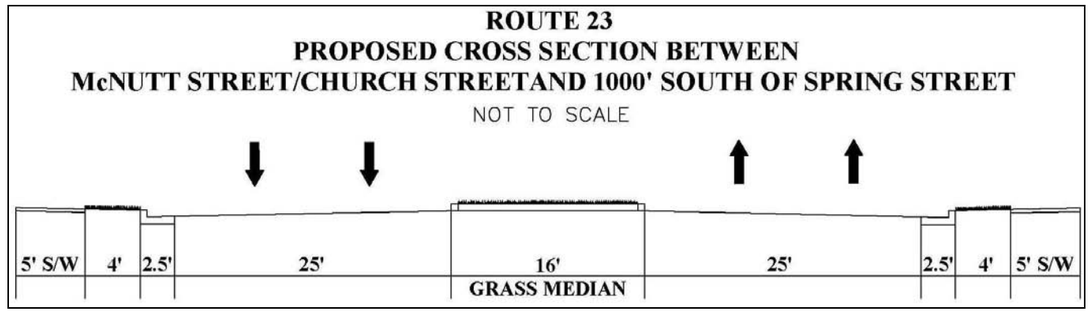


Exhibit 7-4: Proposed Cross Section Between McNutt Street/Church Street and Yuma Road

There are nine median openings in this section, including one signalized opening and eight unsignalized openings. Three median openings were proposed to be closed and one median opening was proposed to be relocated. These proposed changes would result in one signalized and five unsignalized median openings remaining, or a net loss of three median openings on this segment of US 23. The purpose of these recommended geometric modifications was to improve mobility, access management, and corridor safety by attempting to comply with the VDOT standards. Table 7-1 summarizes the proposed median opening modifications within this section.

As described in Section 7.2.2, the Chapel Street at-grade railroad crossing was proposed to be relocated 50 feet to the north to align with US 23 directly across from Jude Street. This would consolidate public road access into one properly-aligned intersection.

Figure 7-2 illustrates the recommended improvements.

7.2.5.1. Spot Improvement - US 23 at Yuma Road (Route 614)

- This signalized intersection includes a fifth leg that provides access to the Holston View Cemetery. This leg is not controlled by a traffic control device (traffic signal, stop sign, stop bar, one-way sign). The driveway access should be terminated to remove the fifth leg from the signalized intersection. The cemetery has additional access locations along US 23 and Yuma Road; therefore, sufficient access can be provided via the alternate entrances.
- Pedestrian accessibility at the intersection should be improved with the installation of new crosswalks, ADA ramps, pedestrian signal heads, and pedestrian push buttons.
- The existing northbound and southbound left-turn signal heads are protected-only; however, the signal heads consists of a 'green arrow', 'yellow arrow', and 'red ball'. To satisfy the 2009 MUTCD, Section 4D.19 standards, the 'red ball' should be replaced with a 'red arrow' indicator.
- The northbound and southbound left-turn lanes along US 23 should be extended to have 200 feet of storage and 100 feet of taper to satisfy current VDOT standards.

Figure 7-2 illustrates the recommended improvements at this intersection.

7.2.6. US 23 – North Fork Holston River to East Carters Valley Road

US 23 is a 4-lane divided roadway with a variable-width, grass median in this segment of roadway. There are eight median openings in this section, including one signalized opening and seven unsignalized median openings. Two of the unsignalized median openings are proposed to be closed and one was proposed to be relocated. These proposed changes would result in one signalized and five unsignalized median openings remaining, or a net loss of two median openings within this segment of US 23. The purpose of these changes is to make this segment closer to compliance with the VDOT standards, thereby improving mobility, access management, and corridor safety. Table 7-1 summarizes these median opening modifications.

State Line Circle is an existing unpaved roadway located to the west of US 23, which intersects US 23 at two locations. The State Line Circle intersections are approximately 1,850 feet apart with the southern intersection located approximately 950 feet north of the Virginia/Tennessee state line. State Line Circle has the potential to serve as a reverse frontage road access for traffic associated with land uses located between State Line Circle and US 23. By applying VDOT access management guidelines, commercial driveway accesses on US 23 should be closed and relocated onto State Line Circle. In addition, State Line Circle should be paved and improved to accommodate increased traffic demand.

Newland Hollow Road intersects US 23 on the east side of the roadway, just south of the North Fork Holston River. Village Center Circle intersects US 23 on the west side, approximately 175 feet south of North Fork Holston River. Newland Hollow Road should be re-aligned to intersect US 23 directly across from Village Center Circle, thereby consolidating public road accesses into one intersection and increasing the distance between existing median openings and the North Fork of the Holston River bridge.

Figure 7-3 illustrates the recommended improvements.

7.2.6.1. Spot Improvement - US 23 at East Carters Valley Road

- Sidewalks exist on all four quadrants of this intersection; however, the only pedestrian features within the intersection are two crosswalks. Pedestrian accessibility at the intersection should be improved with the installation of new crosswalks, ADA ramps, pedestrian signal heads, and pedestrian push buttons.
- Signal back plates exist for the eastbound and westbound approaches on East Carters Valley Road, but not for the northbound and southbound approaches on US 23. Visibility of the signal heads should be improved by installing signal back plates for the northbound and southbound approaches on US 23.
- The southbound left-turn lane taper length on US 23 should be extended to 180 feet to satisfy current TDOT guidelines.

Figure 7-3 illustrates the recommended improvements at this intersection.

7.3. Route 224/SR 93 Improvements

7.3.1. Route 224/SR 93 Access Management

Route 224 is an urban minor arterial within the study area and, similar to US 23, is characterized as unsafe by 60% of respondents and congested 30% of respondents, by the public. An access management plan, based on principles detailed in Chapter 6, was recommended for this corridor is to improve mobility, increase safety and reduce congestion. Types of access management recommendations included modifications to the roadway cross section (shoulder improvements), reduction of median openings, realignment of the roadway, consolidation of driveways and access points, and improvements to turn lanes. Specific recommendations within the Route 224/SR 93 corridor are described throughout Section 7.3 as they are applied to each corridor study segment described hereafter.

Route 224/SR 93 was analyzed as both a 2-lane and 4-lane divided facility under 2035 forecasted future conditions. As expected, the results of the corridor analysis showed improvement when analyzed as a 4-lane divided facility compared to the existing 2-lane configuration. However, Route 224/SR 93 operated with acceptable LOS under the 2035 Build condition with 2 lanes, so widening the road to 4 lanes was not warranted. There were no proposed recommendations to modify the existing cross section on Route 224/SR 93, with the exception of segment between East Carters Valley Road and Bloomingdale Pike described in Section 7.3.5. Access management standards were applied corridor-wide based on the following recommendations:

- Shoulder paving improvements should be completed on both the east and west side of the Route 224 roadway from the intersection of US 58/US 421 south to the Virginia/Tennessee state line. The total length of this shoulder paving is approximately 3.2 miles. The purpose of this shoulder paving is to improve both safety and reduce congestion along the Route 224 corridor in Virginia. Paved shoulders provide a rebound area for drivers if they leave the travel lane. This improvement can prevent crashes for drivers, particularly in poor driving conditions such as snow, rain or fog. Additionally, a paved shoulder improves driver comfort and allows drivers to maintain the speed limit on roadways that are perceived as narrow or challenging to navigate. Finally, a paved shoulder may provide refuge for vehicles during a roadside emergency, which can improve safety and congestion during these incidents.
- Route 224 is a winding road with multiple locations that have short sight distance and sharp horizontal curves. Guardrail is missing, damaged or in poor condition in several areas throughout the Route 224 corridor. Guardrail is necessary in order to prevent vehicles from exiting the roadway in the event of a crash or loss of vehicular control. Guardrail replacement, as well as the installation of guardrail end treatments, was recommended along Route 224 from its intersection with US 58/US 421 south to the Virginia/Tennessee state line. The replacement of damaged guardrail would total 6.4 miles with approximately 54 new guardrail end treatments.

In the event that traffic volumes exceed the forecasted growth potential analyzed in this study, a 4-lane, divided facility with a median would be justified. If Route 224 does become a 4-lane divided facility, median openings should be installed in accordance with current VDOT standards. Design has not been performed for this 4-lane roadway scenario; however, the potential locations of median openings were determined. This information is summarized in Table 7-2, which also includes the average spacing between median openings under existing and proposed conditions.

Table 7-2: Access Management – Proposed Median Openings along Route 224/SR 93 Under a 4-lane Roadway Scenario

Road Segment	Number of Openings	Average Spacing (in Feet)
Between US 23 and US 58/US 421	2	680
Between US 58/US 421 and North Fork Holston River	6	1,230
Between North Fork Holston River and East Carters Valley Road	3	1,775
Between East Carters Valley Road and Chadwell Road	5	1,095
Between Chadwell Road and Bloomingdale Pike	5	1,060
TOTAL	21	1,185

7.3.2. Route 224 – US 23 to US 58/US 421

An additional lane was recommended on southbound Route 224 between US 23 and Skyline Drive/Whispering Hills Circle. The purpose of this lane is to serve as an additional receiving lane for the dual southbound left-turn lanes from US 23. Currently, the inside left-turn lane is received by a left-turn lane into the VDOT area headquarters just east of the existing bridge between US 23 and US 58/US 421. The inside-left turn lane is largely underutilized due to the current lane configuration on this approach, thereby causing congestion issues at the intersection of US 23 and Route 224.

The proposed lane would continue on Route 224 through the existing US 58/US 421 intersection and would terminate as a right-turn lane at Skyline Drive/Whispering Hills Circle. The length of this lane addition is approximately 0.5 miles. This lane addition is not anticipated to impact the exclusive left-turn lane onto US 58/US 421.

Figure 7-1 illustrates the recommended improvements.

7.3.3. Route 224 – US 58/US 421 to North Fork Holston River

Skyline Drive and Emerald Valley Circle both tee into Route 224 from the west. Skyline Drive intersects Route 224 directly across from Whispering Circle, and Emerald Valley Circle intersects Route 224 approximately 400 feet south of the Skyline Drive/Whispering Circle intersection. The intersection of Route 224 and Emerald Valley Circle should be removed and Emerald Valley Circle should be relocated to intersect Skyline Drive. This improvement would consolidate access points along Route 224. Emerald Valley Circle also intersects Route 224 approximately 4,300 feet to the south, which provides an alternative access to

Route 224. This improvement, although recommended assuming Route 224 remains a 2-lane facility, becomes more critical if Route 224 is ultimately widened to a 4 lanes.

Figure 7-4 illustrates the recommended improvements.

7.3.4. Route 224 – North Fork Holston River to East Carters Valley Road

The current cross section on Route 224 is two-lane, undivided roadway with an unpaved shoulder. There is a horizontal curve with a crash history just to the south of the North Fork Holston River bridge, especially in the northbound direction. Resident complaints and feedback were received pertaining to the necessity for a wider roadway and improved horizontal curve radius at this location during the public information meetings. The realignment of this curve should improve safety on the corridor, since it will improve sight distance. The radius of this horizontal curve should be increased to improve driver comfort and safety. The section of roadway this project would encompass is 0.21 miles in length.

Additionally, Cliffview Lane intersects Route 224 in the middle of this horizontal curve. This access should be closed, and the northern terminus of Cliffview Lane should be extended to intersect Route 224 just south of the North Fork Holston River bridge crossing. This location would provide better sight distance and would align directly across from a private driveway.

Figure 7-4 illustrates the recommended improvements.

7.3.4.1. Spot Improvement - Route 224 at East Carters Valley Road (Route 704)

- Public perception is that this intersection has many traffic congestion and safety concerns. The crash data showed there is a higher frequency of crashes when compared to other intersections in the vicinity. Regarding traffic congestion, the projected future traffic volumes do not satisfy the MUTCD warrants for installation of a traffic signal. As an alternative to the installation of a traffic signal at this intersection, since the VDOT-approved traffic signal warrants were not met, an overhead flashing beacon was recommended to improve intersection visibility. The northbound and southbound Route 224 approaches should be controlled by a flashing yellow beacon, and the eastbound and westbound East Carters Valley Road approaches should be controlled by a flashing red beacon. This type of traffic control would maintain the existing free-flow movements on Route 224 and stop-controlled movements on East Carters Valley Road. For East Carters Valley Road, this improvement would serve as a supplement to the existing stop signs (R1-1) currently in place. The flashing beacon should be able to be upgraded to a traffic signal should future traffic volumes warrant this modification.
- While traveling northbound along Route 224, vehicles travel downhill through the intersection of East Carters Valley Road. At this same intersection, a horizontal curve to the left transitions into a tangent segment. There is superelevation present that slopes towards the opposing southbound travel lane. This superelevation may cause northbound motorists to encroach upon the southbound left-turn lane. Additionally, there is a small shoulder and guardrail on the eastern side of the northbound receiving lane (i.e., the northeast quadrant). These shoulder characteristics create a narrowing effect on the travel way and may cause vehicles to drive closer to the double yellow centerline (as opposed to closer to the white edge of pavement line). The following improvements were recommended with the objective of improving intersection safety.
  - Install overhead lighting at the intersection – This will enhance driver visibility for vehicles on Route 224 and East Carters Valley Road approaching the intersection.
  - Widen the northbound shoulder – This will provide a larger shoulder that may increase driver tendencies to drive further away from the double yellow centerline and closer to the white edge of pavement line.
  - Install a gore area between the northbound receiving lane and the southbound left-turn lane – This could be accomplished with 2-4 feet of either a striped island or a raised concrete median, replacing the double yellow centerline throughout the intersection.
  - Widen the northbound receiving lane – This will provide a larger travel lane that may increase drivers' comfort level while driving through the intersection.
  - Increasing the distance between opposing vehicles may improve overall intersection safety considering the geometric roadway features described above.
  - Install snow-plowable pavement markings on the double yellow center line – This will delineate northbound and southbound traffic flows, and should be considered in the vicinity of this intersection.
  - Extend the southbound Route 224 left-turn lane taper length to 200 feet to satisfy current VDOT standards. Furthermore, extend the northbound Route 224 left-turn lane to have 200 feet of storage and 200 feet of taper to satisfy current VDOT standards.

Figure 7-5 illustrates the recommended improvements at this intersection.

7.3.5. Route 224/SR 93 – East Carters Valley Road to Bloomingdale Pike

Route 224 is a 2-lane, undivided facility from East Carters Valley Road to the Virginia/Tennessee state line, while SR 93 is a 4-lane undivided facility from the Virginia/Tennessee state line to Bloomingdale Pike with several residential driveway access points. Undivided multi-lane segments, such as SR 93, require left-turn movements to occur in the inside through lane since no refuge (median or two-way left-turn lane) is provided for turning movements and are safety hazards. Therefore, this section of SR 93 was recommended to be widened to a 5-lane facility with a center two-way, left-turn lane (approximate length of 1.25 miles). The objective of this improvement was to improve safety and access for multiple residential driveways.

There were no proposed cross section improvements recommended for Route 224 under the current geometric conditions. However, should Route 224 be upgraded in the future to a 4-lane divided facility (as discussed in Section 7.3.1), Route 224 should be widened to a 5-lane facility with a center two-way left-turn lane from East Carters Valley Road to the Virginia/Tennessee state line. This improvement would provide continuity in this section of roadway with the proposed cross section for SR 93 and would improve safety and access for multiple residential and commercial driveways.

Figure 7-6 illustrates the recommended improvements.

7.3.5.1. Spot Improvement – SR 93 at Bloomingdale Pike

- All four right-turn movements are channelized with striped gore areas, with some having a small area of raised concrete that has been damaged or crushed. These channelized areas should be removed and all four right-turn

lanes should be extended to the intersection. By removing the channelizing islands on each approach, intersection safety would be improved, since the potential for rear-end and sideswipe crashes would be reduced.

- Improve pedestrian accessibility at the intersection with the construction of new crosswalks, ADA ramps, pedestrian signal heads, and pedestrian push buttons.
- Convert the medians on the northbound and southbound SR 93 approaches to a raised concrete median with streetscape features. These median segments provide ideal locations for "gateway" features including gateway signage and/or landscaping to introduce motorists into Tennessee and/or the City of Kingsport.
- Extend the southbound Route 224 left-turn lane to provide 200 feet of storage and 180 feet of taper to satisfy current TDOT guidelines.

Figure 7-6 illustrates the recommended improvements at this intersection.

7.4. Route 224 at US 58/US 421

The current long-range plan for the existing unsignalized intersection of Route 224 and US 58/US 421 (Bristol Highway) is a cloverleaf interchange based on the results of a 1988 study commissioned by VDOT for the Gate City area of Scott County. This study recommended a series of improvements including the extension of Route 224 to the intersection of Route 71 and Route 72 to the northeast of Gate City (referred to as the "Wadlow Gap Road Extension"), a connection to US 23 north of the railroad overpass from the extension, and a new interchange at the intersection of Route 224 and US 58/US 421. This "bypass" of Gate City would serve to provide an eastern route for traffic originating north and east of Gate City to travel to and from Kingsport, TN.

Since the ultimate plan for US 58/US 421 is an economic development corridor with a four-lane, divided cross section, the 1988 traffic study was updated in 1998 by VDOT. Three intersection configurations were developed and analyzed in the 1998 study, including a traffic signal, a diamond interchange, and a cloverleaf interchange. Compared to an at-grade intersection, the proposed cloverleaf interchange would require a much larger footprint, a significantly larger cost, and more time for construction. For comparison purposes, the estimated construction cost for a two-lane roundabout in a rural condition is approximately $2,500,000, whereas the construction cost for a new grade-separated interchange in the same conditions is approximately $55,000,000. The construction cost for the interchange is over 22 times the construction cost for the roundabout.

The consultant team conducted a level of service analyses to examine possible alternatives to the current long-range plan of a cloverleaf interchange at this intersection. The 2035 traffic volumes did not warrant further analysis of the cloverleaf interchange; however, the alternatives considered included a diamond interchange, a single-point urban interchange (SPUI), a single-lane roundabout, a multi-lane roundabout, and an at-grade signalized intersection. Capacity analyses for the Build 2035 condition were conducted for each of these five alternatives. Table 7-3 provides a summary of the intersection LOS, delay (in seconds per vehicle), and volume-to-capacity ratios during the AM and PM peak hours for each of the five alternatives.

Following this traffic analysis, the single-lane roundabout and at-grade signalized intersection options were chosen for additional consideration since the marginal benefit of grade separation did not outweigh the cost differentials. Future traffic volume figures for each of these alternatives can be found in Appendix F.

Table 7-3: Level of Service - Alternatives to Cloverleaf Interchange, Build 2035

Type of Junction	AM Peak Hour		PM Peak Hour	
	LOS (Delay – Sec/Veh)	V/C	LOS (Delay – Sec/Veh)	V/C
Grade-Separated Diamond Interchange	B (18.8)	0.21	B (19.7)	0.23
Grade-Separated Single-Point Urban Interchange	C (30.1)	0.17	C (27.8)	0.19
At-Grade Single-Lane Roundabout	B (14.1)	0.62	B (14.5)	0.74
At-Grade Multi-Lane Roundabout	B (11.5)	0.30	B (12.1)	0.35
At-Grade Signalized Intersection	C (28.6)	0.40	C (25.6)	0.45

NOTE: v/c = volume-to-capacity ratio

The single-lane roundabout alternative was chosen as the preferred alternative since the results showed that it could accommodate future growth. The design should include geometry that can be easily modified to a multi-lane roundabout if or when future traffic volumes warrant this change. This alternative is also appealing due to its ability to integrate streetscape elements and aesthetics within the roundabout. The proposed roundabout should include a right-turn slip lane for vehicles making a northbound right-turn movement from Route 224 to US 58/US 421, which would provide free-flow access for traffic making this movement. Additional benefits of a roundabout include reducing the frequency and severity of crashes, reducing traffic delays and stops, slowing excessive speeds, and reducing long-term operational costs.

The other alternative considered was an at-grade signalized intersection. This alternative was analyzed based on cost and the smaller footprint that would be necessary to implement this alternative. The proposed signalized intersection would be designed to accommodate traffic beyond the projected future traffic volumes. The purpose of designing beyond the projected future traffic volumes is to avoid congestion if growth occurs beyond the projected levels.

In the near term, it was recommended that a northbound right-turn lane be constructed on Route 224 with 200 feet of storage and 200 feet of taper. The proposed turn lane would improve congestion through this intersection as vehicles would no longer be forced to stop or slow down for right-turning vehicles ahead of them on the road. Rear-end crashes may also be reduced at this location since slowing vehicles will have their own turn lane.

Figure 7-1 illustrates the recommended improvements.

7.5. Conclusions and Cost Summary

Recommendations described previously in the chapter take into consideration field observations, results of the project analyses, and input received during public outreach efforts. These recommendations are intended to enhance the safety and integrity of the existing transportation infrastructure while providing for the continued growth and economic development of the study area region. Many of the improvements can be implemented within a one-year period using federal safety improvement funds or annual maintenance funds. Other improvements would require programming into the VDOT Six-Year Improvement Program for additional planning, engineering, design and construction for future implementation.

Planning level cost estimates were developed to provide VDOT, Kingsport MPO and LENOWISCO MPO a tool for programming prioritizing future improvements in the corridor to meet the needs of the growing region. Planning level costs were included for an optional widening project on Route 224/SR 93 from a 2-lane to 4-lane facility should future growth require additional capacity to achieve desirable levels of service. Table 7-4 contains the planning level cost summary for both corridors in the study area.

Table 7-4: Planning Level Cost Summary

Improvement Section	Planning Level Cost
US 23 Improvements	$43,800,000
Route 224/SR 93 Improvements (as a 2-lane section)	$10,500,000
Route 224/SR 93 Widening (as a 4-lane divided section)	$45,400,000
Route 224 and US 58/US 421 Single-Lane Roundabout	$1,600,000
Route 224 and US 58/US 421 Two-Lane Roundabout	$3,100,000

Costs in Table 7-4 are based on the guidelines in the VDOT Transportation and Mobility Planning Division's Statewide Planning Level Cost Estimates worksheet, dated January 2009. Typical section unit costs include 25% for PE and construction contingencies. The typical section unit costs do not include bridge, right-of-way (ROW) or other improvement costs. These estimates are preliminary and are not based on design. The unit costs used to compute the planning level construction costs were based on an understanding of local conditions. A full summary of planning level costs can be found in Appendix H.

8. PUBLIC INVOLVEMENT

One of the critical aspects of the planning process for this study was the involvement of the public. Input was obtained from residents in the area and other interested persons through the use of an on-line survey and two public information workshops that were held in the corridor. A Public Participation Plan (PPP) (included in Appendix I for reference), based on Kingsport MPO requirements, was created in an effort to maximize the feedback that was received from diverse stakeholders, so that the evaluation of these vital suburban/rural corridors included multi-jurisdictional, urban and suburban representatives. In addition, voices from a variety of modal users were sought to share their comments. Most important to the success of the planning effort are the diverse segments of the population becoming involved with the project. Outreach emphasis was placed on low-income, minority, elderly, disabled, low-literacy, limited English proficiency and non-English speaking individuals, human service groups, and the organizations that advocate and/or provide services on behalf of these traditionally under-represented community members.

The PPP was developed to establish a plan to educate, inform, and involve the public, businesses, localities, and agencies. Generally, the PPP provided guidance on gathering input as identified in the Kingsport Urbanized Area MPO PPP Guidelines.

- Gather input from residents in the area, public agencies, representatives from public transportation companies, freight shippers, providers of freight transportation services, and private providers of transportation, representatives public transportation, pedestrian walkways and bicycle transportation facilities, representatives of the disabled, and other interested persons/parties.
- Gather input from the Kingsport MPO Board and from local, elected officials and planning commissioners of the affected jurisdictions.
- Gather input from other stakeholders such as property owners along the corridor, business associations, and advocacy groups.

The PPP was developed with the following goals in mind:

- To provide public education on the planning process
- To inform and educate community groups, businesses, stakeholders, local, state and federal agencies, and the public about the study, its objectives, and anticipated outcomes
- To encourage and gather input in a formal setting from the above-mentioned individuals, groups, and agencies regarding the alternatives, the issues to be studied, and the results of the process used to develop and refine alternatives

Techniques used to obtain and develop public input included questionnaires (hard copy and internet-based formats), various mapping and visual preference survey exercises made available at public workshops, and the project website as shown in Exhibit 8-1 (www.Route23-224Corridor.com). The objectives of these activities were to gather feedback from the public and to identify:

- Areas of deficiency
- Locations where they would use walking and bicycling facilities
- Visual preference of the overall character of the corridor, pedestrian environment, and multimodal accommodations
- Any other traffic, transit or rideshare, bicycle, pedestrian, land use, or corridor character comments

Exhibit 8-1: Project Website Screen Shot (www.Route23-224Corridor.com)

Results from the public involvement process are included in Appendix I.

A summary of the public outreach efforts that were conducted for this study:

- Public Meeting #1: Project Introduction and Existing Conditions
  - Approximately 50 individuals attended the first public meeting at Gate City High School in Gate City, Virginia on August 19, 2010
- Public Meeting #2: Review of Preferred Concepts and the Draft Final Plan
  - Approximately 75 individuals attended the second public meeting at Gate City High School in Gate City, Virginia on January 18, 2011

Public Meeting #1

8.1 Summary of the Public Feedback from Public Meeting #1

The first public meeting was held in Gate City, Virginia at Gate City High School on August 19, 2010, and was attended by approximately 50 individuals. The meeting was advertised in three local newspapers several weeks in advance of the meeting. Meeting attendees received a questionnaire, a copy of which is included in Appendix I, with questions to answer about their experiences in the corridor with respect to traffic, pedestrian issues, bicycle issues, transit, and overall character of the corridor.

In addition, this survey was also placed on the project website (www.route23-224corridor.com) in a format that could be filled in on-line. This survey should be considered a random sample of the public opinion; therefore, no statistical significance can be concluded from its results. However, the survey does reflect opinions and responses from interested citizens in the area.

A summary of the respondents is shown in Exhibit 8-Exhibit 8-2. The largest number of individuals (8) classified themselves as residents in the corridor, followed by property owners (6), commuters through the corridor (4), business owners in the corridor (3), and employees in the corridor (1).

Fifty percent (50%) of the respondents identified both US 23 and Route 224 as their primary concern, followed by US 23 only (8%) and Route 224 only (42%), as shown in Exhibit 8-3. Most respondents identified left- and right-turn lanes along with through lanes as appropriate treatments to reduce traffic congestion on US 23 and Route 224.

The current conditions for pedestrians were described as poor or very poor by 73% of the respondents, especially since sidewalks do not exist for a majority of the corridor (see Exhibit 8-4). Respondents indicated they would like to see a paved multi-use path or sidewalks, improved crosswalk markings, and a reduction in the number of driveways.

Eighty-two percent (82%) of the respondents stated that bicycling conditions on US 23 and Route 224 are either poor or very poor as shown in Exhibit 8-5. For on-street bicycle facilities, 75% of the respondents indicated they would like to see striped bike lanes to only 25% who favored a signed route only. No respondents indicated they preferred a wide bike-vehicle shared lane. For off-street bicycle facilities, 75% of the respondents also indicated they would like to see a multi-use path/trail (paved) to only 25% who favored a widened sidewalk. Seventy percent (70%) of the respondents stated transit/carpool/rideshare options would not improve travel conditions along Route 224 or US 23.

When discussing the character of the corridor, 91% of the survey respondents stated that the current appearance of the corridor was acceptable to excellent, with 9% stating that it was very poor (see Exhibit 8-6). Sixty percent (60%) of respondents identified user safety as the greatest concern for the future of the US 23 and Route 224 corridors, followed by traffic congestion (30%) and deteriorating conditions/blight (10%) (see Exhibit 8-7).

Citizens also participated in a review and survey of aerial photographs of the corridor to identify: (1) areas of congestion/safety concerns, and (2) desired areas for bicycle, pedestrian, and transit improvements. Route 224 just south of the river and at Carters Valley Road were most frequently listed as areas of congestion/safety concerns, while Route 224 between Carters Valley Road and the VA/TN state line was most frequently listed as a desired area for bicycle, pedestrian, and transit improvements (see Exhibit 8-8). US 23 at Jennings Street was most frequently listed as an area of congestion/safety concerns, while US 23 between the shopping center and Jennings Street was most frequently listed as a desired area for bicycle, pedestrian, and transit improvements (see Exhibit 8-9).

Input from the surveys has been carefully reviewed and analyzed. Much of the information that was received has helped the study team validate the empirical results with public feedback of operations and safety in the corridor.

Several goals emerged from the feedback received at the meeting including the following:

- Improve safety on both US 23 and Route 224
- Reduce speeds on Route 224, especially for heavy trucks
- Pedestrian and bicycle accessibility should be improved, especially on US 23
- Synchronize the traffic signals in Weber City

The vision described for the Route 224 corridor was for it to maintain its current rural character. For US 23, improving safety through access management was an important concept.

8.2 Summary of the Public Feedback from Public Meeting #2

The second public meeting was also held in Gate City, Virginia at Gate City High School on January 18, 2011 following public advertisements in three local newspapers several weeks in advance of the meeting. Meeting attendees received a questionnaire, a copy of which is included in Appendix I, with numerous questions to answer about the proposed improvement concepts for the corridors. In addition, this survey was also placed on the project website (www.route23-224corridor.com) in a format that could be filled in on-line. This survey should be considered a random sample; therefore, no statistical significance can be concluded from its results. However, the survey does reflect opinions and responses from interested and concerned citizens in the area.

This meeting was attended by over 70 citizens and media representatives from the local area. The summary of the five on-line respondents is shown in Exhibit 8-10. The largest number of individuals (3) classified themselves as residents in the corridor, followed by commuters through the corridor (1), and business owners in the corridor (1). None of the individuals who filled out the survey attended the first public meeting and three of the respondents were not in attendance at the second public meeting. The two individuals who attended the meeting stated that the material was complete, but stated that it was a lot of materials to hear in a short period of time. All of the respondents found out about Public Meeting #2 from the newspaper.

The location in the corridors that concerned the respondents most was the intersection of Route 224 at US 58/US 421 followed closely by the intersection of US 23 at E. Carters Valley Road and the intersection of US 23 at Route 224. One respondent mentioned the merits of investigating previous discussions about the US 23 Bypass around Weber and Gate cities.

Key conclusions from feedback received from meeting attendees and survey respondents pertain to both corridors. These conclusions were incorporated into the development of final alternatives for each corridor by the consultant team.

- Parking on US 23 in Weber City is a safety issue
- Signal timing improvements are needed on US 23 in Weber City
- Speeding on Route 224 is a safety issue, especially heavy trucks
- Route 224 should be three or four lanes in the future
- An alternate connection to US 23/US 58/US 421 from Route 224 north of the railroad overpass is needed
- A right-turn lane on northbound Route 224 at US 58/US 421 is needed

Exhibit 8-2: Interest in the Corridor – Public Meeting #1

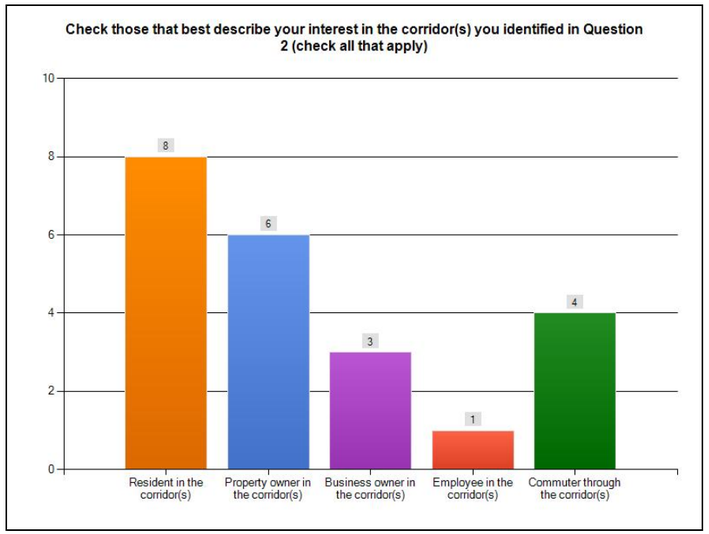


Exhibit 8-3: Corridor of Primary Concern – Public Meeting #1

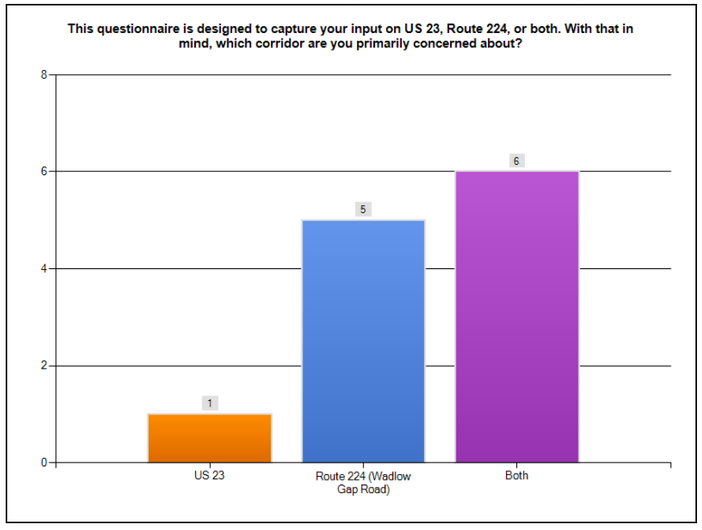


Exhibit 8-4: Current Conditions for Pedestrians along US 23 and Route 224 – Public Meeting #1

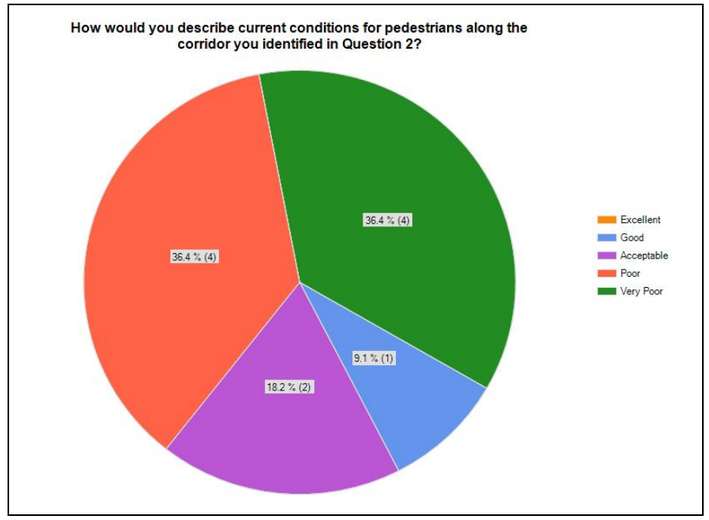


Exhibit 8-5: Current Conditions for Bicyclists along US 23 and Route 224 – Public Meeting #1

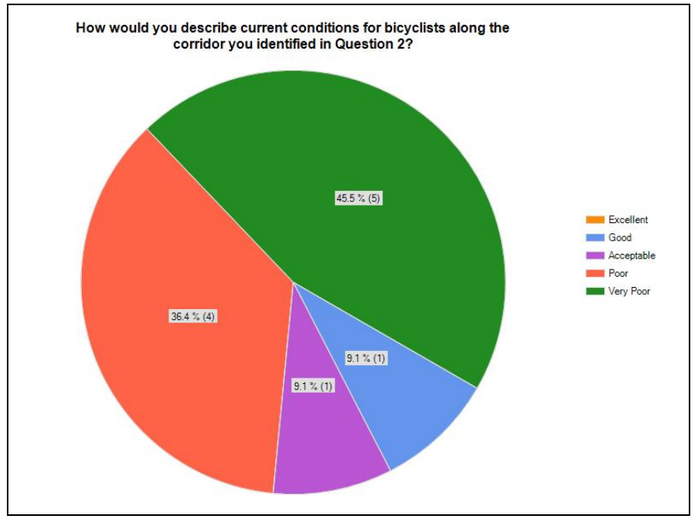


Exhibit 8-6: Current Appearance of US 23 and Route 224 – Public Meeting #1

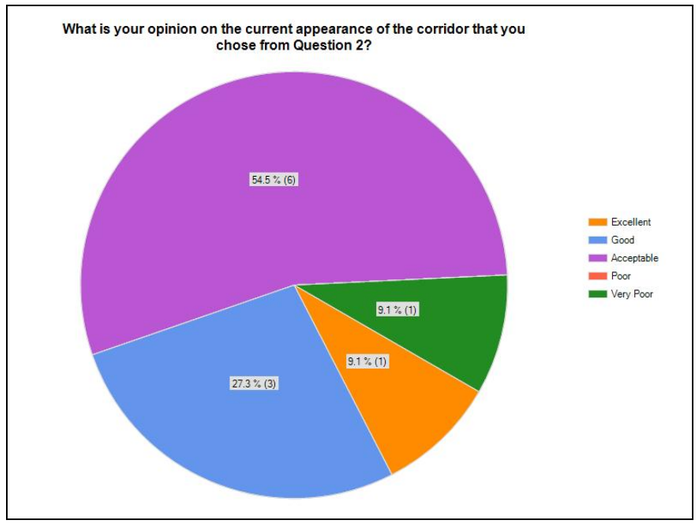


Exhibit 8-7: Greatest Concern for the Future of the US 23 and Route 224 Corridors – Public Meeting #1

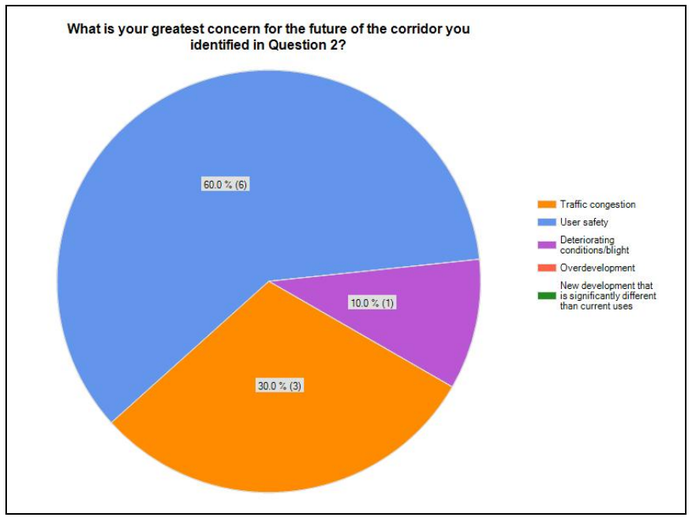


Exhibit 8-8: Route 224 Aerial Survey Results – Public Meeting #1

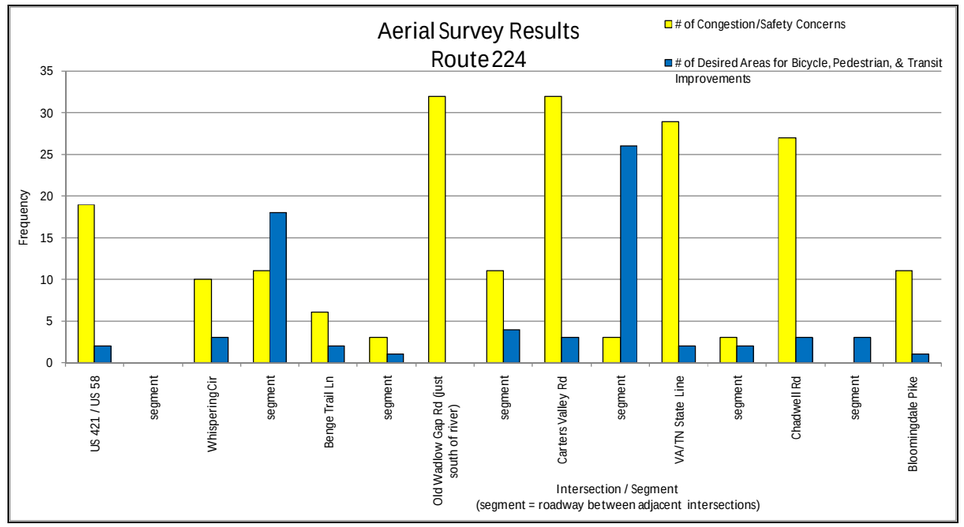


Exhibit 8-9: US 23 Aerial Survey Results – Public Meeting #1

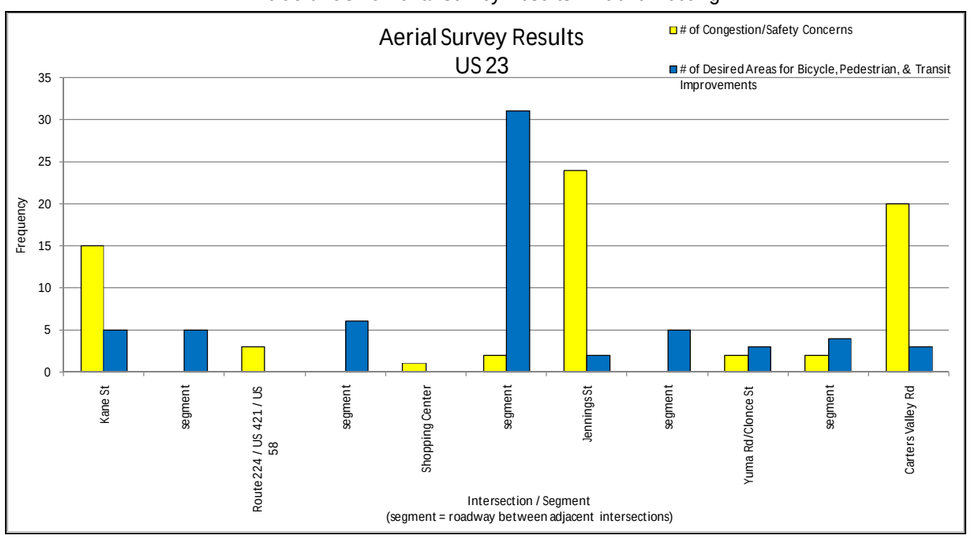
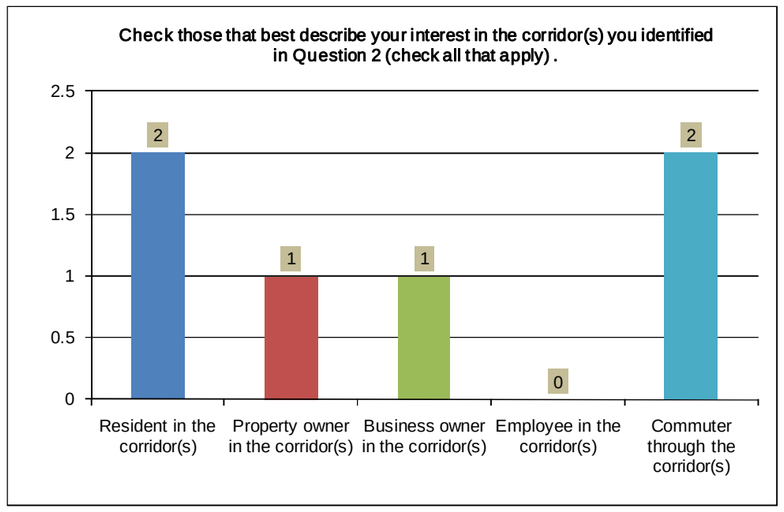


Exhibit 8-10: US 23 Aerial Survey Results – Public Meeting #2



Kingsport
TENNESSEE